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A Visual Analysis of Bibliometric Research in the Field of Scoliosis over the Last Three Years Based on VOS Viewer

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Abstract: *In a comprehensive analysis of scoliosis research conducted over the last three years, the study aims to map out the trajectory of research in this field, inform future studies, enhance clinical treatment efficacy, and stimulate technological advancements. Drawn from the Science Citation Index Expanded (SCI-E) via Web of Science and employing VOS viewer software, the research has scrutinized publication volumes, institutional contributions, key terms, and authorship, culminating in a visual representation of the data. The study encompassed 3,142 English-language articles, revealing an upward trend in scholarly output. Prominent institutions contributing to scoliosis research include the University of California, Johns Hopkins University, University of California San Francisco, Hospital for Special Surgery in New York, and Capital Medical University, with the "European Spine Journal" topping in article publication. The study's keyword analysis indicates that adolescent idiopathic scoliosis and adult spinal deformity are the central research focuses, with a spotlight on adolescent idiopathic scoliosis (AIS), adult spinal deformities (ASD), and surgical interventions as the current research hotspots. The field is in a phase of steady growth, with a projected increase in scoliosis-related publications. Over the past three years, China has emerged as the leading country in terms of publication volume. The research is particularly concentrated on surgical techniques, treatment outcomes, AIS, and ASD.*

Keywords: *Scoliosis; Adolescent Idiopathic Scoliosis; Bibliometrics; Visualization Analysis*

1. Introduction

Scoliosis is an abnormal curvature of the spine, characterized by anomalies in the coronal, sagittal, and axial sequences, which is a three-dimensional deformity involving both the spine and the ribs. The Scoliosis Research Society (SRS) defines scoliosis as a spinal curvature measured on a standing anteroposterior radiograph using Cobb's method with an angle greater than 10°[1,2]. Scoliosis is primarily divided into non-structural scoliosis and structural scoliosis. Non-structural scoliosis refers to a temporary lateral curvature caused by certain factors, which can return to normal once the cause is removed. Structural scoliosis, on the other hand, is the true scoliosis and is classified etiologically into idiopathic scoliosis and other types of scoliosis. Idiopathic scoliosis has an unknown cause and is the most common type of scoliosis in children and adolescents, accounting for approximately 75–80%, with a predominance in adolescent girls. Idiopathic scoliosis is further classified by age into: infantile type: 0–3 years; juvenile type: 4–9 years; and adolescent type: 10–18 years. The adolescent type of idiopathic scoliosis is the most common, representing about 70–90% of idiopathic scoliosis cases[2].

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2. Materials and Methods

2.1 Data Acquisition

The bibliometric analysis was conducted using the Science Citation Index Expanded (SCI-E) from the Web of Science (WoS), which is considered the optimal database for bibliometric studies. A search was conducted in the database for all publications from January 1, 2022, to October 28, 2024. The search criteria for this study were: Topic = scoliosis AND Publication Year = (2022-01-01 to 2024-10-28) AND Language = (English) AND Document Type = (Article or Review). A total of 3,142 papers were retrieved. Full records of each publication, including title, publication year, author names, nationality, affiliations, journal names, keywords, and abstracts, were downloaded from the WoS database and imported into Microsoft Excel 2017 in TXT file format.

2.2 Data Processing

Excel software was used to record, sort, and filter the overall output, literature time distribution characteristics and trends, and citation frequencies of the referenced literature. VOS viewer software was employed for the visualization analysis of the aforementioned literature data, conducting visualization analysis on various node types such as authors, institutions, and keywords, and mapping the corresponding knowledge graphs to uncover research hotspots and directions in scoliosis. The author of this article selected and extracted data items and datasets, then manually cleaned and analyzed the data in Microsoft Excel 2017.

2.3 Bibliometric Analysis

Bibliometric analysis is a research method that uses mathematical and statistical tools to conduct quantitative research on data within literature. This method quantifies different components of literature (e.g., authors, keywords, cited references, and citations) to reveal the trends in scientific inquiry, concentrated research areas, and patterns of scientific collaboration. This paper utilized the inherent functions of WoS to describe the basic characteristics of the aforementioned eligible publications.

2.4 Visualization Analysis

Visualization analysis was conducted using VOS viewer (Leiden University, Leiden, Netherlands) to visualize the publications. In this study, VOS viewer was utilized for bibliographic coupling, co-authorship, co-citation, and co-occurrence analysis.

