

International Publication Trends in Low Back Pain Research: A Bibliometric and Visualization Analysis

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Research

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Abstract

Background

Despite the increasing research on low back pain, the bibliometric literature in the field of low back pain is limited. The aim of this study was to perform a bibliometric and visualization analysis of low back pain.

Methods

The authors searched the Web of Science database to extract publications regarding low back pain in the last 22 years. A total of 12,201 publications were eligible. We classified and analyzed publications such as total citations, average citations per item, H-index, research types, countries/regions, institutions and journals by using standard bibliometric indicators. Bibliometric methods and tools were used to explore the trends of low back pain research.

Results

Over the past 22 years, the number of publications on low back pain in the world had continually remained an increasing trend. Regional differences existed in the research of low back pain and developed countries played a leading role in the research. Research institutions and researchers have successively invested in the research of low back pain. However, there were limitations to the present study that should be noted that the study was relatively scattered and a systematic summary of the trends and characteristics was lacking. Visualization analysis provides valuable information for researchers to identify new perspectives on potential collaborators and cooperative institutions, which promote indirect cooperation. Besides, the most burst keywords were “primary-care”, “lumbar spine” and “disability”.

Conclusion

This study provided a number of important insights into the global research trends and current status related to low back pain which is helpful for clinicians, researchers and policy makers to understand the research field and predict its dynamic directions. Our article could be used to quantify and academic publications about low back pain in order to obtain an overview of the given field of study and provide references and suggestions for the future work of low back pain.

1. Introduction

Low back pain (LBP) is one of the most common diseases encountered by medical workers which is often associated with other complications, such as symptoms of sciatica and lumbalgia [1]. The prevalence of LBP gradually augments 11.4% each year and between 60% and 80% of the population will encounter this problem in the world [2]. Recent studies have described it will cause 40% of all absences from work and reduces the productivity of the affected in the world [3, 4]. In America, the economic loss due to reducing productivity of LBP amounted to \$100 billion in 2006 [5, 6, 7]. The number of literature and funds on LBP are growing with the increasing attention to LBP [6]. The concentration of research has contributed to alleviating long-term suffering from LBP and reducing the medical economic burden. Furthermore, more achievements in scientific research are

published in various journals in the form of articles [8]. Bibliometrics is a statistical analysis and quantitative implement to published works [9, 10]. The qualitative and quantitative evaluation of literature could be analyzed by bibliometrics through the literature system and characteristics of literature metrology as objects of study [11–13]. It plays an important role in the scientific research by researchers because researchers could understand the current status of research fields characterized by bibliometrics through measuring scientific output. Bibliometrics also assists them to confirm the range of research topics, recognize new topics, and helps them to project their research directions and predict research trends [14].

Although some attempts have been made by researchers about bibliometrics of LBP, there are still some shortcomings of quality and timeliness of literature. None of the studies have reported the overall research status of LBP in the world yet. So we adopted bibliometric analysis methods to analyze the research progress and growth trends in this field during the 22-year period from 1999 to 2020, by which we could understand the current situation of LBP research and provide objective data for subsequent research.

2. Methods

2.1. Data Sources and Search Strategy

We chose the Web of Science database as the data source to identify and extract relevant publications existing no ethical questions. A list of key words and free text terms was determined with the help of the thesaurus of Medical Subject Headings (MeSH) and guidelines. A search strategy is expressed in Table 1. This strategy was searched in Aug. 2020 yielding a total of 12,201 hits, which were downloaded into Endnote X7. Moreover, we screened titles and abstracts in relation to the inclusion and exclusion criteria. The inclusion criteria were as follow: (1) published in English; (2) published between 1999 and 2021 Feb.; (3) the outcome is potent; (4) the publications types were classified into article. Studies meeting the following were excluded: (1) publication type was animal experiment; (2) publications of low quality assessed by impact factor (IF), using total citations frequency, average citations per item and H-index; (3) repeated publications; (4) treatment effect is not obvious.

Table 1
Electronic search strategy.

