

# Fifty top-cited spine articles from mainland China: A citation analysis

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## Abstract

**Objective:** To identify the 50 top-cited spine articles from mainland China and to analyze their main characteristics.

**Methods:** Web of Science was used to identify the 50 top-cited spine articles from mainland China in 27 spine-related journals. The title, year of publication, number of citations, journal, anatomic focus, subspecialty, evidence level, city, institution and author were recorded.

**Results:** The top 50 articles had 29–122 citations and were published in 11 English-language journals; most (32) were published in the 2000s. The journal *Spine* had the largest number of articles and *The Lancet* had the highest impact factor. The lumbar spine was the most discussed anatomic area (18). Degenerative spine disease was the most common subspecialty topic (22). Most articles were clinical studies (29); the others were basic research (21). Level IV was the most common evidence level (17).

**Conclusions:** This list indicates the most influential articles from mainland China in the global spine research community. Identification of these articles provides insights into the trends in spine care in mainland China and the historical contributions of researchers from mainland China to the international spine research field.

## Keywords

Spine, citation analysis, mainland China

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## Introduction

Mainland China has the largest population in the world and has shown rapid economic progress. These factors have led to substantial biomedical developments<sup>1-5</sup> and recent improvements in spine care in mainland China.<sup>6,7</sup> In addition, the country has the largest number of orthopedic surgeons in the world.<sup>8</sup> Therefore, mainland China is an important leader in the field of spine research,<sup>6,7,9-11</sup> although influential spine research from this region has yet to be studied.

Multiple methods are used to assess the significance of medical studies. The citation of a previous paper indicates the importance of the previous study to the current article. The importance of a study is often assessed using citation analysis.<sup>12-14</sup> The number of citations is a marker of the influence of an article and offers a reliable method to rank articles. The larger an article's citation history, the more valuable the article is to its field.<sup>15,16</sup>

Web of Science is an important database that provides citation metrics and other academic impact information. This platform has been widely used to analyze the most-cited articles in various medical fields.<sup>17-33</sup> One 2012 study used a citation index to examine the most-cited articles in the spine research field,<sup>34</sup> permitting a deeper understanding of the characteristics of influential papers. However, this previous study did not include any Chinese spine articles.<sup>34</sup> Moreover, to the best of our knowledge, there are no analyses of the top-cited spine papers from mainland China, indicating that the contribution of Chinese spine surgeons and researchers to the global spine research community has not been adequately investigated. Therefore, this study aimed to identify the 50 top-cited spine papers originating from mainland China, to analyze their main characteristics and to provide a unique insight into mainland

China's most important contributions to the spine research field.

## Materials and methods

The citation search was performed on April 6, 2016, using the Web of Science database (Thomson Reuters, Philadelphia, Pennsylvania), which has been used in previous similar studies.<sup>16,29,33-36</sup> Based on a previous paper published in 2012,<sup>34</sup> 27 spine-related journals were included in the literature search (Table 1). These journals were chosen from the Web of Science categories, including "Orthopedics,"

**Table 1.** List of journals searched.

Journal name
American Journal of Neuroradiology
American Journal of Roentgenology
Clinical Biomechanics
Clinical Journal of Pain
Clinical Orthopaedics and Related Research
European Spine Journal
Journal of Neurosurgery
Journal of Pediatric Orthopaedics
Journal of Spinal Disorders
Journal of Spinal Disorders and Techniques
Journal of Trauma
Journal of the American Medical Association
Journal of Bone and Joint Surgery. American Volume
Journal of Bone and Joint Surgery. British Volume
Journal of Neurosurgery: Spine
Journal of Vascular and Interventional Radiology
The Lancet
New England Journal of Medicine
Neurosurgical Review
Neurosurgery
Orthopedic Clinics of North America
Pain
Physical Therapy
Radiology
Regional Anesthesia and Pain Medicine
Spine
The Spine Journal

“Neurosciences,” “Neurology,” “Rehabilitation,” “Sports Sciences,” “Medicine, General and Internal” and “Radiology, Nuclear Medicine, and Medical Imaging.” These 27 journals regularly publish articles about spine research.

The inclusion criteria of this study were (1) spine-related articles; (2) from mainland China; and (3) ranked in the top 50 papers according to the number of citations. Based on previous similar publications,<sup>16,33-37</sup> the articles from these 27 journals were ordered by number of citations. To exclude papers not from mainland China, “Peoples R China” was selected in the record field “Countries/territories.” Articles that lacked

a primary or reprint address in mainland China were excluded. This ensured that articles with one or more Chinese co-authors but that were not from mainland China were not included.