3. Results

3.1 Publication Output

3.1.1 Publication Trend

From 2022 to 2024, a total of 3,142 articles that met the search criteria were published globally. Considering the timing of the search, it is estimated that the publication volume for the year 2024 should be on par with the previous two years. This indicates that the number of publications has been relatively consistent over the past three years, and the field of scoliosis research is currently in a period of stable peak following a surge in research activity(see Figure 1a).

3.1.2 Country Contribution

A total of 95 countries and regions have conducted research in this field. Among these, China published the highest number of articles with 884 (28.135%), followed by the United States with 841 (26.766%), Japan with 216 (6.875%), Canada with 187 (5.952%), and Italy with 187 (5.952%)(see Figure 1b).

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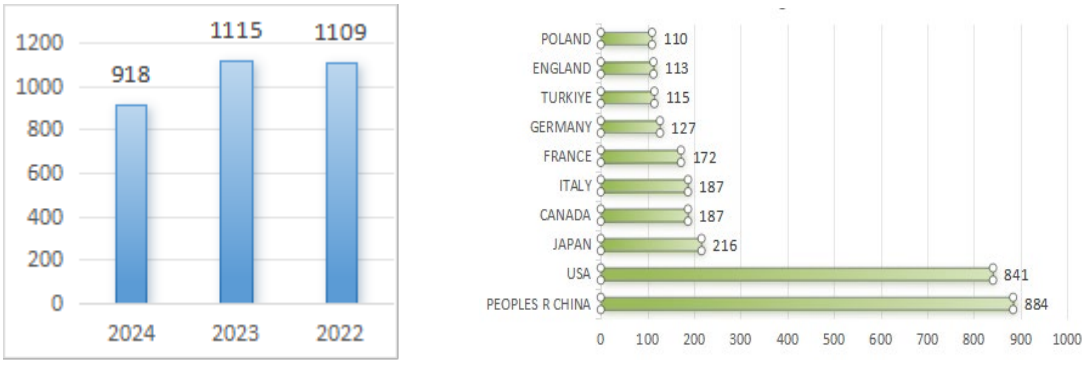

(1a) *(1b)*

Figure 1: 1a: Global publication output related to scoliosis from 2022 to the search date in 2024; 1b: Publication output from different countries related to scoliosis.

3.2 Quality of Publications from Different Countries

Utilizing VOS viewer for the analysis of the total citation frequency of the selected literature, it was found that in the research on scoliosis over the past three years, papers from the United States had the highest citation frequency (2,321 times). China ranked second in total citation frequency (1,867 times), followed by Italy (639 times), France (503 times), and Germany (498 times) (see Figure 2a).

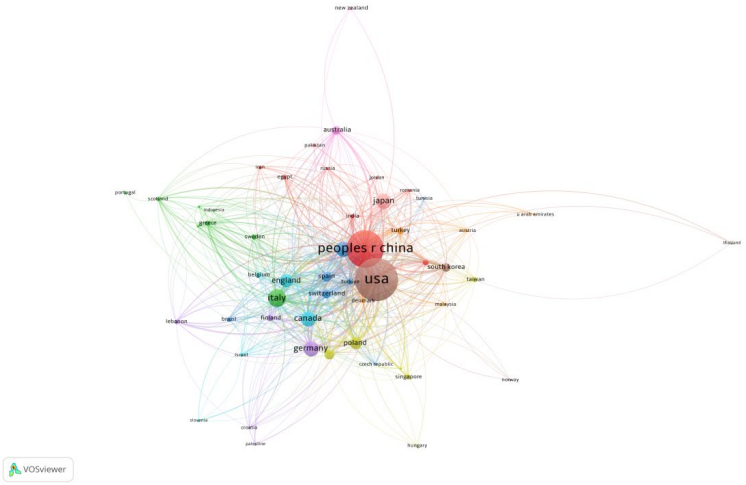

Figure 2a: A schematic diagram showing the connection strength of total citation frequencies of scoliosis research by different countries.

3.3 Global Publication Analysis

3.3.1 Journal Analysis

The "European Spine Journal" (Impact Factor IF of 3.1 in 2023) published a total of 238 research articles on scoliosis. The "Journal of Pediatric Orthopaedics" (Impact Factor IF of 1.8 in 2023) included 147 related articles. The "Journal of Spinal Disorders Techniques" published 128 studies. Meanwhile, "Spine" (Impact Factor IF of 3.3 in 2023) contained 136 research papers on scoliosis. Figure 3a illustrates the distribution of the top 10 journals publishing the most scoliosis research.

3.3.2 Research Directions

Figure 3b shows the distribution of research directions in scoliosis-related literature. The most popular research fields are orthopedics, neuroscience, surgery, pediatrics, and general internal medicine.

