A Bibliometric Analysis of the 100 Most Cited Articles on Adjacent Segment Degeneration in Worldwide from 1985 to 2021

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Abstract

Study design.

A bibliometric review of the literature.

Objective.

The objective of our study is to research and analyze the most frequently cited 100 articles on adjacent segment degeneration (ASD).

Background.

Fusion is an effective method for degenerative diseases, however the problem of adjacent segment degeneration (ASD) after the fusion are also becoming increasingly important. Numerous of literatures and related researches promoted the development of this field. A bibliometric analysis of the 100 most cited articles on adjacent segment degeneration can supply lots of information and guide the future researches.

Methods.

We searched and identified the 100 top-cited articles from Web of Science (WOS), using title-specific search "adjacent segment degeneration". All articles published in English language between 1985 and 2021 were included. The following information were recorded and analyzed with bibliometric method: first author, article title, journal of publication, year of publication, total number of citations, country, institution and authors' specialty.

Results.

The most prolific years were 2015 and 2016, each had 12 articles published. The most citation years were 2020 and 2018, which the total citations were 522 and 438, respectively. The citation count of the top 50 articles ranged from 22 to 421. European Spine Journal contributed the maximum of 17 articles. With regard to the primary author's specialty, clinical neurology contributed to the majority of top 100 list with 75 articles, SHEN Y published the most of 5 articles. China mainland had produced 29 articles in the first. With regard to institutions, the most one was from Yonsei University with 8 articles.

Conclusion.

This study searched and analyzed the top 100 influential articles on ASD and provided a meaningful resource with detailed information for spine surgeons who may much more better to understand the trend in this filed. They can also benefit from the emphasis on citation count to prepare high-level articles by themselves in the future.

Introduction

With the development and application of lumbar pedicle screw fixation surgery, Posterior lumbar interbody fusion (PLIF) has become a classic spinal surgery and is widely used in the lumbar spine. This surgical method is effective for degenerative diseases, but the problem of adjacent segment degeneration (ASD) after the fusion are also becoming increasingly prominent, attracting more and more attention of scholars in this field.¹⁻³ In the 1950s, Cloward first developed the anterior cervical discectomy (anterior cervical discectomy and fusion, ACDF), gradually becoming the standard surgery for the treatment of cervical spondylosis.⁴ However, long-term studies have found that ACDF may affect the adjacent vertebral body of the fusion segment and the intervertebral disc is destroyed, resulting in ASD.⁵

Core collection of Web of Science (WOS) is the most authoritative natural scientific citation database and it contains more than 8,000 international, high influence academic journals about natural science, which is internationally recognized important tools for scientific statistics and scientific evaluation.⁶ More frequent citations of the article play more important role in the field.⁷ Bibliometric analysis of the most cited articles citation is a systematic method to identifying the influence of scientific researches.⁸ However, little is known about the most frequently cited literature on ASD.

The aim of this citation analysis is to identify and analyze the 100 most cited articles on ASD through a systematic search strategy, in order to better understand the research focus and development trend. Most importantly, our study provides valuable information for spine surgeons and researchers in the field of ASD.

Methods

The Core collection of WOS was searched using title-specific search “adjacent segment degeneration.” All studies published in English language between 1985 and 2021 and confined to ASD were included. The top 100 cited articles were identified using “Times cited” arranging articles from high to low according to citation count. All articles were evaluated by two independent reviewers in order to confirm their relevance to ASD. We recorded and analyzed the following information: first author, article title, journals of publication, year of publication, total number of citations, country/region, institution and authors’ specialty.

Results

Article Analysis

This search collected a total of 169 articles between 1985 and 2021 from Web of Science. Top 50 most cited articles are showed, including their rank, primary author, article title, journal, publication year and WOS citations. 30 articles focused on ASD after lumbar fusion and 20 articles on cervical fusion (Table 1). The citation count of the top 50 articles ranged from 22 to 421. The top article had 421 citations and was published in 2004 by Ghiselli, G⁹, followed by Kumar, MN¹⁰ with 400 citations in 2001 and Rahm¹¹ with 219 citations in 1996. The top 100 cited articles were identified and included for further statistical

analysis. The oldest article was published by Rahm in 1996.¹¹ and the most recent articles were published in 2020 by Sakaura Hironobu¹² and Xiong WY¹³ The articles published in recent 5 years accounted for 33% (Supplemental Figure). The most prolific years were 2015 and 2016, each had 12 articles published (Figure 1). The most citation years were 2020 and 2018, which the total citations were 522 and 438, respectively. Most importantly, the cited frequency of each year was significantly increased year by year except 2019 and 2021(Figure 2).

