# Bibliometric Evaluation and Hot Spot Analysis of Developmental Dysplasia of the Hip

**YiNuo Fan**
Guangzhou University of Chinese Medicine
**Haitao Zhang**
Guangzhou University of Chinese Medicine
**Zhiying Guan**
guangzhou university of chinese medicine
**Weifeng Li**
guangzhou university of chinese medicine
**Zhongfeng Li**
Guangzhou University of Chinese Medicine
**Wei He**
Guangzhou University of Traditional Chinese Medicine First Affiliated Hospital
**Zhenqiu Chen** ( chenzq2019@126.com )
Guangzhou University of Traditional Chinese Medicine First Affiliated Hospital

**Research article**

**Keywords:** Bibliometrics, Visual analysis, Developmental dysplasia of the hip(DDH), Co-occurrence analysis

**Posted Date:** November 2nd, 2020

**DOI:** https://doi.org/10.21203/rs.3.rs-99418/v1

# Abstract

**Purpose:** To analyze the research development process and research hotspots of DDH in order to guide the future research direction.

**Methods:** Using the Web of Science database to search the relevant English literatures of DDH from 1994 to May 31,2020 and analyze them with Bibliometric analysis methods. The statistics and the analysis of the collected publications are for the sake of hierarchical refinement and quality assessment of the publications of different countries, authors, institutions, funding agencies, and journals. Using the VOS viewer software for visual conversion and researching direction and important fields of DDH simultaneously.

**Results:** With a total of 2156 articles, the numbers of DDH published articles is increasing steadily. In funding agencies, the National Natural Science Foundation of China has funded most of the researches. In journals, the published articles of JOURNAL OF BONE AND JOINT SURGERY AMERICAN VOLUME are of the highest quality. For authors, KIM YJ is the author who not only published most of the articles, but also published the ones of the highest quality. In countries, the USA is ahead in the quantity and quality of published articles. In institutions, the published articles of UNIV BERN are of the highest quality. Through co-occurrence analysis, it can be seen that the research direction in the DDH field consists of four categories: Diagnosis, Complications, Hip replacement, and Staging treatment before hip replacement. Current research hotspots are mainly focused on treatment.

**Conclusions:** At present, arthroplasty and osteotomy are research hotspots in recent years. It is recommended that researchers start the study of DDH from osteotomy, trying to optimize the adaptation age of various osteotomy to DDH and reduce its complications.


# Introduction

Developmental dysplasia of the hip (DDH) refers to the decline or the loss of stability of the hip joint caused by abnormal structural development of the hip joint which includes the acetabulum and femoral head, resulting in subluxation or complete dislocation of the hip joint[1, 2]. Some of these babies had total hip dislocation before their birth, so DDH had been diagnosed as congenital dislocation of the hip (CDH). Since DDH further clarified the undesirable changes in the hip structure that continue to develop after the birth and progress during their growth and development, CDH is replaced [3–5]. According to reports, the disease has a high prevalence in Asia, the Mediterranean, and the United States, where for every 1,000 newborns, there are 1-1.5 children suffering from DDH[6]. The incidence of DDH in women is relatively high, about 4 to 10 times higher than men[7]. The early detection of DDH can change the progress and prognosis of the disease, which is the current international consensus[8, 9]. The study found that ultrasound is the best choice for the baby who less than 4 months; After the age of 6 months, femoral skullization will be more obvious, at when X-ray is the preferred method for evaluating and monitoring DDH[10]. For DDH after diagnosis, there are different treatment methods at different ages, and

it is required for the orthopaedic doctor to grasp the dynamic development process of DDH in detail in order to respond in a proper way. The DDH, which was not found early, is closely linked to adult osteoarthritis(OA)[11], at the same time one-third of hip replacements in adults under the age of 60 are caused by DDH[12]. Therefore, DDH has attracted much more scholars from all over the world.

However, there is no bibliometric report on the current status of DDH research and the global development trends. Bibliometrics apply statistical methods to quantitatively evaluate research trends based on literature databases and their characteristics, which can not only help scholars grasp the development trends and research directions of specific research fields but also evaluate journals, institutions, countries, and others in specific research in the field and provide a basis for the development of clinical guidelines[13]. The purpose of this study is to analyze the status of global DDH research publications to carry out layered refinement and quality assessment of the distribution of publications in different countries, authors, institutions, funding agencies, and journals. In addition, we also performed a co-occurrence analysis of keywords from DDH-related publications in order to understand their research directions and hotspot areas.

## Methods

Web of Science's Science Citation Index Expanded (SCI-E) database was used for Bibliometric analysis[14, 15]. Through advanced search, the limited time is from 1994 to May 31, 2020. Then we entered " developmental dysplasia of the hip" and free words to search for the required English literature, and obtained the information of the documents including authors, countries, journals, institutions, annual publications and funding agencies. We then downloaded and saved the information to TXT format and imported it into the Microsoft Excel 2019 for analyzing, by which we ensure that the information is correct. Subsequently, two independent researchers (Yinuo Fan, Haitao Zhang) separately verified and evaluated the data and unified the opinions through discussion. Finally, the subsequent literature measurement parameters were determined: Total Publications, Sum of Times Cited, Average citations per item, H-index (Journals including IF).

# Bibliometric Analysis

Web of Science can analyze the retrieved literature, and the retrieved results are analyzed and extracted separately for funding agencies, journals, literature related to the authors, the countries, and the institutions. The data for the measurement parameters are tabulated. The frequency of citations represents the total number of citations in the corresponding years. H-index is the number of publications which have been cited at least H time, which could reflect the quantity and quality of the published articles by researchers and institutions[16, 17]. Average citations per item are the average number of cited per articles, and it can also represent the quality of the publication to some extent., while the IF of a journal represents its influence.

# Visual Analysis

Vos viewer software (version 1.6.11) exploited by Netherlands Leiden University was utilized for visual analysis of the literature. The .txt file containing all the literature information obtained from the Web of Science database is imported into the software for "co-occurrence analysis", and the network and overlay visualization analysis structure diagrams are separately exported. Co-occurrence analysis can be employed to discern current research directions and hotspot areas of research.

# Results

2491 documents were found on the web of science, adding to a total of 2156, details are shown in Fig1of the explicit inclusion and exclusion criteria chart.