Electronic database
Web of Science (http://isiknowledge.com)
Search strategy for the Web of Science database
Search 1: T1 = ("Low Back Pain", "Back Pain, Low", "Back Pains, Low", "Low Back Pains", "Pain, Low Back", "Pains, Low Back", "Lumbago", "Lower Back Pain", "Back Pain, Lower", "Back Pains, Lower", "Lower Back Pains", "Pain, Lower Back", "Pains, Lower Back", "Low Back Ache", "Ache, Low Back", "Aches, Low Back", "Back Ache, Low", "Back Aches, Low", "Low Back Aches", "Low Backache", "Backache, Low", "Backaches, Low", "Low Backaches", "Low Back Pain, Postural", "Postural Low Back Pain", "Low Back Pain Posterior Compartment", "Low Back Pain, Recurrent", "Recurrent Low Back Pain", "Low Back Pain, Mechanical", "Mechanical Low Back Pain")(combined by OR operator).
Search 2: T2 = ("article", "review", "meeting abstract", "pro-ceedings paper", "letter", "case report") (combined by OR operator).
Final Search: (Search 1 AND Search 2)

2.2. Statistical analysis

We used Endnote X7 (<https://endnote.com/>) to exclude publications and further screen after reading the information. Total publications, research types, research orientations, research organization, author's contribution, journal and publications situation (total citations frequency, average citations per item and H-index) were analyzed statistically by HistCite software to mitigate the disagreements. We used VOSviewer1.6.13 to perform a bibliometric analysis to establish visualization knowledge maps. Figures were processed by Adobe Illustrator CS5 software (Adobe Corporation). Bibliometric analysis platform ([https:// bibliometric.com](https://bibliometric.com)) was used to analyze International collaboration between countries/regions. We also used CiteSpace 5.7.R1 to analyze the strongest citation bursts. Furthermore, in order to analyze year related to publishment outputs and Impact Factor (IF) related to journal, we used IBM SPSS Statistics software 22.0 to conduct Pearson's correlation analysis.

3. Results

3.1. Total publications of LBP per year in the world

A total number of 12,477 records were retrieved. Based on the inclusion and exclusion criteria, a total of 12,201 articles were eventually included with the flow diagram of the data collection process and were further evaluated (Fig. 1). As shown in Fig. 2(a), the publication outputs went through a period of fluctuation between 1999 and 2011. Conversely, the number of published articles has a very large acceleration after 2011. Pearson's correlation analysis revealed that the publication outputs are highly correlated to the year of publication ($r = 0.889$, $P < 0.001$). As previously mentioned in the literature, researchers develop a more rational and deeper understanding of LBP.

3.2. Countries/regions related to LBP

The 12,201 articles were published by journals of 117 countries/regions participating in LBP research. Among them, the United States published the most articles (26.5%) followed by Australia (10.1%), England (9.7%), Canada (6.4%) and Netherlands (6.2%) (Fig. 2bc). This demonstrated that there are regional differences in the degree of research on LBP. The United States has the highest total local citation score and the H-index playing a leading role in the research of LBP.

3.3. Analysis of subject categories

The papers covered 114 subject categories. In the top 20 subject categories (Fig. 3), the Orthopedics subject category had the most number of papers and open access. The Clinical Neurology had the most citations, citations per paper and the highest H-index. The two subject categories showed that the research of musculoskeletal system and nervous system play indispensable roles in LBP. The top 20 subject categories indirectly indicated the related aetiology and treatment for LBP.

3.4. Analysis of journals

The included publications were published in 1466 journals, which revealed that scores of journals attach great significance to the relevant research of LBP and the range of research is wide. As shown in Table 2, Spine published the most papers (7.5%), meanwhile, it had the highest H-index. Journals and IF by Pearson's correlation analysis had low correlations. ($r = -0.142$, $P = 0.696 > 0.001$). From this we could speculate that journals with high IF may have stricter and higher standards to publish articles. It is an ambitious work to publish articles in the journals with high IF.

Table 2
Top 10 leading journals with LBP publications.