Table 1

50 Top-Cited Articles on Adjacent Segment Degeneration (ASD).

Rank	First author	Article title	Journal	Year	WOS
					citations
1	Ghiselli, G	Adjacent segment degeneration in the lumbar spine	Journal of Bone and Jointsurgery-American Volume	2004	421
2	Kumar, MN	Correlation between sagittal plane changes and adjacent segment degeneration following lumbar spine fusion	European Spine Journal	2001	400
3	Rahm, MD	Adjacent-segment degeneration after lumbar fusion with instrumentation: A retrospective study	Journal of Spinal Disorders	1996	219
4	Harrop, JS	Lumbar adjacent segment degeneration and disease after arthrodesis and total disc arthroplasty	Spine	2008	192
5	Okuda, S	Risk factors for adjacent segment degeneration after PLIF	Spine	2004	147
6	Matsumoto, M	Anterior Cervical Decompression and Fusion Accelerates Adjacent Segment Degeneration Comparison With Asymptomatic Volunteers in a Ten-Year Magnetic Resonance Imaging Follow-up Study	Spine	2010	120
7	Xia, XP	Prevalence of Adjacent Segment Degeneration After Spine Surgery A Systematic Review and Meta-analysis	Spine	2013	98
8	Jawahar, A	Total disc arthroplasty does not affect the incidence of adjacent segment degeneration in cervical spine: results of 93 patients in three prospective randomized clinical trials	Spine Journal	2010	97
9	Chou, WY	Adjacent segment degeneration after lumbar spinal posterolateral fusion with instrumentation in elderly patients	Archives of Orthopaedic and Trauma Surgery	2002	96
10	Helgeson, MD	Update on the evidence for adjacent segment degeneration and disease	Spine Journal	2013	94
11	Elsawaf, A	Effect of cervical dynamics on adjacent segment degeneration after anterior cervical fusion with cages	Neurosurgical Review	2009	68

12	Min, JH	The clinical characteristics and risk factors for the adjacent segment degeneration in instrumented lumbar fusion	Journal of Spinal Disorders & Techniques	2008	61
13	Kaito, T	Induction of early degeneration of the adjacent segment after posterior lumbar interbody fusion by excessive distraction of lumbar disc space Clinical article	Journal of Neurosurgery-Spine	2010	60
14	Anandjiwala, J	Adjacent segment degeneration after instrumented posterolateral lumbar fusion: a prospective cohort study with a minimum five-year follow-up	European Spine Journal	2011	59
15	Luo, JQ	Incidence of adjacent segment degeneration in cervical disc arthroplasty versus anterior cervical decompression and fusion meta-analysis of prospective studies	Archives of Orthopaedic and Trauma Surgery	2015	58
16	Korovessis, P	Does Wallis implant reduce adjacent segment degeneration above lumbosacral instrumented fusion?	European Spine Journal	2009	55
17	Yang, BH	The Incidence of Adjacent Segment Degeneration after Cervical Disc Arthroplasty (CDA): A Meta Analysis of Randomized Controlled Trials	Plos One	2012	54
18	Yang, JY	The impact of adjacent segment degeneration on the clinical outcome after lumbar spinal fusion	Spine	2008	52
19	Bae, JS	Adjacent Segment Degeneration After Lumbar Interbody Fusion With Percutaneous Pedicle Screw Fixation for Adult Low-Grade Isthmic Spondylolisthesis: Minimum 3 Years of Follow-up	Neurosurgery	2010	51
20	Carrier, CS	Evidence-based analysis of adjacent segment degeneration and disease after ACDF: a systematic review	Spine Journal	2013	50
21	Mannion, AF	ISSLS Prize Winner: Long-Term Follow-up Suggests Spinal Fusion Is Associated With Increased Adjacent Segment Disc Degeneration But Without Influence on Clinical Outcome Results of a Combined Follow-up From 4 Randomized Controlled Trials	Spine	2014	47
22	Disch, AC	Higher risk of adjacent segment	Journal of	2008	44