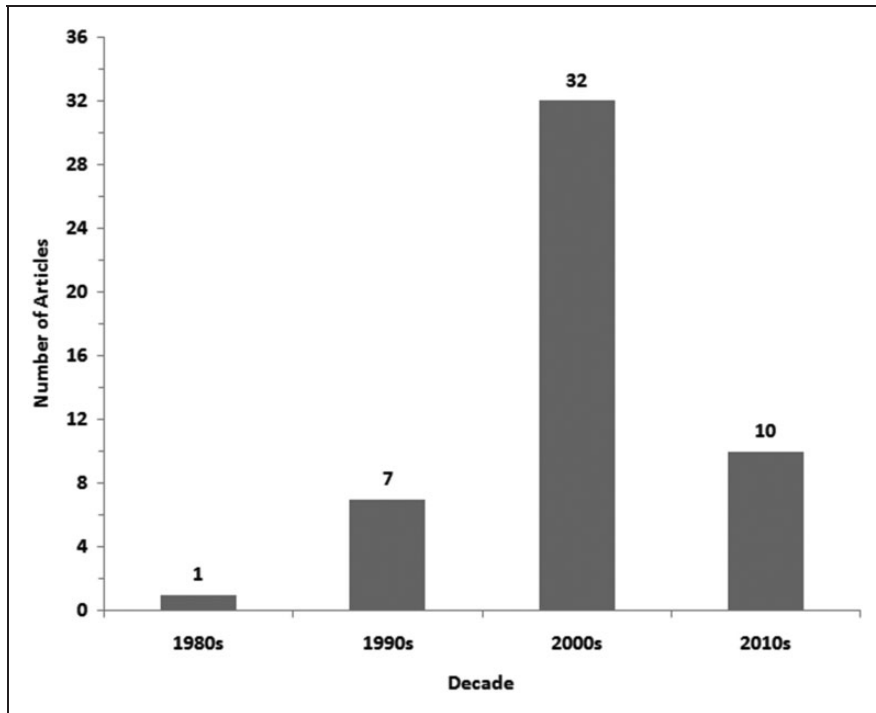
The 50 top-cited spine papers from mainland China were included in this study. The title, year of publication, number of citations, journal, anatomic focus, subspecialty, level of evidence, city, institution and author were recorded and analyzed.

**Results**

The top 50 articles and their citations are shown in Table 2.<sup>38-87</sup> These articles

**Table 2.** Fifty top-cited articles in the field of spine surgery.

Rank	Article	Number of citations	Rank	Article	Number of citations
1	Hu and Xing, 1998 (38)	122	26	Dai, 2001 (63)	38
2	Peng et al., 2005 (39)	108	27	Li et al., 2006 (64)	38
3	Peng et al., 2006 (40)	102	28	Zhang et al., 2008 (65)	37
4	Bao and Ling, 1997 (41)	97	29	Han et al., 2008 (66)	36
5	Zhang et al., 2005 (42)	83	30	Dai et al., 1998 (67)	35
6	Tan et al., 2003 (43)	83	31	Hou et al., 2003 (68)	35
7	Liao et al., 2003 (44)	70	32	Li et al., 2006 (69)	35
8	Holmes et al., 1994 (45)	61	33	Sheng et al., 2010 (70)	35
9	Zhao et al., 2005 (46)	61	34	Ma et al., 2005 (71)	35
10	Wang et al., 2007 (47)	58	35	Jian et al., 2010 (72)	35
11	Hou et al., 1993 (48)	54	36	Tian et al., 2011 (73)	34
12	Wu et al., 2006 (49)	53	37	Feng et al., 2010 (74)	34
13	Wu et al., 2006 (50)	53	38	Fan et al., 2010 (75)	33
14	Jin et al., 2004 (51)	51	39	Chen et al., 2005 (76)	33
15	Dai, 1998 (52)	47	40	Xue et al., 2012 (77)	33
16	Peng et al., 2006 (53)	47	41	Wang et al., 2008 (78)	32
17	Wang et al., 2006 (54)	46	42	Kai et al., 2003 (79)	32
18	Ruan et al., 2007 (55)	45	43	Fu et al., 2008 (80)	31
19	Li et al., 2011 (56)	45	44	Dai et al., 2005 (81)	31
20	Dai et al., 2009 (57)	44	45	Guo et al., 2010 (82)	31
21	Wang et al., 2010 (58)	44	46	Qiu et al., 2005 (83)	30
22	Shi et al., 1999 (59)	44	47	Kong et al., 2007 (84)	30
23	Sung et al., 1987 (60)	43	48	Chen et al., 2007 (85)	30
24	Yan et al., 2008 (61)	40	49	Hu et al., 2010 (86)	30
25	Dai and Jiang, 2008 (62)	40	50	Dai and Jia, 2000 (87)	29