Journal	Papers	Citations (Total global citation score)	Average citations	H- index	Open access	WoS categories	IF (2019)	Quartile
Spine	918	45816	19.93	114	77	Clinical Neurology; Orthopedics	2.646	Q2; Q2
European Spine Journal	392	14856	16.96	57	278	Clinical Neurology; Orthopedics	2.458	Q3; Q2
BMC Musculoskeletal Disorders	312	5947	7.55	37	316	Orthopedics; Rheumatology	1.879	Q3; Q4
Spine Journal	224	6434	11.36	43	28	Clinical Neurology; Orthopedics	3.191	Q2; Q1
Annals of the Rheumatic Diseases	214	1680	2.82	13	66	Rheumatology	16.102	Q1
Pain	210	9563	14.74	57	39	Anesthesiology; Clinical Neurology; Neurosciences	5.483	Q1; Q1; Q1
Journal of Manipulative and Physiological Therapeutics	207	3640	7.12	35	24	Health Care Sciences Services; Integrative Complementary Medicine; Rehabilitation	1.23	Q4; Q3; Q3
Journal of Back and Musculoskeletal Rehabilitation	191	1227	2.78	16	13	Orthopedics; Rehabilitation	0.821	Q1; Q1; Q1
Journal of Orthopaedic & Sports Physical Therapy	177	3975	9.80	32	70	Orthopedics; Rehabilitation; Sport Sciences	3.839	Q1; Q1; Q1
Pain Medicine	165	3081	5.48	30	153	Anesthesiology; Medicine General Internal	2.513	Q2; Q2

3.5. Analysis of collaboration

In the co-authorship (Fig. 4a), 29,365 authors involved in publishing 12,201 articles. We elected “Minimum number of documents of an author” as 53 and “Minimum number of citations of an author” as 100. The network map showed some dominant teams. Maher, christopher g., Latimer, jane, Hancock, mark j., Maher, chris g., Mcauley, james h., Koes, bart w., Van tulder, maurits w. and Hodges, paul w. cooperated closely, while Fritz, julie m. and

George, Steven Z. had less collaboration. In the collaboration of institutions (Fig. 4b), 9,274 institutions involved in LBP research. University of Sydney showed a comparably broad range of cooperation with others and a strong academic influence. The strongest partnerships were identified among University of Sydney, Macquarie University, University of Newcastle, University of Fed Minas Gerais and University of Cidade Sao Paulo. In the collaboration of countries/regions (Fig. 4c), the USA was the most engaged in international cooperation followed by Australia, Netherlands, Canada and UK. USA and Brazil as well as Belgium and Netherlands had cohesive collaboration.

3.6. Analysis of references

Reference analysis is one key characteristic of bibliometric studies. The top 25 references with the strongest occurrence burst are shown in Fig. 5a. References are representatives of the knowledge basics of research frontiers. The top 25 references increased sharply in 1999 or even before. Citation bursts were led by Jensen MC, et al. which had the strongest burst (22.2288), Shekelle PG, et al., Ware JE, et al., Papageorgious AC, et al. and Riihimaki H, et al.

3.7. Analysis of keywords

The top 25 keywords with the strongest occurrence burst are shown in Fig. 6a. Occurrence burst, which indicates a steep increase in occurrence over a period of time, represents changes in frontier topics and dynamics in a research field [15]. The 25 keywords increased sharply in 1999 or even before. In the following years the occurrence of 25 keywords declined, which demonstrated that researchers contiguously strengthen research and infuse new blood into the development of LBP research. From the network map of keywords (Fig. 6b), the clinical classification of LBP studies had increased in recent years. The keywords of low back pain, disability, management and lumbar spine showed the highest occurrence, revealing that etiology, treatment, effect and prognosis have become the leading direction of LBP research.

4. Discussion

In 22 years of relevant articles showed that research interest in LBP was growing, which revealed that greater emphasis is now placed on LBP research. Albeit with the concerted efforts of all countries/regions, developed countries such as the United States and the United Kingdom played a crucial role during this period. A startling discovery is that universities and other teaching institutions become the forefront of academic research. Journals related to the etiology and treatment of LBP stand out. Furthermore, the most burst keywords were “primary-care”, “lumbar spine” and “disability” in the field of LBP, among of which showed the research priorities of LBP.