### Number of global publications

From 1994 to 2020, the quantity of DDH articles has been steadily growing. It can be seen from Fig2 that the volume of annual articles are divided into two periods: the first period is from 1999 to 2005, and the second period is from 2006 to 2019. In the first period, the rate of publication fluctuated slightly with the annual growth in publication rising and falling, but the overall upward. In the subsequent period, except for 2014, the number of articles sent showed a steady and continuous increase, averaging about 12 per year. 1994. Though there are only 13 publications in the year, the number of articles on DDH reached 2156 by the end of May, 2020.

### Assessment of global publications

### Funding agencies

A total of 540 funders have supported the research in this area, the ones ranked in the top 10 are shown in Table 1, and these funding agencies supported nearly 12% of the researches. Interestingly enough, half of the funding agencies are from the US, the rest are from the UK, Japan, and China. The National Natural Science Foundation of China that ranked the first funded 81 studies (3.757%), followed by National Institutes of Health (40 studies, 1.855%) and United States Department of Health Human Services (40 studies, 1.855%).

### Journals

There are 372 journals published researches about DDH in total. Table 2 displays the top 10 journals in terms of the number of publications, which published about 47.26% of the literature. When it comes to the number of publications, JOURNAL OF PEDIATRIC ORTHOPAEDICS is the most prominent journal with 203 articles published, followed by JOURNAL OF PEDIATRIC ORTHOPAEDICS PART B (142 articles) and CLINICAL ORTHOPAEDICS AND RELATED RESEARCH (139 articles); In term of quality: JOURNAL OF BONE AND JOINT SURGERY AMERICAN VOLUME (H-index 32, Sum of Times) Cited 2782, Average citations per item37.57. IF4.716) was of the highest quality, followed by CLINICAL ORTHOPAEDICS and

RELATED RESEARCH(H-index 32, Sum of Times Cited 3886, Average citations per item27.95. IF4.154) and JOURNAL OF BONE AND JOINT SURGERY BRITISH VOLUME (H-index 31, Sum of Times Cited 2587, Average citations per item30.06. IF 3.309). Not surprisingly, the overall quality of these 10 journals is high, with IFs mostly above 2.

### Authors

About 6580 authors have authored DDH-related research. Table 3 lists the top 10 authors who are considered the most active in the field of DDH. In terms of the number of articles published, the top three authors are KIM YJ (29 articles), SANKAR WN (28 articles), and CLARKE NMP (27 articles); from the analysis of the quality of the articles, we presume that KIM YJ (H-index 16, Sum of Times Cited 1144, Avg. citations per item39.45) wrote articles of the best quality, followed by ROSENDAHL K J (H-index 15, Sum of Times Cited 719, Average citations per item35.95) and MILLIS MB (H-index 13, Sum of Times Cited 598) Average citations per item23). There is no doubt that the number of citations by authors is not necessarily proportional to the quality of the citations.

### Countries

Currently, 74 countries have published relevant studies about DDH. The top 10 countries/areas in terms of the number of publications are listed in Table 4. In terms of the number of articles issued, the USA (538) issued the most articles, followed by China (263) and Japan (265). Analyzing from the quality of the publication, the USA is still leading(H-index 48, Sum of Times Cited 9385, Average citations per item17.44), UK (H-index 32, Sum of Times Cited 3358, Average citations per item15.19) and Japan (H -index 30, Sum of Times Cited 3222, Average citations per item12.44) followed behind. Although China has published numerous articles, there is space for improvement in the quality of the articles.

### Institutions

About 2079 institutions have published articles in the field and Table 5 lists the top 10 institutions in terms of the number of publications. In terms of the number of publications, it is clear that SHANGHAI JIAO TONG UNIV which published 48 studies located in the First, followed by CHILDRENS HOSP PHILADELPHIA (43 articles) and WASHINGTON UNIV (32 articles); in terms of the quality of the articles, there is no doubt that the first prize goes to UNIV BERN (H-index 18, Sum of Times Cited 1488, Average citations per item51.28), followed by CHILDRENS HOSP (H-index 13, Sum of Times Cited 794, Average citations per item31.76) and WASHINGTON UNIV (H-index 13, Sum of Times) Cited 817, Average citations per item25.5). UNIV BERN is at the forefront of the research in the field of DDH.

### Co-occurrence analysis

### Research direction analysis

All the published literatures included in the study have a total of 4319 keywords. Each keyword is defined to appear at least 5 times through the Vos viewer software, and a total of 519 keywords are retained. As

the Fig3 shows, the research direction of the field is divided into 4 categories:Diagnosis (cluster1, in blue), Complications (cluster2, in green and yellow), Hip replacement (cluster3, in red) and Staging treatment before hip replacement (cluster4, in purple).The high-frequency keywords in cluster1 are ultrasound, ultrasonography and diagnosis; in cluster2, the most frequently occurred keywords are DDH, acetabular dysplasis and Osteoarthritis; In cluster3, the most frequently used keywords are replacement, follow-up and dislocation; In cluster4, the most commonly used keywords are congenital dislocation, closed reduction and open reduction.

### Hotspot analysis

The Vos viewer software can be used to classify the keywords in the literature according to the chronological order of their appearance, so that their research hot spots are expressed with different colors. As the Fig4 shows, it can be seen from the time scale under the figure that the color purple appears early and belongs to the previous research hotspot, followed by blue, green and yellow, and the latest is red, which is the current research hotspot. The color changes gradually from purple to red. By analyzing the emergence of keywords, we can tell that the current research hotspots mainly focus on treatment, such as arthroplasty, different osteotomy (for example, Bernese periacetabular osteotomy, salter innominate osteotomy and pelvic osteotomy, etc.) and postoperative follow-up.

## Discussion

Although DDH has a long history and many scholars have studied it, little is known about its exact cause. What we can do is to diagnose, treat in advance, and minimize the use of total hip replacement (THR) at the end stage[18]. At present, there is already a mature program for the diagnosis and treatment of DDH. Therefore, it is time to review the development of DDH to better understand the past, the present and the future. Bibliometrics is a research method that can provide comprehensive, objective, and macro information, and can also find the research directions and hot spots in a certain field[19, 20]. This study aims to summarize the development of DDH through bibliometrics, and evaluate publications in DDH-related fields, and visually analyze the research directions and hot spots.