**Figure 1.** Number of articles per decade.

received 29 to 122 citations (mean number of citations: 48). The oldest paper (published in 1987) was ranked 23rd and the latest paper (published in 2012) was ranked 40th. Most articles (32) were published in the 2000s, followed by the 2010s ( $n = 10$ ), 1990s ( $n = 7$ ) and 1980s ( $n = 1$ ) (Figure 1).

The 50 articles were published in 11 English-language journals (Table 3). Most papers were published in *Spine* ( $n = 23$ ), followed by *European Spine Journal* ( $n = 10$ ), *Clinical Orthopaedics and Related Research* ( $n = 3$ ) and *Journal of Neurosurgery: Spine* ( $n = 3$ ). *The Lancet* had the highest impact factor (45.217), far more than any other journal included in this study. Table 4 shows the articles classified by anatomic focus. The lumbar spine was the most discussed anatomic area ( $n = 18$ ), followed by the entire spine ( $n = 12$ ) and the cervical spine ( $n = 11$ ). Of the top 50 papers,

**Table 3.** Number of articles on the top 50 list by source journal.

Journal	Number of articles	Impact factor
Spine	23	2.297
European Spine Journal	10	2.066
Clinical Orthopaedics and Related Research	3	2.765
Journal of Neurosurgery: Spine	3	2.383
Journal of Bone and Joint Surgery. American Volume	2	5.280
Pain	2	5.213
Neurosurgery	2	3.620
Journal of Bone and Joint Surgery. British Volume	2	3.309
The Lancet	1	45.217
American Journal of Neuroradiology	1	3.589
The Spine Journal	1	2.426

29 were clinical studies and 21 reported basic research. Of the 29 clinical studies, most showed evidence levels of IV (n=17), far more than any other level of evidence (Figure 2). Degenerative spine disease was the most popular subspecialty topic (n=22) in the top 50 list, followed by general spine (n=13) and trauma (n=5) (Table 5).

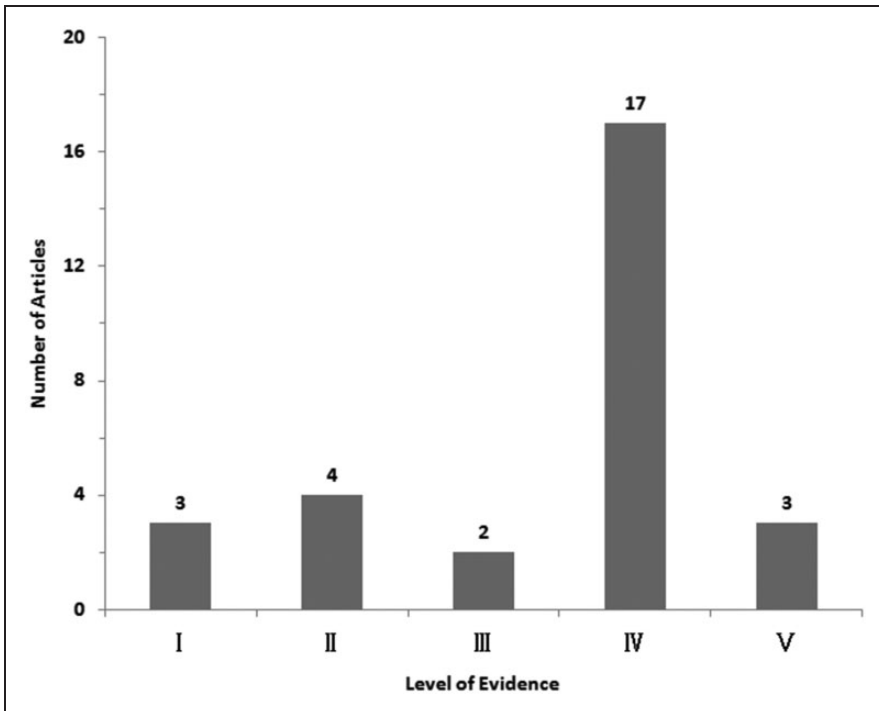
The top 50 articles were published by authors from 12 Chinese cities (Table 6). The largest number of articles were published in Beijing (n=15), followed by Shanghai (n=14) and Hangzhou (n=4) (Table 6). A total of 27 institutions published these 50 top-cited articles. Eight