Clinically, a certain disease roughly undergoes some research process including pathogenesis, pathology, clinical manifestation, diagnosis, treatment and prevention [16]. We used VOSviewer to visualize the frequency of occurrence and the trend of keywords in the wake of time, by which we found that the current research focused on the pathology, classification and diagnosis of LBP. LBP is a complicated symptom that has many factors. The factors could be roughly divided into physical agents (such as prolonged standing and lifting heavy weights), an unhealthy lifestyle (such as smoking and obesity) and psychological factors (such as distress and the expectations that pain indicates bodily harm or injury) [17, 18]. Clinically, when the pathological cause of the LBP cannot be identified, the pain will be classified as non-specific LBP [19]. Currently, there is no well accepted single classification since the taxonomy of LBP is underdeveloped [20]. Some studies indicated that there is a classification system for LBP as mechanical or neuropathic in clinical practice [21], which was consistent with our

analysis of subject categories. In the management of LBP, musculoskeletal system and nervous system hold great potential [22]. Despite an intensive research focus on LBP, definitive diagnostic methods are largely unavailable and standard terminology is not yet broadly adopted [21]. Therefore, it is necessary to develop consensus diagnostic methods and standard terminology for the application of LBP as tools to guide clinicians toward a better mastery of clinical decisions, focusing on accurate diagnosis and detection of red flags and avoid the establishment of false-positive or false-negative diagnoses [23]. Treatment of LBP is also a hot topic of researches. On the basis of the maps of our analysis, physiotherapy, drugs, surgical treatment and complementary and alternative medicine were the vital research contents of treatment, whereas over time, the research on drug and surgical treatment decreased gradually. Some evidence showed that there is a wide acceptance that the management of LBP should begin in primary care [24]. With a strong growth in research on different therapy, developing comprehensive and multilevel guidelines to provide specific recommendations to fill the gaps in research is likely to become increasingly important in the world [25, 26]. At present, the guidelines will be updated within three to five years after publication if new evidence alters the recommendations [27]. The current guidelines urgently need more clinical trials to conduct reasonable research on the diagnosis and treatment of LBP [28].

In the last years, there were two bibliometric analysis studies on LBP [29, 30]. The one provided an insight into the trends of development in the applications of acupuncture for LBP, and the other concentrated on the evaluation of the research situation and captured subsequent developmental dynamics regarding nonspecific LBP [29, 30]. Compared with previous studies, we generated a comprehensive strategy and did not limit the search for document types of LBP, or did not present specific treatment for LBP. Therefore, we can provide more valuable information for researchers to identify hot topics and research frontiers on LBP. What's more, we conducted Pearson's correlation analysis by SPSS software to show development trends on LBP scientifically. Such a bibliometric analysis on LBP related to data analysis has never been performed previously.

The limitations existed in the study, which should be taken into consideration in the further research. First, the electronic database was limited to Web of Science, which might lead to some influential papers missed. Second, we aimed to do research on the global trend of LBP, but the non-English papers were excluded, which may have led to selection bias. Third, the cited frequency of the paper is influenced by the IF, author, organization, other factors of the journal and the time of publication (the previously published research should be cited more frequently than the recent research). Therefore, there may be some deviations in reflecting the academic impact of the paper by the number of citations.

Conclusion

In conclusion, the annual number of publications on LBP have increased sharply in the past two decades, showing that LBP had the potential to be studied precisely and was getting more and more attention. Developed countries like the United States is leading this research field with the largest number of publications, therefore, Chinese researchers should absorb the experience of other countries to identify gaps in the current scientific knowledge to be addressed through future research and promote the development of the research of LBP. Our study offered an insight into the trend of LBP, which may help researchers to explore new directions for future research in this field.

Declarations

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Author contributions

FH and BSZ were responsible for concept and design, CSW, BSZ, SYZ, YYX, ZYL and CYH for drafting the article and its critical revision, and ZYF and SW for approval of the article.

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Availability of data and materials

All data generated or analysed during this study are included in this published article.

Ethics approval and consent to participate

Not applicable.

Consent for publication

Not applicable.

Competing interests

The authors declare that they have no competing interests.