		degeneration after floating fusions: Long-term outcome after low lumbar spine fusions	Spinal Disorders & Techniques		
23	Zhang, C	Adjacent Segment Degeneration Versus Disease After Lumbar Spine Fusion for Degenerative Pathology A Systematic Review With Meta-Analysis of the Literature	Clinical Spine Surgery	2016	42
24	Malakoutian, M	Do in vivo kinematic studies provide insight into adjacent segment degeneration? A qualitative systematic literature review	European Spine Journal	2015	38
25	Li, J	Adjacent segment degeneration after single-level anterior cervical decompression and fusion: Disc space distraction and its impact on clinical outcomes	Journal of Clinical Neuroscience	2015	37
26	Park, JY	What are the associative factors of adjacent segment degeneration after anterior cervical spine surgery? Comparative study between anterior cervical fusion and arthroplasty with 5-year follow-up MRI and CT	European Spine Journal	2013	35
27	Kim, JY	Paraspinal muscle, facet joint, and disc problems: risk factors for adjacent segment degeneration after lumbar fusion	Spine Journal	2016	34
28	Yoshida, G	Subaxial sagittal alignment and adjacent-segment degeneration after atlantoaxial fixation performed using C-1 lateral mass and C-2 pedicle screws or transarticular screws	Journal of Neurosurgery-Spine	2010	34
29	Okuda, S	Lamina Horizontalization and Facet Tropism as the Risk Factors for Adjacent Segment Degeneration After PLIF	Spine	2008	34
30	Axelsson, P	Adjacent segment hypermobility after lumbar spine fusion - No association with progressive degeneration of the segment 5 years after surgery	Acta Orthopaedica	2007	34
31	Chen, BL	Adjacent segment degeneration after single-segment PLIF: the risk factor for degeneration and its impact on clinical outcomes	European Spine Journal	2011	33
32	Bertagnoli, R	Treatment of symptomatic adjacent-segment degeneration	Journal of Neurosurgery-	2006	32

after lumbar fusion with total disc arthroplasty by using the ProDisc prosthesis: a prospective study with 2-year minimum follow up

Spine

33	Pan, AX	Adjacent segment degeneration after lumbar spinal fusion compared with motion-preservation procedures: a meta-analysis	European Spine Journal	2016	31
34	Ji, GY	Stand-alone Cervical Cages Versus Anterior Cervical Plates in 2-Level Cervical Anterior Interbody Fusion Patients Analysis of Adjacent Segment Degeneration	Journal of Spinal Disorders & Techniques	2015	31
35	Zencica, P	Adjacent Segment Degeneration after Lumbosacral Fusion in Spondylolisthesis: A Retrospective Radiological and Clinical Analysis	Acta Chirurgiae Orthopaedicae Et Traumatologiae Cechoslovaca	2010	31
36	Komura, S	Lower Incidence of Adjacent Segment Degeneration After Anterior Cervical Fusion Found With Those Fusing C5-6 and C6-7 Than Those Leaving C5-6 or C6-7 as an Adjacent Level	Journal of Spinal Disorders & Techniques	2012	29
37	Kim, HJ	The influence of intrinsic disc degeneration of the adjacent segments on its stress distribution after one-level lumbar fusion	European Spine Journal	2015	28
38	Cho, KS	Risk Factors and Surgical Treatment for Symptomatic Adjacent Segment Degeneration after Lumbar Spine Fusion	Journal of Korean Neurosurgical Society	2009	28
39	Park, JY	New prognostic factors for adjacent-segment degeneration after one-stage 360 degrees fixation for spondylolytic spondylolisthesis: special reference to the usefulness of pelvic incidence angle	Journal of Neurosurgery-Spine	2007	28
40	Heo, Y	Symptomatic adjacent segment degeneration at the L3-4 level after fusion surgery at the L4-5 level: evaluation of the risk factors and 10-year incidence	European Spine Journal	2015	27
41	Liang, JQ	Risk factors for predicting symptomatic adjacent segment degeneration requiring surgery in patients after posterior lumbar fusion	Journal of Orthopaedic Surgery And Research	2014	27
42	Videbaek, TS	Adjacent Segment Degeneration	Spine	2010	27

After Lumbar Spinal Fusion: The Impact of Anterior Column Support A Randomized Clinical Trial With an Eight- to Thirteen-Year Magnetic Resonance Imaging Follow-up