3.3.3 Institutional Output

Figure 3c presents the top 10 institutions with the highest number of published scoliosis research

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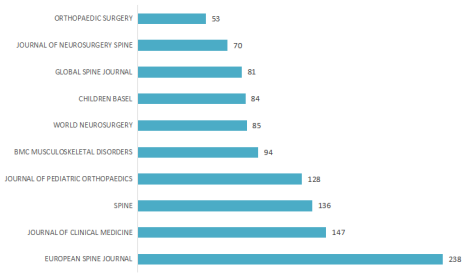
papers. The University of California tops the list with 139 publications; Johns Hopkins University ranks second with 102 papers; the University of California, San Francisco, comes in third with 97 publications; the Hospital for Special Surgery in New York is in fourth place with 63 publications; and Capital Medical University is fifth with 91 publications.

3.3.4 Funding Sources

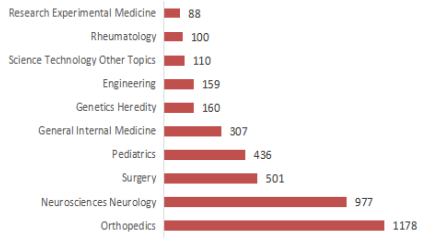
As shown in Figure 3d, it displays the top 10 funding agencies supporting the research field, with a total of 1290 studies funded. Among these funding agencies, the National Natural Science Foundation of China (NSFC) leads with 231 funded projects; the U.S. Department of Health and Human Services is in second place with 76 funded projects; the National Institutes of Health and Medtronic, a U.S. company, both rank third with 40 funded projects each; and the Japan Society for the Promotion of Science is in fourth place with 37 funded projects.

3.3.5 Authors

The top 10 authors published a total of 525 papers, accounting for 16.709% of all papers in the field (see Figure 3e). The three authors with the most publications in the scoliosis field are Smith Justin S. (61 papers), followed by Lafage Virginie (60 papers) and Lafage Renaud (58 papers).



(3a)



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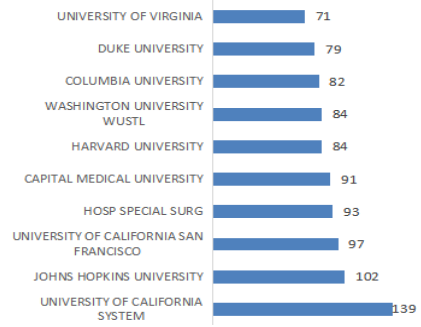

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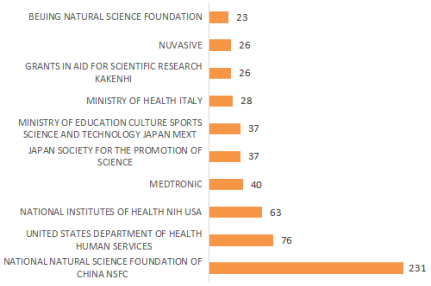

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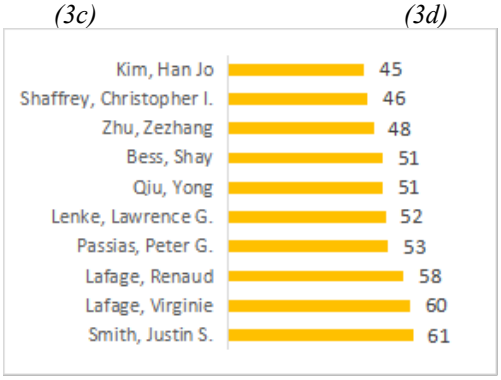

(3e)

Figure 3: 3a: The number of articles published in various journals related to scoliosis; 3b: The number of articles published in different research directions related to scoliosis; 3c: The number of articles published by different institutions related to scoliosis; 3d: The number of projects supported by different funding sources in the field of scoliosis; 3e: The number of articles published by the most prolific authors in the field of scoliosis.

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3.4 Bibliographic Coupling Analysis

Bibliographic coupling is a method that uses citation analysis to establish similarities between documents. VOS viewer was utilized to analyze journal names among the total publications.

3.4.1 Journals

As shown in Figure 4a, a total of 109 identified journals appeared in the overall link strength (defined as a minimum number of publications of more than 5 for a magazine). The top 5 journals in terms of total link strength are, in order: European Spine Journal (total link strength = 56,173 times), Journal of Spinal Disorders & Techniques (total link strength = 43,044 times), Spine (total link strength = 35,801 times), Children (total link strength = 26,806 times), and Global Spine Journal (total link strength = 22,470 times).