### Assessment of global publications

Between 1994 and 2020, global publications on DDH have gradually grown. Interestingly, we found that China was catching up in this field, the National Natural Science Foundation of China has funded most for the research, and SHANGHAI JIAO TONG UNIV has published the largest number of articles (simply in terms of institutions), But the United States is still a giant overall in the field of DDH research. The United States not only has more funding agencies to fund research in this field, but also has high-quality journals in this field. In addition, it is also in a leading position in terms of the quantity and quality of national documents. In terms of the author's contribution to the DDH research, KIM YJ's has the largest contribution. He is the author with the largest number of articles published and the highest quality of published articles which inspires us that If we want to grasp the latest development in this field, we can start with the journals with publications of the highest quality; if we consider cooperation issues, the USA

and UNIV BERN are considered first; if we want to fund the research of an author to overcome DDH Relevant problems, there is no doubt that KIM YJ is the most worthy author.

### Co-occurrence analysis

### The analysis of research direction and hotspot

Visualization of statistical keyword clusters by Vos viewer software and global research directions in the field of DDH. It was split into 4 major categories: Diagnoses, Complications, Hip replacement, and Staging treatment before hip replacement. By analyzing the occurrence of keywords, we determined that the current research focus is primarily on the treatment of Aspects such as arthroplasty, different osteotomy, and postoperative follow-up. We analyze each of these directions and research hotspots intending to find breakthroughs regarding the diagnosis and treatment of DDH.

### Diagnosis

Ultrasound (US) is the preferred imaging modality for infants younger than 4 months of age. In the United States, ultrasound is recommended for selective screening of newborns, rather than universal screening, because the latter has not been turned out to help. Decrease the diagnosis of DDH[21-23]. Femoral ossification becomes more pronounced after 6 months of age when x-rays are used to diagnose DDH [10]. Since the diagnostic imaging of DDH after birth is improving, it is challenging for us to achieve a breakthrough in this area[9]. Nowadays, some scholars are gradually focusing on the direction of genetics, and it is found that genetic factors play an important role in the development of DDH and the role of CX3CR1 has been more recently studied as demonstrated in Fig4[24]. CX3CR1 was found to be involved not only in inflammatory processes but also in the differentiation of mesenchymal stem cells into chondrocytes, and the error of this gene expression may contribute to the abnormal formation of acetabular cartilage[7]. We reviewed the literature and found that not only CX3CR1, WISP3, PAPPA2, HOXB9, and HOXD9, among others, also play a role in the genetics of DDH[24]. Although every patient with DDH needs to be evaluated individually by precise radiological and clinical examination, the discovery of the causative gene will greatly assist in diagnosis and treatment[25]. Therefore, in the future, gene-based prediction of infants and children with a positive family history of DDH will have a significant impact on the etiology and pathogenesis of DDH.

### Complications

The most common and serious complication of DDH in the population is hip OA, and when the disease makes progress towards end-stage, the THR is required[11,12]. Therefore, the most essential thing is the early diagnosis and early intervention to delay the progression of OA and thus reduce the likelihood of surgery.

### Hip replacement

THR is a last resort for when DDH develops into terminal OA. However, concerning that this complication does not only occur in the elderly but also the young. What's more, THR is performed at a young age[25]. While THR is exposed to the possibility of infection and revision, this procedure is not suitable for young and middle-aged patients. Although studies regarding THR and its related aspects are still commonplace as saw in Fig3, we have to acknowledge the significance of early diagnosis and treatment of DDH.

**Staging treatment before hip replacement**

Pavlik harness is a common treatment for children with DDH less than 6 months of age. We can see from Fig 4, that this is a hotly researched issue. It has been found that after successful Pavlik stenting if the acetabulum is developing normally by age 2 years, at an average of 10 years from the acetabulum continues to develop normally at all follow-up visits[26]. However, failure of Pavlik harness treatment can also lead to a series of complications [10], such as avascular necrosis (AVN) of the femoral head and femoral nerve palsy. Therefore, future research could be aiming at improving the success rate of Pavlik harness and reducing its complications.

We usually use closed reduction if the patient is diagnosed at 6-18 months of age. Although there is a better understanding of surgical outcomes of closed repositioning and ways to reduce its failure rate[27], it still has a Complications, such as AVN, a current concern and problem for orthopedic surgeons to address[28].

In general, open reduction is usually considered if patients are older than 12 ~ 18 months or ithey have failed to closed reduction, but AVN is still an issue to consider. The upper age limit at the time of open reduction is currently unclear. It has been found that younger children (<8 years old) may be the best time to perform the procedure and that the results of surgery are poor for patients with DDH diagnosed after 8 years of age at open reduction, so it is still debatable whether to operate on these patients[29, 30].

Pelvic osteotomy is an excellent option for children with DDH who have failed initial treatment and are older (3-5 years). We can perform osteotomies to restore normal development of the acetabulum, which can be reconstructed up to the age of 5[31]. The most commonly used pelvic osteotomies are the Salter, Pemberton, and Dega osteotomies, which are performed at the age of 5 years. Fig4 hotspots are also seen in the graph. However, the osteotomy is at the discretion of the orthopedic surgeon, as this procedure is not superior to other procedures[10].

The recent rapid development of hip-sparing surgery aimed to prevent OA associated with DDH. Bernese Periacetabular osteotomy (PAO) is a common hip-sparing surgery performed in the mid- to late-1980s. PAO aims to improve coverage of the femoral head in the acetabulum, thereby delaying hip osteoarthritis and hip arthroplasty. The study found that a significant improvement in the quality of life is brought to patients after PAO in the short to medium term and THR is not required within 10 years[32-34]. In a study of a long-term follow-up that lasts more than 30 years shows that 71% of patients had continued progression of pain symptoms, the presence of osteoarthritis on imaging, and the presence of chronic disease, evidence, or require THR[35]. In addition, although the age limit for this PAO has not been

clarified, studies have found a poorer postoperative prognosis in patients older than 35 years of age[36]. Therefore, future research should focus on how to delay the progression of OA and THR for a longer period, and expand the age scope to that fits PAO.