43	Hoogendoorn, RJW	Adjacent segment degeneration - Observations in a goat spinal fusion study	Spine	2008	27
44	Shriver, MF	Adjacent segment degeneration and disease following cervical arthroplasty: a systematic review and meta-analysis	Spine Journal	2016	26
45	Hashimoto, K	Adjacent segment degeneration after fusion spinal surgery a systematic review	International Orthopaedics	2019	25
46	Maruenda, JI	Adjacent segment degeneration and revision surgery after circumferential lumbar fusion: outcomes throughout 15 years of follow-up	European Spine Journal	2016	25
47	Lundine, KM	Prevalence of adjacent segment disc degeneration in patients undergoing anterior cervical discectomy and fusion based on pre-operative MRI findings	Journal of Clinical Neuroscience	2014	24
48	Sun, Y	Comparison of adjacent segment degeneration five years after single level cervical fusion and cervical arthroplasty: a retrospective controlled study	Chinese Medical Journal	2012	24
49	Xu, S	Adjacent segment degeneration or disease after cervical total disc replacement: a meta-analysis of randomized controlled trials	Journal of Orthopaedic Surgery and Research	2018	22
50	Lu, K	Reduction in adjacent-segment degeneration after multilevel posterior lumbar interbody fusion with proximal DIAM implantation	Journal of Neurosurgery-Spine	2015	22

Abbreviation: ASD, Adjacent Segment Degeneration; WOS, Web of Science.

Journal Analysis

The top 100 articles were published in 33 different journals. European Spine Journal had the highest number of articles 17. Second journal with highest number of articles is Spine with 15 articles, followed by Journal of Neurosurgery Spine with 11 articles, Spine Journal with 9 articles and Journal of Spinal

Disorders Techniques with 6 articles (Table 2). In addition, there were still 4 journals with 2 articles for each and 19 journals with only 1 article.

Table 2

List of Top 10 Journals on Adjacent Segment Degeneration.

Journal	Number of Articles	Impact factor (5 year)
European Spine Journal	17	2.586
Spine	15	3.119
Journal of Neurosurgery -Spine	11	3.230
Spine Journal	9	3.558
Journal of Spinal Disorders Techniques	6	2.490
Journal of Orthopaedic Surgery and Research	5	2.145
Archives of Orthopaedic and Trauma Surgery	3	2.070
Plos One	3	3.227
Clinical Spine Surgery	2	1.694
Journal of Clinical Neuroscience	2	1.749

Specialty and author Analysis

With regard to the primary author's specialty, clinical neurology contributed to the majority of top 100 list with 75 articles. Second specialty with highest number of articles is Orthopedics with 65 articles, followed by Surgery with 29 articles, Multidisciplinary Sciences with 3 articles and Medicine General Internal with 2 articles (Table 3). The most frequently mentioned author in all articles was Shen Y, who came from the department of orthopaedic surgery in the third hospital of Hebei Medical University in China. He has contributed to top 100 list with 5 publications¹⁴⁻¹⁸, 4 of them were as corresponding author. The total citation of these articles was 81 times. Most of his study focused on clinic researches, but he also did basic research, which was published on Journal of Bone and Mineral Research in 2015.¹⁴ An HS and other 12 authors contributed to 3 publications each.

Table 3

List of Primary Authors' Specialty on Adjacent Segment Degeneration.

Rank	Specialty	Number of Articles
1	Clinical neurology	75
2	Orthopedics	65
3	Surgery	29
4	Multidisciplinary sciences	3
5	Medicine general internal	2
6	Medicine research experimental	2
7	Neurosciences	2
8	Endocrinology metabolism	1
9	Health care sciences services	1

Table 4

List of Most Frequent Authors on Adjacent Segment Degeneration.

Author	Number of Articles	Author	Number of Articles
Shen Y	5	Iwasaki M	3
An HS	3	Kim KS	3
Andersson GBJ	3	Kuh SU	3
Chin Dk	3	Lee SH	3
Cho YE	3	Natarajan RN	3
Fuji T	3	Okuda S	3
Hosono N	3	Park JY	3

Countries /regions Analysis

China had contributed 29 articles to the top 100 at rank 1. United States is the second contributing country with 21 articles, followed by South korea with 19 articles and Japan with 14 articles. These four countries contributed to more than 80% of the top100 cited articles.

Rest of the countries and their number of articles are shown in Table 5.