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Figures

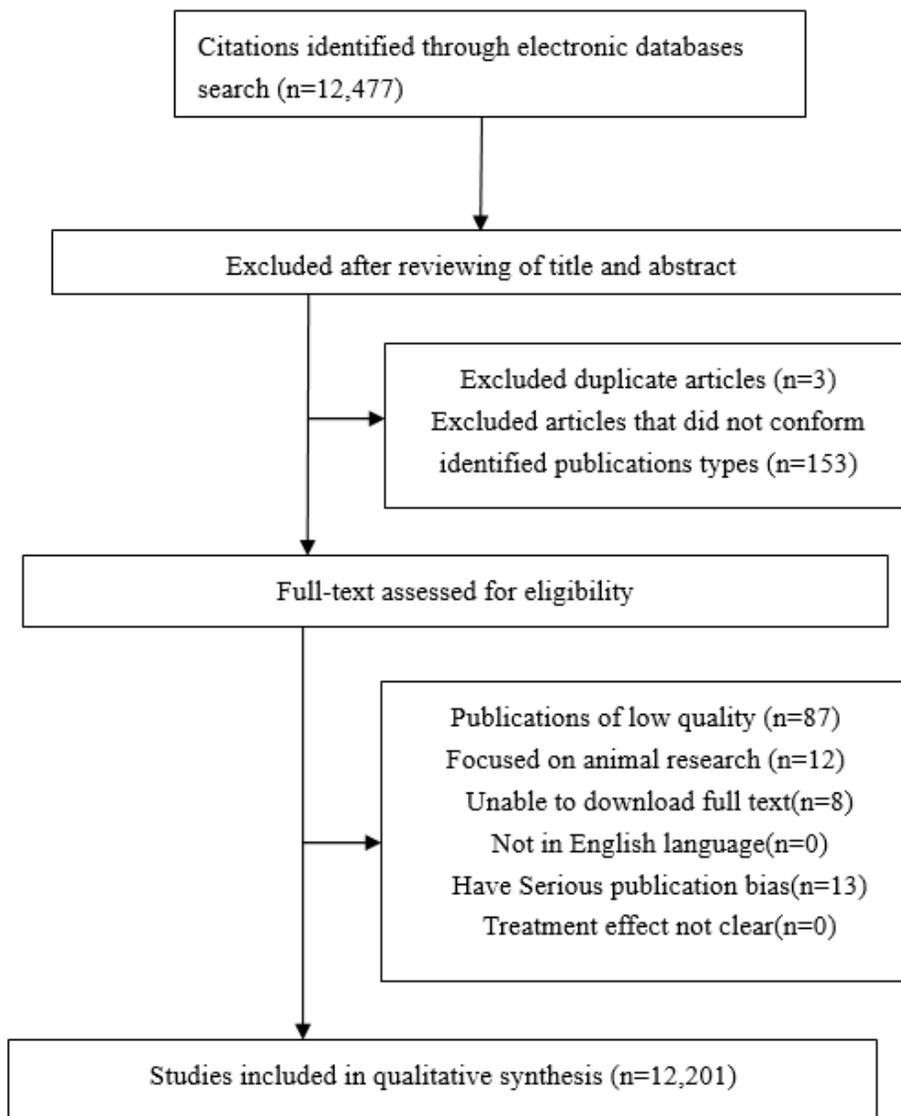
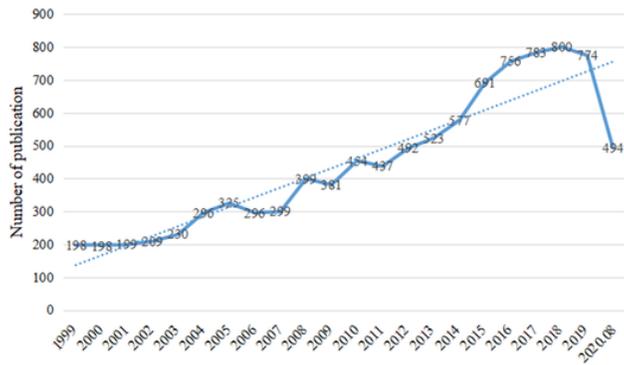
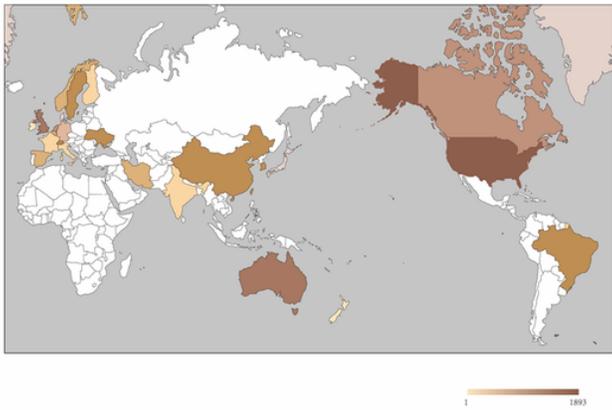