# Limitations

Firstly, this research is restricted to English literature. DDH is not only found in Europe and the United States, but other languages were not included in the literature. Secondly, studies are limited to the period up to May 31, 2020, after which studies have not yet been included. Finally, due to the still brief period of recently published literature, which may have resulted in a lower number of citations and affected the overall citation frequency and H-index, thus the statistical results could be affected.

# Conclusion

With the United States currently leading the way in DDH-related research and China having a fairly active presence in the field, we consider that scholars could pay more attention to the progress of U.S. research in this area, and collaborate with leading authors or research institutions to major insights from DDH. The key point of the research related to DDH is gradually moving from diagnosis to treatment. Hip replacement and staging treatment before hip replacement are the main research directions, while Arthroplasty and Osteotomy are the hotspots of recent research. It is recommended that researchers start the study of DDH from genetic early diagnosis and osteotomy, and try to optimize the adaptation age of various osteotomy to DDH and reduce its complications.

# Abbreviations

OA, Osteoarthritis; KOA, knee osteoarthritis; TKR, total knee replacement; WOMAC, Western Ontario and McMaster Universities Osteoarthritis Index; VAS, Visual Analog Scale; KOOS, knee injury and osteo arthritis outcome score; KOOS-ADL, KOOS- Activi ties of Daily Living; RCTs, randomized controlled trials.

# Declarations


### Acknowledgments

No acknowledgement.


### Declaration of conflicting interest

The authors declare that there are no conflicts of interest.


### Funding

This work was supported by National Natural Science Foundation of China (Grant No: 81573996) in the form of covering the consultation fees of data statistical analysis. Zhenqiu Chen received scientific funding from National Natural Science Foundation of China and the grant number is 81573996.

### Authors' Contributions

Conceptualization: Yinuo Fan and Zhenqiu Chen. Literature search: Yinuo Fan, Haitao Zhang and Zhiying Guan. Data extraction and quality assessment: Haitao Zhang and Zhiying Guan. Software: Weifeng Li. Formal analysis: Yinuo Fan, Haitao Zhang, and Zhongfeng Li. Validation: Wei He and Zhenqiu Chen. Writing: Yinuo Fan, Haitao Zhang. Yinuo Fan and Haitao Zhang contributed equally to this work. All authors read and approved the final manuscript.

### Availability of data and materials

The datasets used and/or analyzed during the current study are not publicly available due to feasibility but are available from the corresponding author on reasonable request.

### Ethics approval and consent to participate

Not applicable.

### Consent to publication

Not applicable.

### Competing interests

The authors declare that they have no competing interests.

## References

1. Dunn PM, et al. Congenital dislocation of the hip: early and late diagnosis and management compared. Arch Dis Child. 1985;60(5):407–14.
2. MacKenzie IG, Wilson JG. Problems encountered in the early diagnosis and management of congenital dislocation of the hip. J Bone Joint Surg Br. 1981;63-B(1):38–42.
3. Dezateux C, Rosendahl K. Developmental dysplasia of the hip. Lancet. 2007;369(9572):1541–52.
4. Kotlarsky P, et al. Developmental dysplasia of the hip: What has changed in the last 20 years? World Journal Of Orthopedics. 2015;6(11):886–901.
5. Loder RT, Skopelja EN. The epidemiology and demographics of hip dysplasia. ISRN Orthop. 2011;2011:238607.
6. Feldman GJ, et al. Linkage Mapping and Whole Exome Sequencing Identify a Shared Variant in CX3CR1 in a Large Multi-Generation Family. Journal Of Arthroplasty. 2014;29(9):238–41.

7. Li LY, et al. CX3CR1 polymorphisms associated with an increased risk of developmental dysplasia of the hip in human. Journal Of Orthopaedic Research. 2017;35(2):377–80.
8. Tyagi R, Zgoda MR, Short R. Targeted Screening of Hip Dysplasia in Newborns: Experience at a District General Hospital in Scotland. Orthop Rev (Pavia). 2016;8(3):6640.
9. Walton S, et al. Evaluating the role of prereduction hip traction in the management of infants and children with developmental dysplasia of the hip (DDH): protocol for a systematic review and planned meta-analysis. BMJ Open. 2018;8(1):e019599.
10. Yang S, et al., *Developmental Dysplasia of the Hip*. Pediatrics, 2019. 143(1).
11. Jackson JC, Runge MM, Nye NS. Common Questions About Developmental Dysplasia of the Hip. Am Fam Physician. 2014;90(12):843–50.
12. Barrera CA, et al. Imaging of developmental dysplasia of the hip: ultrasound, radiography and magnetic resonance imaging. Pediatr Radiol. 2019;49(12):1652–68.
13. Pu QH, Lyu QJ, Su HY. *Bibliometric analysis of scientific publications in transplantation journals from Mainland China, Japan, South Korea and Taiwan between 2006 and 2015*. Bmj Open, 2016. 6(8).
14. Xing D, et al. Global research trends in stem cells for osteoarthritis: a bibliometric and visualized study. International Journal Of Rheumatic Diseases. 2018;21(7):1372–84.
15. Zhang WJ, et al. National Representation in the Plastic and Reconstructive Surgery Literature A Bibliometric Analysis of Highly Cited Journals. Annals Of Plastic Surgery. 2013;70(2):231–4.
16. Kalcioglu MT, et al. Evaluation of the academic productivity of the top 100 worldwide physicians in the field of otorhinolaryngology and head and neck surgery using the Google Scholar h-index as the bibliometrics ranking system. Journal Of Laryngology Otology. 2018;132(12):1097–101.
17. Kustritz MVR, Nault AJ. *Measuring Productivity and Impact of Veterinary Education-Related Research at the Institutional and Individual Levels Using the H-Index*. J Vet Med Educ, 2019: p. e0618072r1.
18. Zidka M, Dzupa V. National Register of Joint Replacement Reflecting the Treatment of Developmental Dysplasia of the Hip in Newborns. Acta Chirurgiae Orthopaedicae Et Traumatologiae Cechoslovaca. 2019;86(5):324–9.
19. Jin Y, et al. Upregulation of long non-coding RNA PlncRNA-1 promotes proliferation and induces epithelial-mesenchymal transition in prostate cancer. Oncotarget. 2017;8(16):26090–9.
20. Tijssen RJW, Winnink J. Twenty-first century macro-trends in the institutional fabric of science: bibliometric monitoring and analysis. Scientometrics. 2016;109(3):2181–94.
21. Nguyen JC, et al. Imaging of Pediatric Growth Plate Disturbances. Radiographics. 2017;37(6):1791–812.
22. Oestreich AE. The acrophysis: a unifying concept for understanding enchondral bone growth and its disorders. II. Abnormal growth. Skeletal Radiol. 2004;33(3):119–28.
23. Strayer LM Jr. Embryology of he human hip joint. Clin Orthop Relat Res. 1971;74:221–40.
24. Gkiatas I, et al. Developmental dysplasia of the hip: a systematic literature review of the genes related with its occurrence. Efort Open Reviews. 2019;4(10):595–601.