Table 5

List of Top 10 Countries /regions and Number of Articles Published on ASD

Rank	Country/ region	Number of Articles
1	China Mainland	29
2	United States	21
3	South korea	19
4	Japan	14
5	China (Taiwan)	4
6	England	3
7	France	3
8	Germany	3
9	Spain	3
10	Sweden	3

Institutions Analysis

There are 11 different institutions with 3 or more publications on ASD in all over the world. Yonsei University contributed the most number of articles with 8 publications, followed by Yonsei University Health System with 7 articles, Hebei Medical University and Rush University with 5 articles each (Table 6).

Table 6
Institutions With 3 or More Publications on ASD

Name of Institution	Number of Articles
Yonsei University	8
Yonsei University Health System	7
Hebei Medical University	5
Rush University	5
Peking University	4
Capital Medical University	3
Catholic University Of Korea	3
Osaka Rosai Hospital	3
Seoul National University Snu	3
University Of California System	3
Yale University	3

Discussion

Lumbar fusion has been used to treat lumbar spine diseases for more than a century. In recent years, surgical methods for lumbar fusion and internal fixation instruments have become more and more mature. The fusion rate of lumbar fusion surgery has significantly increased than before.¹⁹⁻²⁰ However, fusion surgery changes the biomechanics of the spine, which possibly accelerate the degeneration of adjacent segments²¹⁻²². The recurrence of back and leg pain in patients affects the long-term curative effect after fusion. In addition, some patients even need reoperation²³⁻²⁵, which will bring a heavy economic and psychological burden to patients. ACDF is the most commonly used surgical method for the treatment of cervical spondylosis, although this surgery has achieved significant clinical results effective, but about 3% of patients have degenerative changes in adjacent segments after surgery.²⁶ Therefore, a great number of literature has emerged on this field in recent years.

From our bibliometric analysis of the 100 most cited articles on adjacent segment degeneration, we know the study with highest number of citations was a retrospective investigation with Level of IV Evidence, titled "Adjacent segment degeneration in the lumbar spine", which was published in 2004 in Journal of Bone and Joint Surgery-American Volume.⁹ The citations of this article was 421. Two hundred and fifteen patients who had undergone posterior lumbar arthrodesis were included in this study. The study group included 126 female patients and eighty-nine male patients. The average duration of follow-up was 6.7 years. They got a conclusion that the rate of symptomatic degeneration at an adjacent segment warranting either decompression or arthrodesis was predicted to be 16.5% at five years and 36.1% at ten

years. There appeared to be no correlation with the length of fusion or the preoperative arthritic degeneration of the adjacent segment.

The second most cited article was by Malhar Kumar published in 2001 in European Spine Journal with 400 citations¹⁰. The title of this study was correlation between sagittal plane changes and adjacent segment degeneration following lumbar spine fusion. Eighty-three consecutive patients who underwent lumbar fusion for degenerative disc disease were reviewed retrospectively. Mean follow-up period was 5 years. It was concluded that normality of sacral inclination was an important parameter for minimizing the incidence of adjacent level degeneration. Retrolisthesis was the most common type of adjacent segment change. Patients with post-operative sagittal plane abnormalities should preferably be followed-up for at least 5 years to detect adjacent level changes.

The third most cited article was also a retrospective study carried by Marked D Rahm in Journal of Spinal Disorders in 1996, focusing on the issue of ASD after lumbar fusion with instrumentation.¹¹ At the same time, this article was also the oldest published literature on ASD, indicating that spine surgeons have already realized the problem of ASD after fusion since 1996. The most recent publication in the 100 top list was a comparative study published in 2020 in Journal of Neurosurgery-Spine, which compared cortical bone trajectory (CBT) screw fixation and traditional trajectory screw fixation in posterior lumbar interbody fusion.¹² The medical records of all patients who had undergone single-level CBT-PLIF or single-level using traditional trajectory screw fixation(TT-PLIF) for degenerative lumbar spondylolisthesis (DLS) and with at least 3 years of postsurgical follow-up were retrospectively reviewed. It was concluded that CBT-PLIF, as compared with TT-PLIF, significantly reduced the incidence of early cephalad radiological ASD changes (R-ASD). One possible explanation may be that cephalad CBT screws reduced the risk of proximal facet violation by the screw, which reportedly can increase biomechanical stress and lead to destabilization at the suprajacent segment to the fused segment.²⁷⁻²⁹ It may provide a better choice to deal with ASD after fusion. However, the long-term effect of using CBT screws is still unknown. Multi-center and long-term follow-up study with more patients is needed. Spine surgeons and researchers should pay more attentions to it.