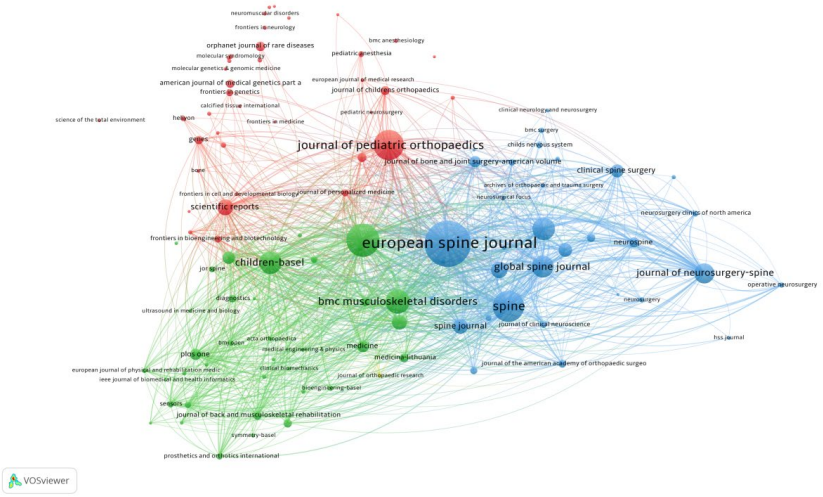

Figure 4a: Schematic diagram of journal link strength for the 109 identified scoliosis related fields

3.4.2 Institutions

Utilizing VOS viewer, an analysis was conducted on the publications identified from 92 institutions (defined as an organization with more than 15 minimum publications). The top five institutions in terms of total link strength are as follows: University of California, San Francisco (total link strength = 93,543 times), University of Virginia (total link strength = 90,676 times), Hospital for Special Surgery in New York (total link strength = 90,030 times), Duke University (total link strength = 89,391 times), and Washington University in St. Louis (total link strength = 83,153 times).

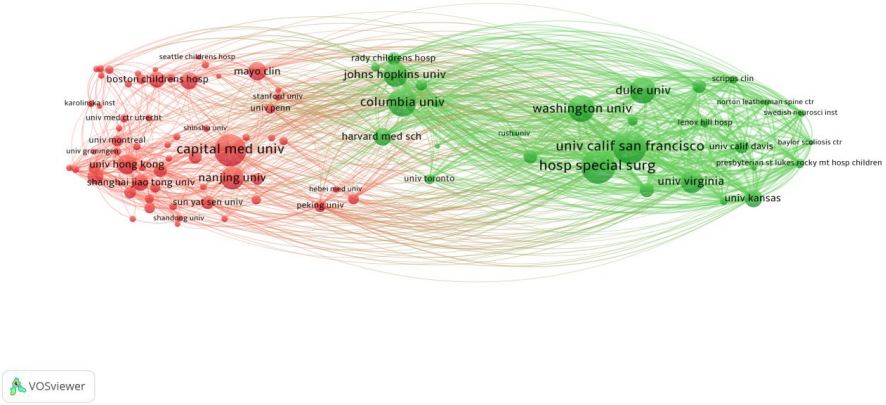

Figure 4b: Link Strength Diagram of 92 Institutions in the Field of Scoliosis-Related Research

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3.4.3 Countries

VOS viewer was employed to analyze the publications identified from 45 countries (defined as a country with more than 10 minimum publications). The top five countries in terms of total link strength are, in order: China (total link strength = 237,636 times), the United States (total link strength = 226,032 times), Canada (total link strength = 89,128 times), Italy (total link strength = 81,957 times), and Japan (total link strength = 72,984 times).

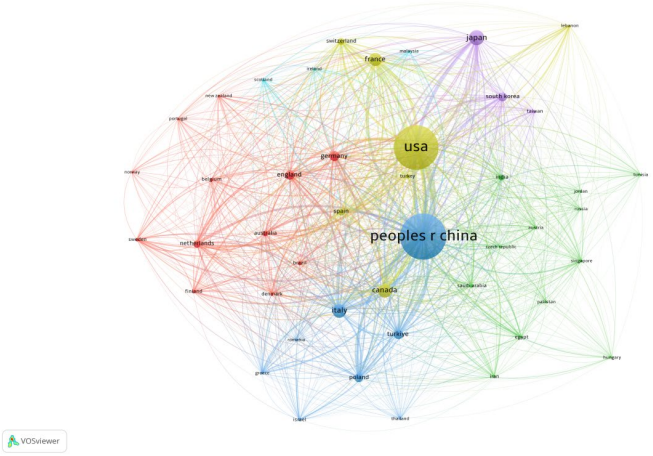

Figure 4c: Link Strength Diagram of 45 Countries in the Field of Scoliosis-Related Research