25. Harsanyi S, et al., *Developmental Dysplasia of the Hip: A Review of Etiopathogenesis, Risk Factors, and Genetic Aspects*. Medicina-Lithuania, 2020. 56(4).
26. Allington NJ. Successful Pavlik Harness Treatment for Developmental Dysplasia of the Hip and Normal X-Ray at the Age of 2 Years: Is a Longer Follow-up Necessary? Journal Of Pediatric Orthopaedics. 2017;37(5):328–31.
27. Race C, Herring JA. Congenital dislocation of the hip: an evaluation of closed reduction. J Pediatr Orthop. 1983;3(2):166–72.
28. Sankar WN, et al. Closed Reduction for Developmental Dysplasia of the Hip: Early-term Results From a Prospective, Multicenter Cohort. Journal Of Pediatric Orthopaedics. 2019;39(3):111–8.
29. Ning B, et al., *Analyses of outcomes of one-stage operation for treatment of late-diagnosed developmental dislocation of the hip: 864 hips followed for 3.2 to 8.9 years.* Bmc Musculoskeletal Disorders, 2014. **15**.
30. Yagmurlu MF, et al. Clinical and radiological outcomes are correlated with the age of the child in single-stage surgical treatment of developmental dysplasia of the hip. Acta Orthop Belg. 2013;79(2):159–65.
31. Brougham DI, et al. The predictability of acetabular development after closed reduction for congenital dislocation of the hip. J Bone Joint Surg Br. 1988;70(5):733–6.
32. Clohisy JC, et al. Patient-Reported Outcomes of Periacetabular Osteotomy from the Prospective ANCHOR Cohort Study. J Bone Joint Surg Am. 2017;99(1):33–41.
33. Grammatopoulos G, et al. What Is the Early/Mid-term Survivorship and Functional Outcome After Bernese Periacetabular Osteotomy in a Pediatric Surgeon Practice? Clinical Orthopaedics Related Research. 2016;474(5):1216–23.
34. Wells J, et al. Intermediate-Term Hip Survivorship and Patient-Reported Outcomes of Periacetabular Osteotomy The Washington University Experience. Journal Of Bone Joint Surgery-American Volume. 2018;100(3):218–25.
35. Lerch TD, et al. One-third of Hips After Periacetabular Osteotomy Survive 30 Years With Good Clinical Results, No Progression of Arthritis, or Conversion to THA. Clinical Orthopaedics Related Research. 2017;475(4):1154–68.
36. Matheney T, et al., *Intermediate to Long-Term Results Following the Bernese Periacetabular Osteotomy and Predictors of Clinical Outcome Surgical Technique.* Journal Of Bone And Joint Surgery-American Volume, 2010. **92a**: p. 115–129.

# Tables

### Table 1. The top 10 funds sources

| Ranking | Fund source | Total Publications | Ranking | Fund source | Total Publications |
|---|---|---|---|---|---|
| 1 | National Natural Science Foundation of China | 81 | 6 | National Institute of Arthritis Musculoskeletal Skin Diseases | 15 |
| 2 | National Institutes of Health-USA | 40 | 7 | JAPAN Society for The Promotion of Science | 13 |
| 3 | United States Department of Health Human Services | 40 | 8 | International Hip Dysplasia Institute | 12 |
| 4 | Ministry of Education Culture Sports Science and Technology-JAPAN | 18 | 9 | Medical Research Council -UK | 10 |
| 5 | Versus Arthritis | 16 | 10 | Smith Nephew | 9 |

**Table 2. The top 10 journals with most publications from 1994 to 2020.**

| Ranking | Journal | Total Publications | Sum of Times Cited | Average citations per item | H index | IF |
|---|---|---|---|---|---|---|
| 1 | JOURNAL OF PEDIATRIC ORTHOPAEDICS | 203 | 2926 | 14.4 | 28 | 2.046 |
| 2 | JOURNAL OF PEDIATRIC ORTHOPAEDICS PART B | 142 | 1113 | 7.84 | 19 | 0.74 |
| 3 | CLINICAL ORTHOPAEDICS AND RELATED RESEARCH | 139 | 3886 | 27.95 | 32 | 4.154 |
| 4 | JOURNAL OF ARTHROPLASTY | 127 | 1904 | 14.98 | 22 | 3.524 |
| 5 | HIP INTERNATIONAL | 86 | 326 | 3.79 | 10 | 1.25 |
| 6 | JOURNAL OF BONE AND JOINT SURGERY BRITISH VOLUME | 86 | 2587 | 30.06 | 31 | 3.309 |
| 7 | JOURNAL OF BONE AND JOINT SURGERY AMERICAN VOLUME | 74 | 2782 | 37.57 | 32 | 4.716 |
| 8 | INTERNATIONAL ORTHOPAEDICS | 73 | 752 | 10.27 | 15 | 2.384 |
| 9 | BONE JOINT JOURNAL | 48 | 361 | 7.52 | 11 | 4.301 |
| 10 | JOURNAL OF CHILDRENS ORTHOPAEDICS | 41 | 126 | 3.07 | 6 | 1.296 |