Figure 1

Flow chart of selection processes for eligible studies



b



c

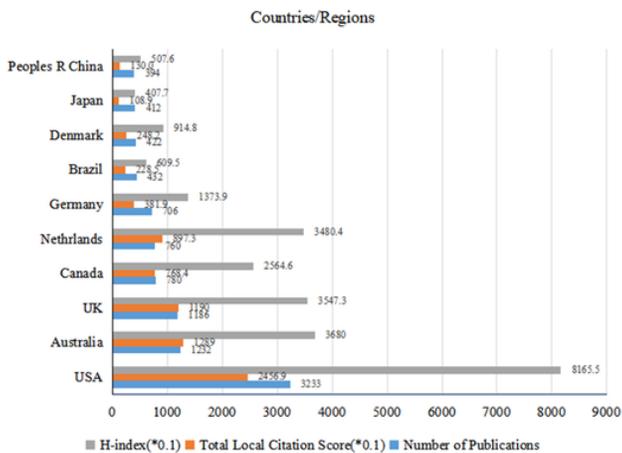


Figure 2

Articles related to LBP in the world. (a) Number of publications per year and growth trend for LBP. (b) The distribution of LBP publications. (c) Number of publications, total local citation score (number of citations of country or region publications in Web of Science) and H-index among top 10 productive countries. Note: The designations employed and the presentation of the material on this map do not imply the expression of any opinion whatsoever on the part of Research Square concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. This map has been provided by the authors.