3.5 Co-citation Analysis

3.5.1 Co-cited Documents Analysis

VOS viewer was utilized to analyze the reference literature of 3,142 documents, defining a document as having been cited more than 30 times as the minimum citation threshold (see Figure 5a), a total of 114 documents meeting the criteria were retrieved. The top five studies with the greatest total link strength are as follows: Weinstein SL, 2008, Lancet, v371, p1527, doi 10.1016/s0140-6736(08)60658-3 (total link strength = 1,334 times) [3]; Negrini S, 2018, Scoliosis Spinal Dis, v13, doi 10.1186/s13013-017-0145-8 (total link strength = 1,162 times) [4]; Weinstein SL, 2013, New Engl J Med, v369, p1512, doi 10.1056/nejmoa1307337 (total link strength = 1,064 times) [5]; Konieczny MR, 2013, J Child Orthop, v7, p3, doi 10.1007/s11832-012-0457-4 (total link strength = 967 times) [6]; Schwab F, 2012, Spine, v37, p1077, doi 10.1097/brs.0b013e31823e15e2 (total link strength = 799 times) [7].

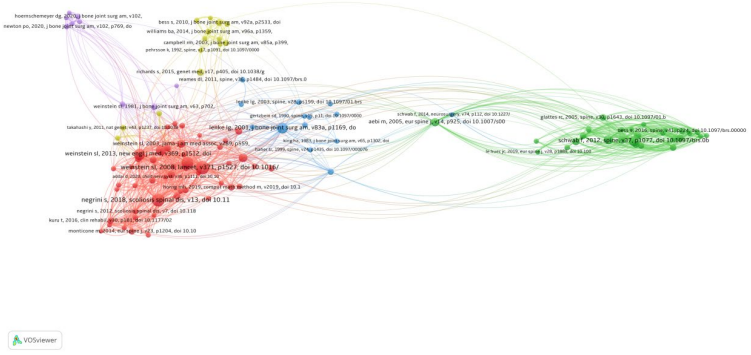

Figure 5a: Link Strength Diagram of Citation Frequency for 114 Articles in the Field of Scoliosis-Related Research

3.5.2 Journals

VOS viewer was used to analyze the journal names in the co-citation analysis (with the journal

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being defined as a source cited at least more than 100 times). As shown in Figure 5b, a total of 153 identified journals appeared in the overall link strength. The top five journals in terms of total link strength are, in order: Spine (total link strength = 336,559 times), European Spine Journal (Eur Spine J, total link strength = 172,959 times), The Journal of Bone & Joint Surgery, American Volume (J Bone Joint Surg Am, total link strength = 100,776 times), Spine Deform (total link strength = 82,014 times), and Spine Journal (total link strength = 72,564 times).

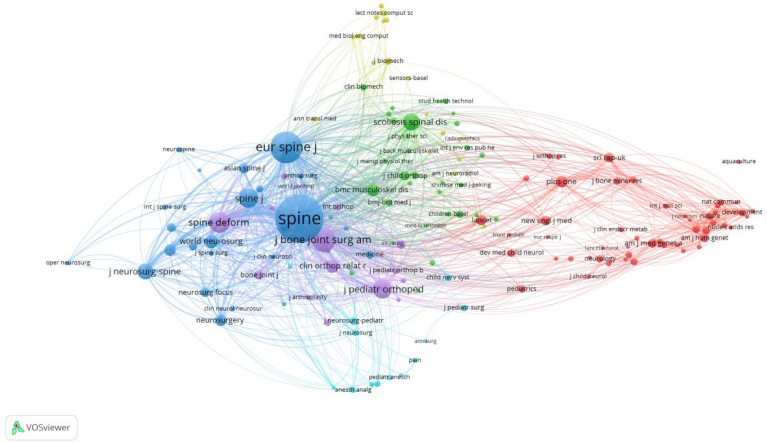

Figure 5b: Link Strength Diagram of Citation Frequency for 153 Journals in the Field of Scoliosis-Related Research