**Table 3. The top 10 active authors with most publications from 1994 to 2020.**

| Ranking | Author | Total Publications | Sum of Times Cited | Average citations per item | H index |
|---|---|---|---|---|---|
| 1 | KIM YJ | 29 | 1144 | 39.45 | 16 |
| 2 | SANKAR WN | 28 | 242 | 8.64 | 11 |
| 3 | CLARKE NMP | 27 | 582 | 21.56 | 12 |
| 4 | MILLIS MB | 26 | 598 | 23 | 13 |
| 5 | PATON RW | 22 | 342 | 15.55 | 10 |
| 6 | CLOHISY JC | 21 | 591 | 28.1 | 9 |
| 7 | ZHANG LJ | 21 | 171 | 8.14 | 8 |
| 8 | NAKASHIMA Y | 21 | 409 | 19.48 | 11 |
| 9 | ROSENDAHL K | 20 | 719 | 35.95 | 15 |
| 10 | BICIMOGLU A | 20 | 208 | 10.4 | 8 |

**Table 4. The top 10 countries with most publications from 1994 to 2020.**

| Ranking | Author | Total Publications | Sum of Times Cited | Average citations per item | H index |
|---|---|---|---|---|---|
| 1 | USA | 538 | 9385 | 17.44 | 48 |
| 2 | PEOPLES R CHINA | 263 | 1357 | 5.16 | 18 |
| 3 | JAPAN | 259 | 3222 | 12.44 | 30 |
| 4 | ENGLAND | 221 | 3358 | 15.19 | 32 |
| 5 | TURKEY | 213 | 1429 | 6.71 | 19 |
| 6 | CANADA | 92 | 1219 | 13.25 | 17 |
| 7 | GERMANY | 75 | 987 | 13.16 | 19 |
| 8 | SWITZERLAND | 58 | 1920 | 33.1 | 24 |
| 9 | NETHERLANDS | 53 | 558 | 10.94 | 15 |
| 10 | FRANCE | 52 | 568 | 10.92 | 13 |

**Table 5. The top 10 institutions with most publications from 1994 to 2020.**

| Ranking | Institution | Total Publications | Sum of Times Cited | Average citations per item | H index |
|---|---|---|---|---|---|
| 1 | SHANGHAI JIAO TONG UNIV | 48 | 279 | 5.81 | 10 |
| 2 | CHILDRENS HOSP PHILADELPHIA | 43 | 478 | 11.12 | 13 |
| 3 | WASHINGTON UNIV | 32 | 817 | 25.5 | 13 |
| 4 | SHRINERS HOSP CHILDREN | 29 | 677 | 23.34 | 13 |
| 5 | UNIV BERN | 29 | 1488 | 51.28 | 18 |
| 6 | UNIV UTAH | 27 | 672 | 24.85 | 13 |
| 7 | HOSP SICK CHILDREN | 26 | 362 | 13.92 | 11 |
| 8 | MAYO CLIN | 25 | 586 | 23.4 | 13 |
| 9 | CHINA MED UNIV | 25 | 173 | 6.68 | 8 |
| 10 | CHILDRENS HOSP | 25 | 794 | 31.76 | 13 |