Xiong WY et al¹³ conducted a retrospective analysis with Level of IV Evidence, titled “0.5-to 1-Fold Intervertebral Distraction Is a Protective Factor for Adjacent Segment Degeneration in Single-level Anterior Cervical Discectomy and Fusion”, which was published in 2020 in Spine. They focused on the issue of ASD after cervical fusion. They concluded that good clinical and radiological outcomes were achieved in ACDF with 0.5- to 1-fold distraction. Segmental kyphosis is a risk factor for ASD in ACDF, whereas 0.5- to 1-fold distraction is a protective factor of ASD.

In this study, we found that the most articles were published in European Spine Journal (17/100). As all we know, European Spine Journal is a publication founded in response to the increasing trend toward specialization in spinal surgery and spinal pathology in general. The Journal is devoted to all spine related disciplines, including functional and surgical anatomy of the spine, biomechanics and

pathophysiology, diagnostic procedures, and neurology, surgery and outcomes. It is an influential Journal in the field of spine.

According to the result, we found that the 100 most cited articles were published by researchers with totally different specialties, including clinical neurology, orthopedics, surgery, multidisciplinary sciences, medicine general internal, and so on. Clinical neurology was the top 1 in the list with 75 articles, suggesting that neurosurgeons pay more attentions to ASD than spine surgeons. Meanwhile, when it comes to the list of top 10 countries and institutions on ASD, we knew China Mainland was the first with 29 articles, in which Hebei Medical University, Peking University and Capital Medical University were involved. They contributed more than 40% articles in China Mainland. The main reason may be China has the most patients who had undergone fusion surgery in all over the world. This is also in accordance with the fact that the most frequently mentioned author was Shen Y, who came from Hebei Medical University in China. The second country was USA with 21 articles, Rush University and University of California System contributed most. Yonsei University from South korea was the most institutions with 8 Publications on ASD.

Limitations

As all we know, bibliometric analysis is widely used to measure the impact of articles in recent years. However, there are still some limitations in this method. First and foremost, we only used the core collection of Web of Science (WOS) for searching literature, which is a single database in fact. The more databases we use, the more information we can get and analyze. Other databases such as InCites and MEDLINE should be considered in future. Second, we searched and identified these articles using title-specific search“adjacent segment degeneration”, which more specific articles were involved. But it definitely missed some related articles on ASD. On the other hand, using the topic of ASD to search was also a potential limitation. Third, main language of WOS is English. Articles written by other languages are excluded, which means some relevant articles to be not included. Last but not the least, citation number of each literature is time-dependent. Different time to search the articles, different citations may obtain. However, the trend of citation number of each literature is nearly the same.

This study has several advantages in despite of some limitations we have mentioned. It is the first time to use bibliometric method to search and identify literatures on ASD, which has attracted increasing attention in recent years. Most importantly, our study provides valuable information for spine surgeons and researchers in the field of ASD.

Conclusion

Our study is the first time to analyze the top 100 most cited articles on ASD by a bibliometric procedure. It sheds light on the contribution of different authors, journals, Specialty, Countries /regions and institutions to the evolution of current understanding of adjacent segment degeneration ASD, which we believe it will

better guide the future researches from the most influential publications. In addition, it can also serve as the foundation of clinical strategy making and recent studies on ASD.

Abbreviations

ASD: Adjacent segment degeneration; WOS: Web of Science; PLIF: Posterior lumbar interbody fusion; ACDF: Anterior cervical discectomy and fusion; CBT: Cortical bone trajectory; DLS: Degenerative lumbar spondylolisthesis; R-ASD: Radiological adjacent segment degeneration.

Declarations

Ethics approval and consent to participate

Not applicable

Consent for publication

Not applicable

Availability of data and materials

The data collected and analyzed in the article are from WOS, an open access database of scholarly articles, and are properly adopted and collected.

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

Lijin Zhou and Yunzhong Cheng designed the study. Yue Li and Hongyi Lu collected the data. Yuzeng Liu performed the data analysis. Yunzhong Cheng wrote the manuscript. Yong Hai revised the manuscript and decided to submit the manuscript for publication. All authors read and approved the final manuscript.

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Figures

Figure 1

The most prolific years were 2015 and 2016, each had 12 articles published (Figure 1).

Figure 2

Most importantly, the cited frequency of each year was significantly increased year by year except 2019 and 2021(Figure 2).

Supplementary Files

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