3.6 Co-occurrence Analysis of Keywords

Keywords are words chosen by authors to represent the core content of the article, and their frequency is often used to indicate the research heat of the field. In this paper, a co-occurrence network of keywords is constructed based on the co-occurrence relationship between keywords in the same literature. VOS viewer can calculate the centrality of each keyword in the network to determine the core keywords in the field, and then visualize clustering to generate a clustering map of research hotspots, thereby analyzing the research hotspots in the scoliosis field. Using VOS viewer, the keywords in related publications are colored coded according to clustering (see Figure 6a), where the color of an element represents its clustering, and different clusters are represented by different colors. The size of the nodes in the figure suggests the frequency of keyword appearance, while the thickness of the lines suggests the degree of closeness between keywords. After analyzing the results, it can be concluded that the high-frequency keywords related to scoliosis research mainly focus on the following four aspects: (1) classification of scoliosis; (2) surgical treatment methods and complications of scoliosis; (3) epidemiological investigation of scoliosis;(4) clinical manifestations of scoliosis.

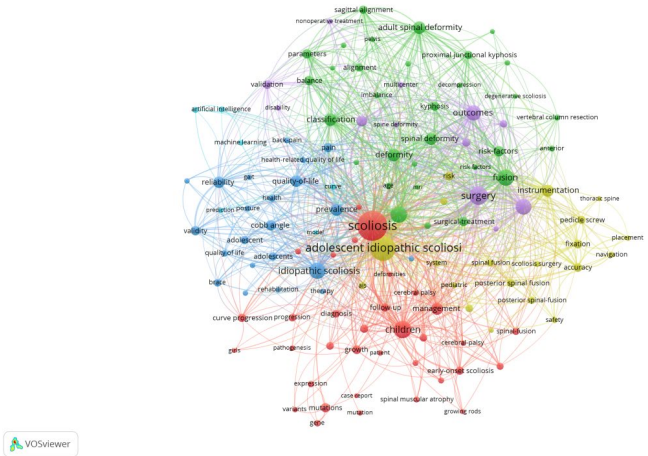

Figure 6a: A schematic diagram of the number of keywords in the literature in the field of scoliosis in the past three years

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4. Discussion

4.1 Current Status of Research in Scoliosis Field

Bibliometrics and visualization analysis can present the current status of a search field and predict future trends. Therefore, this study aims to evaluate the field of scoliosis, including contributing countries, institutions, funding bodies, and research focuses. In terms of the number of publications, the field of scoliosis has reached a publication volume of thousands of articles per year in recent years, which can reflect the development speed and level of a field to some extent. It is evident that research in the field of scoliosis continues to expand and deepen. Research interest in this field has increased dramatically over the past few years, with a total of 95 countries publishing related research in this field. The publication of these documents is mainly concentrated in China and the United States, which may be related to the economic prosperity of the aforementioned regions, high incidence rates, advanced medical equipment, and exquisite medical technology, as well as relatively higher scientific research standards of researchers. Core journals, as journals with higher professional standards and service quality in a discipline, play a role in promoting and guiding professional research development and are more likely to receive attention from scholars in the discipline. A total of 3,142 documents include 14,691 authors. According to Price's Law [8], authors who have published more than two articles are the core authors in this field, totaling 3,017 core authors. According to Lotka's Law [9], in a relatively mature research field, if there are more than 60% authors who have published one paper, it indicates that the distribution in the field is relatively even, the contribution of high-yield authors is relatively small, and a core group of authors has not yet formed. In this paper, authors who have published two articles only account for 20.536%, indicating that the field of scoliosis research has not yet formed a core group of authors globally, and there is a lack of cooperation between authors and regions worldwide. In terms of publishing institutions, it can be seen that the institutions with the highest number of publications and total link strength are all located in the United States, indicating that the United States is relatively concentrated in the research of scoliosis. Although China ranks first in national publications, only Capital Medical University enters the top five in terms of institutional publications, indicating that China's research on scoliosis is relatively scattered and has not formed a concentrated trend.

4.2 Research Hotspots in the Field of Scoliosis

The results of this study show that the current research hotspots in this field are adolescent idiopathic scoliosis, adult spinal deformities, and surgical treatment.