# Figures

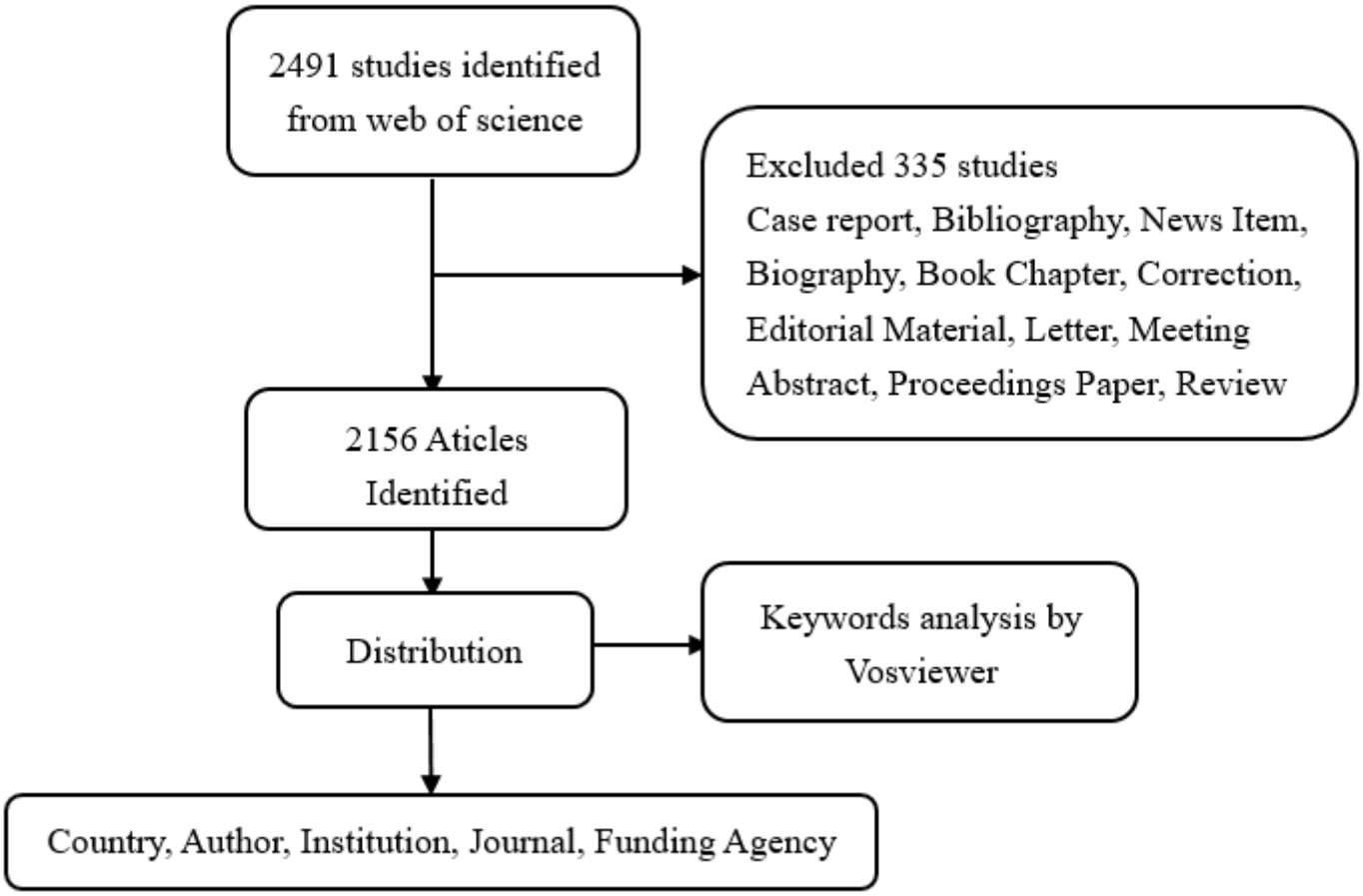
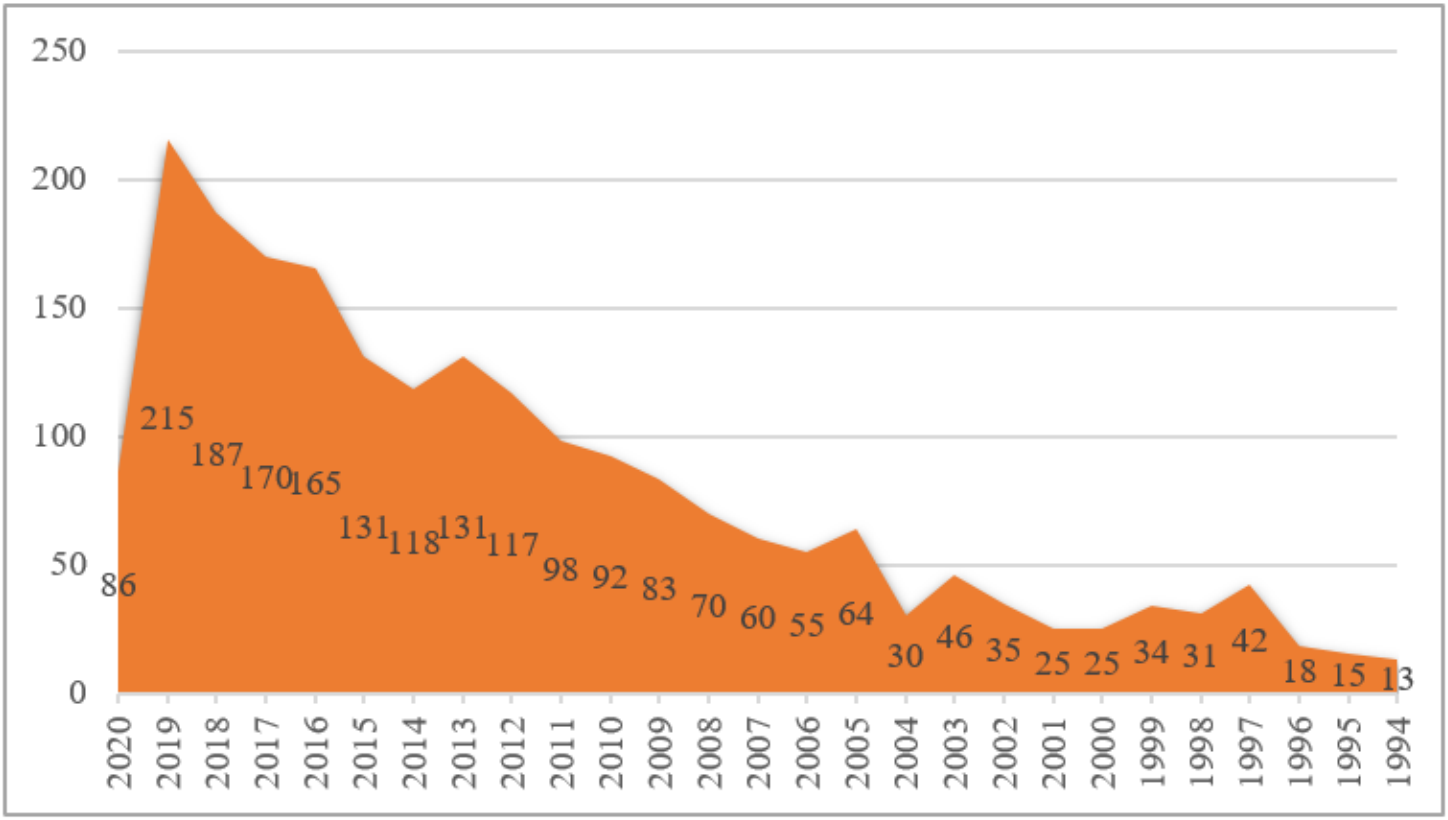