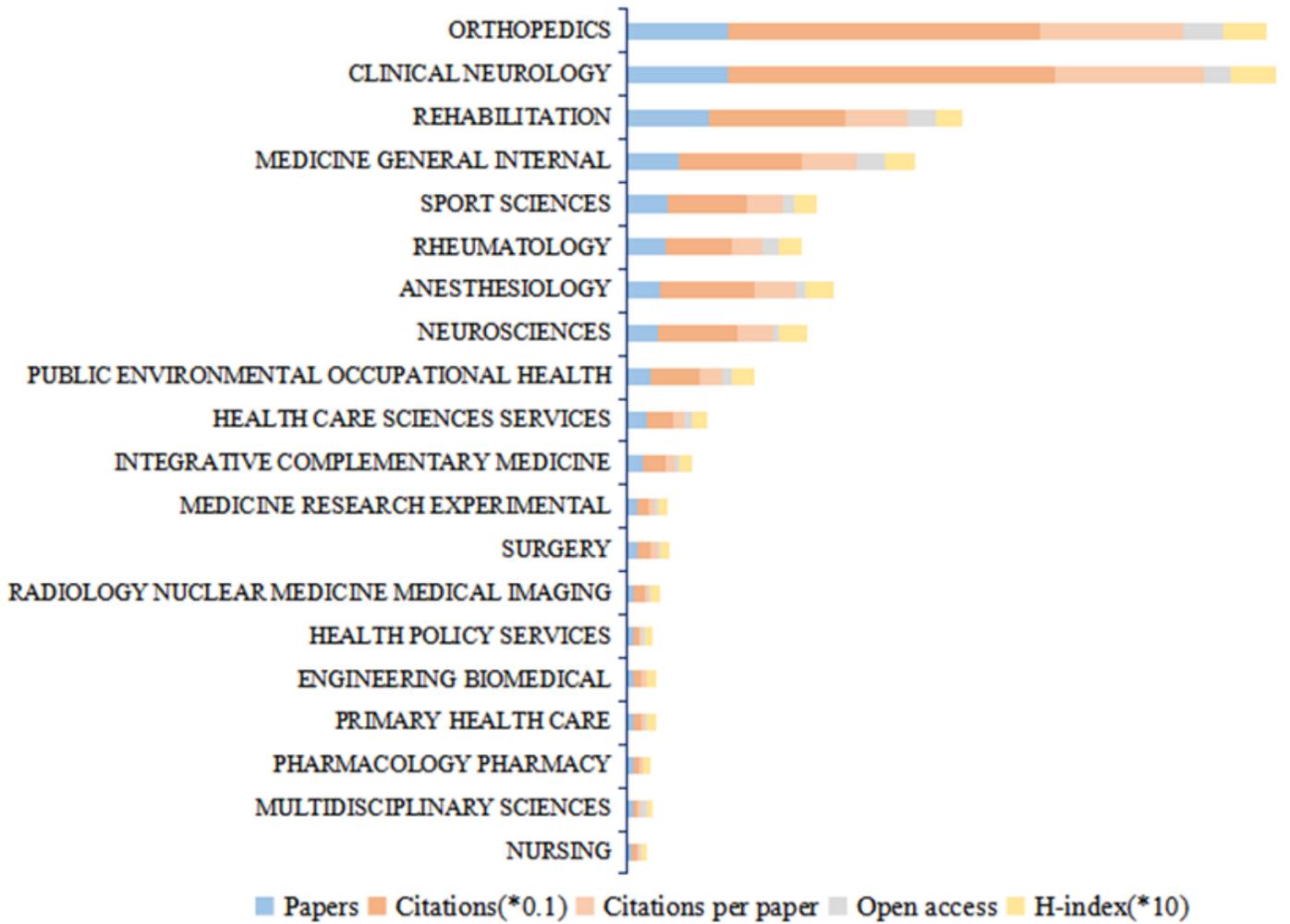


Figure 3

Number of papers, citations, citations per paper, open access papers, and H-index of the top 20 subject categories.

Top 25 References with the Strongest Citation Bursts

References	Year	Strength	Begin	End	1999 - 2020
JENSEN MC, 1994, NEW ENGL J MED, V331, P69, DOI	1994	22.2288	1999	2002	
SHEKELLE PG, 1995, SPINE, V20, P1668, DOI	1995	4.7268	1999	2003	
WARE JE, 1995, MED CARE, V33, P0, DOI	1995	3.3851	1999	1999	
Papageorgiou AC, 1996, PAIN, V66, P181, DOI	1996	8.2738	1999	2003	
RIIHIMAKI H, 1994, SPINE, V19, P138, DOI	1994	5.2725	1999	2000	
COSTE J, 1994, BRIT MED J, V308, P577, DOI	1994	18.5196	1999	2002	
Hides JA, 1996, SPINE, V21, P2763, DOI	1996	13.4392	1999	2004	
LINDSTROM I, 1992, PHYS THER, V72, P279, DOI	1992	7.9099	1999	2000	
MANNICHE C, 1991, PAIN, V47, P53, DOI	1991	3.3851	1999	1999	
KUJALA UM, 1992, MED SCI SPORT EXER, V24, P627	1992	3.3851	1999	1999	
SHEKELLE PG, 1992, ANN INTERN MED, V117, P590, DOI	1992	9.229	1999	2000	
VLAEYEN JWS, 1995, PAIN, V62, P363, DOI	1995	20.1092	1999	2003	
KOES BW, 1995, SPINE, V20, P228, DOI	1995	8.2738	1999	2003	
LEINO PI, 1993, SPINE, V18, P863, DOI	1993	5.724	1999	2001	
FRYMOYER JW, 1991, ORTHOP CLIN N AM, V22, P263	1991	6.7715	1999	1999	
WADDELL G, 1996, LOW BACK PAIN EVIDEN, V0, P0	1996	11.8225	1999	2003	
Carey TS, 1996, SPINE, V21, P339, DOI	1996	15.1209	1999	2004	
Frank JW, 1996, SPINE, V21, P2908, DOI	1996	16.2422	1999	2004	
Ghonaime ESA, 1999, JAMA-J AM MED ASSOC, V281, P818, DOI	1999	7.279	1999	2005	
Waddell G, 1996, SPINE, V21, P2820, DOI	1996	17.3637	1999	2004	
WALSH K, 1992, J EPIDEMIOL COMMUN H, V46, P227, DOI	1992	6.5911	1999	2000	
BIGOS SJ, 1991, SPINE, V16, P1, DOI	1991	4.7395	1999	1999	
DELITTO A, 1993, PHYS THER, V73, P216, DOI	1993	9.5422	1999	2001	
BIGOS SJ, 1992, CLIN ORTHOP RELAT R, V0, P21	1992	8.5694	1999	2000	
VONKORFF M, 1993, SPINE, V18, P855, DOI	1993	11.452	1999	2001	

Figure 5

Top 25 References with the Strongest Citation Bursts.