4.2.1 Adolescent Idiopathic Scoliosis

Adolescent idiopathic scoliosis (AIS) refers to a three-dimensional deformity of the spine in adolescents, including lateral curvature in the coronal plane, imbalance in the sagittal plane, and rotation of the vertebral body in the axial plane, without any congenital spinal abnormalities or concurrent neuromuscular and skeletal diseases. It is the most common structural scoliosis in clinical practice. The cause of AIS is unknown and may involve genetics, unbalanced spinal growth, and abnormalities in connective tissue (skeletal muscle and nerves) [10]. Currently, the prevalence of AIS in China is showing an upward trend, becoming an important health issue threatening the health of adolescents. Treatment methods for scoliosis include surgery and conservative treatment. Conservative treatment includes brace correction and exercise therapy. Exercise therapy has a positive effect on the prevention and treatment of AIS, but its potential mechanism is not yet very clear [11]. Current academic focuses include: the correlation between Cobb angle and treatment strategy, the comparison of the efficacy of exercise therapy and posterior spinal fusion surgery, and the consistency of prognosis among patients with different curvatures. Currently, there is a lack of in-depth research on whether the prognosis of patients with different severities of scoliosis is universal. The specific cause of adolescent idiopathic scoliosis remains an unsolved mystery, prompting researchers to explore the potential connection between curvature and prognosis. Therefore, future research trends may focus on exploring the connection between curvature and prognosis, as well as uncovering the mystery of the cause of adolescent idiopathic scoliosis. These studies will provide new perspectives and scientific basis for the clinical treatment of scoliosis.

4.2.2 Adult Spinal Deformity

Adult spinal deformity (ASD) refers to spinal deformities that occur in skeletally mature individuals, usually including lateral curvature in the coronal plane and kyphosis or lordosis in the sagittal plane.

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These diseases have diverse clinical manifestations and complex imaging findings, similar to adolescent idiopathic scoliosis (AIS), but with a greater emphasis on pain control and prevention of functional impairment [12]. Treatment of adult spinal deformity tends to be non-surgical, such as anti-inflammatory, muscle relaxation, analgesics, and physical therapy. However, with the advancement of surgical techniques and instruments, there has been significant progress in the treatment of degenerative scoliosis, including more accurate diagnostic imaging and functional diagnostic tests. Indications for surgical treatment include progression of deformity, poor spinal balance function, severe impact on cardiorespiratory compensation function, and neurological impairment. Research hotspots in adult spinal deformity include postoperative PJK (Proximal Junctional Kyphosis) after spinal orthopedic surgery, postoperative sagittal plane alignment and coronal plane balance, surgical techniques, gene mutations, prediction of deformity progression, brace treatment, traction treatment, overall balance, selection of fusion segments, etc. In addition, the SRS-Schwab classification system plays an important role in evaluating adult spinal deformity (ASD), helping communication between doctors and setting treatment goals. However, when using this classification system, age and racial differences must be considered, as these factors may affect the assessment results [12]. Research also emphasizes the importance of sagittal plane balance, as it has a significant impact on the quality of life of the elderly, and sagittal plane deformities can lead to severe functional impairment and decreased quality of life. Therefore, maintaining or restoring sagittal plane balance is one of the key goals of treating adult spinal deformity.

4.2.3 Surgical Treatment of Scoliosis

Surgical treatment of scoliosis is a field that is constantly developing and progressing. In recent years, with the advancement of medical technology and in-depth research, many new hot issues and progress have emerged in this field. The development of the field of scoliosis surgery in recent years has shown a diversified trend, among which non-fusion surgical techniques are particularly noteworthy. The core goal of this technique is to maintain the mobility of the spine and reduce the risk of postoperative complications, contrasting with traditional fusion surgery. Vertebral Body Tethering (VBT), as an innovative method of non-fusion surgery, involves inserting screws on the convex side of the curve and using artificial ligaments for fixation, allowing the spine to gradually correct the curve during growth, especially suitable for growing children and adolescents, as it corrects the curve without restricting the normal growth of the spine [13]. In terms of screening and diagnosis, the application of artificial intelligence (AI) technology is becoming more and more widespread, capable of automatically diagnosing scoliosis and measuring the Cobb angle with an accuracy rate of up to 98.37%, with minimal error compared to manual measurement [14]. AI technology is also used to develop screening systems based on convolutional neural networks (CNN), estimating spinal alignment and vertebral rotation angles based on moiré images, improving the accuracy and convenience of screening. The application of 3D printing technology is another important progress in the field of scoliosis surgical treatment, allowing doctors to make personalized correction braces and surgical guides according to the specific situation of patients, which can better fit the patient's body and improve the correction effect [15]. The application of minimally invasive surgery techniques is also becoming more widespread, reducing surgical trauma and postoperative recovery time through small incisions. Thoracoscopic-assisted scoliosis surgery can reduce postoperative pain, accelerate recovery, and reduce the risk of postoperative complications. Minimally invasive surgery combined with precise navigation systems and robotic assistance technology further improves the accuracy and safety of surgery [16]. With the development of medical imaging technology and computer-aided design (CAD), scoliosis surgery tends to be personalized and precise. Doctors can use advanced imaging technologies such as CT scans and MRI, combined with CAD software, to design personalized surgical plans for each patient, minimizing surgical risks and improving surgical outcomes. The development of these technologies has jointly promoted the treatment of scoliosis to develop in a more efficient and precise direction.