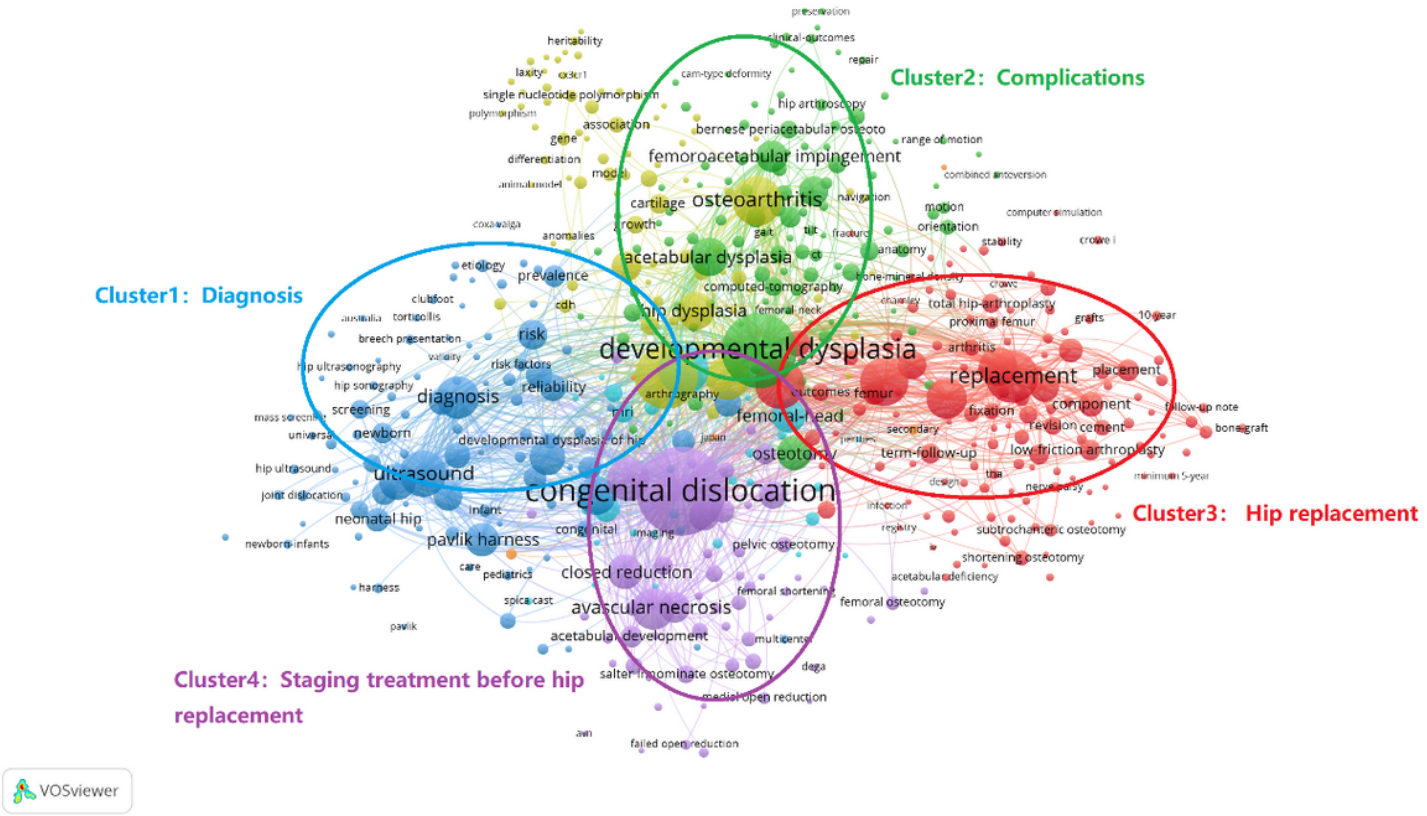

**Figure 1**

The inclusion and exclusion process of DDH research



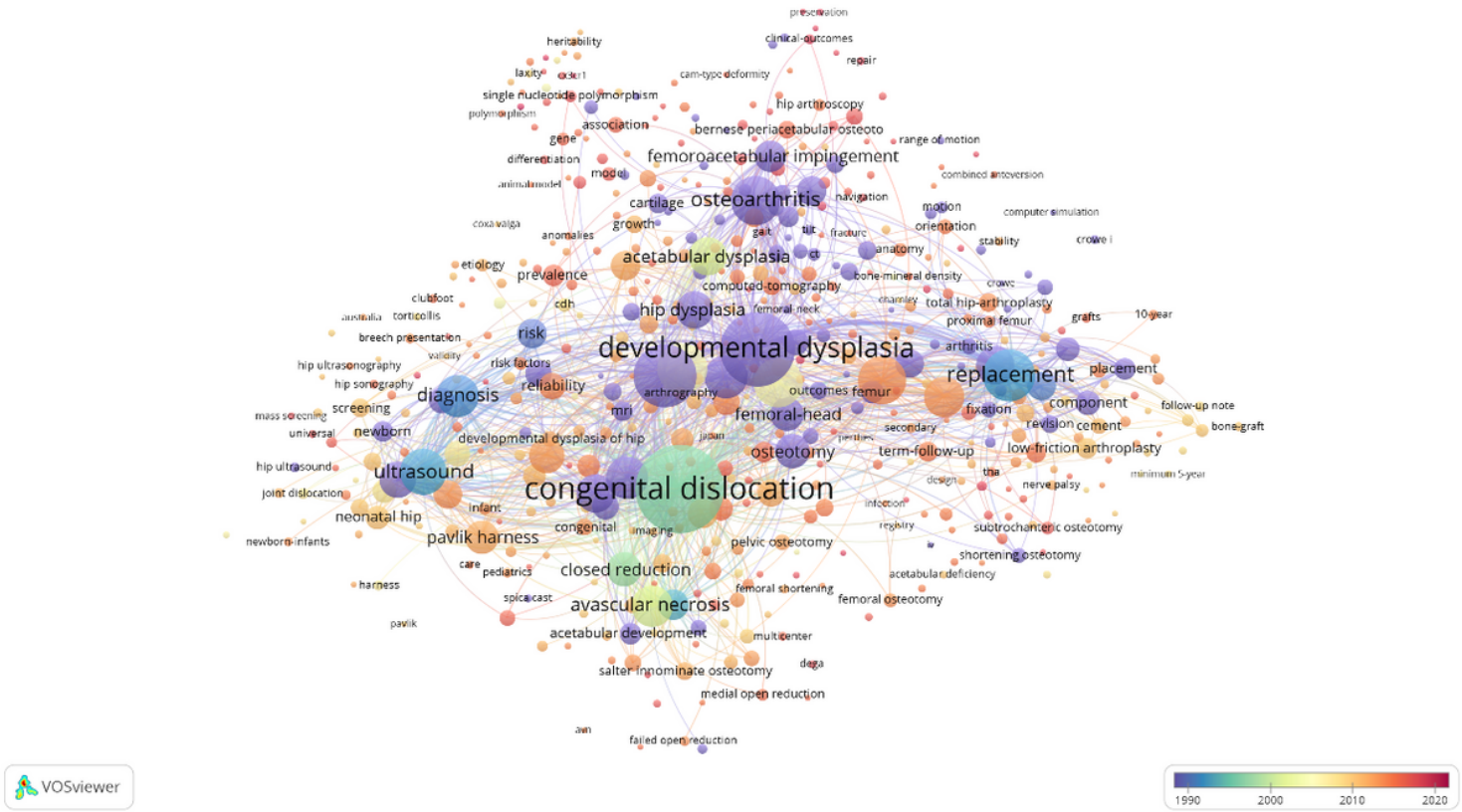

## Figure 2

Number of publications per year



## Figure 3

Co-occurrence analysis of research directions




## Figure 4

Co-occurrence analysis of research hotspot.