In summary: Research on scoliosis is currently in a stable development stage, and the number of academic papers in related fields will continue to increase. China is the country with the most publications in this field in the past three years. The research hotspots in this field are mainly focused on its surgical methods and efficacy, adolescent idiopathic scoliosis, adult spinal deformities, etc. These research results can be used to predict future research directions and hot issues.

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References

[1] Kuznia AL, Hernandez AK, Lee LU. Adolescent Idiopathic Scoliosis: Common Questions and Answers. Am Fam Physician. 2020; 101(1):19-23.
[2] Jin C, Wang S, Yang G, Li E, Liang Z. A Review of the Methods on Cobb Angle Measurements for Spinal Curvature. Sensors (Basel). 2022; 22(9):3258. Published 2022 Apr 24. doi:10.3390/s22093258
[3] Hwang, Changju, et al. "Adolescent idiopathic scoliosis." Journal of the Korean Orthopaedic Association 43.3(2008).
[4] Negrini, Stefano, et al. "2016 SOSORT guidelines: Orthopaedic and rehabilitation treatment of idiopathic scoliosis during growth." Scoliosis and Spinal Disorders, 13(2018).
[5] Weinstein, Stuart L., et al. "Effects of bracing in adolescents with idiopathic scoliosis." Child Care Health and Development 40.1(2014):1512-1521.
[6] Konieczny M R,Hüsseyin Senyurt….Epidemiology of adolescent idiopathic scoliosis[J].Journal of Childrens Orthopaedics, 2013, 7(1):3.DOI:10.1007/s11832-012-0457-4.
[7] Schwab, Frank, et al. "Scoliosis Research Society-Schwab adult spinal deformity classification: a validation study. " Spine 37.12(2012):1077-1082.
[8] Knowlson C, Dean A, Doherty L, Fairhurst C, Brealey S, Torgerson DJ. Recruitment patterns in multicentre randomised trials fit more closely to Price's Law than the Pareto Principle: A review of trials funded and published by the United Kingdom Health Technology Assessment Programme. Contemp Clin Trials. 2022;113:106665. doi:10.1016/j.cct.2021.106665
[9] Povedano-Montero F J,álvarez-Peregrina, Cristina, Fernando H S C,et al.Bibliometric Study of Scientific Research on Scleral Lenses[J].Eye & Contact Lens, 2018:1.DOI:10.1097/ICL. 0000000000000478.
[10] Almahmoud OH, Baniodeh B, Musleh R, Asmar S, Zyada M, Qattousah H. Overview of adolescent idiopathic scoliosis and associated factors: a scoping review. Int J Adolesc Med Health. 2023; 35(6):437-441. Published 2023 Nov 21. doi:10.1515/ijamh-2023-0166
[11] LIAO Yuesheng, BAI Lili. Research updates on the pathogenesis of adolescent idiopathic scoliosis and sports intervention[J]. Chinese Journal Of School Health, 2022, 43(9): 1436-1440. doi: 10.16835/j.cnki.1000-9817.2022.09.038
[12] Schwab, Ungar, Blondel, et al.Scoliosis research society-schwab adult spinal deformity classification: A validation study[J].Spine, 2012.
[13] Mariscal, Gonzalo, et al. "Meta-analysis on the efficacy and safety of anterior vertebral body tethering in adolescent idiopathic scoliosis." European Spine Journal 32.1(2023):140-148.
[14] Xie, L., Zhang, Q., He, D., Wang, Q., Fang, Y., Ge, T., Jiang, Y., & Tian, W. (2022). Automatically measuring the Cobb angle and screening for scoliosis on chest radiograph with a novel artificial intelligence method. American journal of translational research, 14(11), 7880–7888.
[15] Chen, Xuanhuang et al. "Feasibility Analysis of 3D Printing-Assisted Pedicle Screw Correction Surgery for Degenerative Scoliosis." Evidence-based complementary and alternative medicine: eCAM vol. 2022 4069778. 6 Sep. 2022, doi:10.1155/2022/4069778
[16] Lefranc, Michel et al. "Minimally invasive, robot-assisted iliosacral screw insertion for fusionless fixation in children with neuromuscular scoliosis." Neurosurgical focus vol. 45,VideoSuppl1 (2018): V2. doi:10.3171/2018.7.FocusVid.1899