**Table 4.** Articles classified by anatomic focus.

Anatomic focus	Number of articles
Lumbar spine	18
Entire spine	12
Cervical spine	11
Thoracolumbar spine	7
Thoracic spine	1
Sacrum	1

**Table 5.** Number of articles by subspecialty.

Subspecialty	Number of articles
Degenerative	22
General spine	13
Trauma	5
Infection	3
Deformity	3
Developmental/congenital	2
Oncology	2



**Figure 2.** Level of evidence of clinical articles.

**Table 6.** Cities from which the articles originated.

City	Number of articles
Beijing	15
Shanghai	14
Hangzhou	4
Nanjing	3
Soochow	3
Guangzhou	2
Wenzhou	2
Xi'an	2
Chengdu	1
Nanchong	1
Urumqi	1
Chongqing	1

institutions with more than one article published 31 of the top 50 articles (62%). Among them, Xinhua Hospital published the greatest number of articles ( $n = 10$ ), followed by 304th Hospital ( $n = 5$ ) and Peking University Third Hospital ( $n = 4$ ) (Table 7). Three authors contributed more than one article. Dai LY published the largest number of the 50 top-cited articles ( $n = 7$ ), followed by Peng BG ( $n = 3$ ) and Hou SX ( $n = 2$ ) (Table 8).

## Discussion

Citation analysis has been widely used to investigate the top-cited papers in many biomedical fields,<sup>16–33,37</sup> and has been applied to the field of spine research.<sup>34</sup> However, previous research has not included Chinese articles in the global top-cited spine articles.<sup>34</sup> In addition, to the best of our knowledge, the top-cited spine papers from mainland China have not been reported, despite the increasing importance of Chinese spine surgeons and researchers to the international spine community.<sup>6,7,36</sup> Therefore, we aimed to identify and

**Table 7.** Institutions associated with more than one article.

Institution (City)	Number of articles
Xinhua Hospital (Shanghai)	10
304th Hospital (Beijing)	5
Peking University Third Hospital (Beijing)	4
The First Affiliated Hospital of Soochow University (Soochow)	3
Changzheng Hospital (Shanghai)	3
The Second Affiliated Hospital of Zhejiang University (Hangzhou)	2
Sir Run Run Shaw Hospital (Hangzhou)	2
The 2nd Affiliated Hospital of Wenzhou Medical University (Wenzhou)	2

**Table 8.** First authors with more than one article.

Author name	Number of articles
Dai LY	7
Peng BG	3
Hou SX	2

characterize the 50 most-cited spine articles from mainland China and to provide a unique perspective on Chinese spine research.

We found that the 50 top-cited papers were reported between 1987 and 2012 and that 2000–2009 was the most prolific decade. This finding is inconsistent with analysis of the global spine research field, which showed that 1990–1999 was the most important decade.<sup>34</sup> This may be explained by an historical lack of financial funds and articles published in English in mainland China

owing to a less developed economy.<sup>88,89</sup> In contrast, the recent increase in influential papers reflects the greater development of the Chinese spine research field.<sup>6,7</sup>

The 50 top-cited spine papers had between 29 and 122 citations. These numbers are substantially lower than those for the global spine field (which showed the lowest citation number as 244);<sup>34</sup> this may be because the previous study did not include Chinese articles.<sup>34</sup> This finding indicates that although the quantity of Chinese articles has increased, the quality of Chinese articles needs to improve.<sup>6,7</sup>

All the included papers were published in English. One of the main reasons for this is that English is the most common language of influential articles in the field of spine research and other orthopedic subspecialties.<sup>16,34,35,37,90–94</sup> This result may indicate that Chinese authors experience a language barrier that results in fewer spine research publications from China than from Western countries.

The 50 top-cited papers were reported in 11 journals. Among them, *Spine* published the greatest number of papers. The first four journals published nearly three-quarters of the total number of articles: *Spine*, *European Spine Journal*, *Clinical Orthopaedics and Related Research*, and *Journal of Neurosurgery: Spine*. Three of these are subspecialty spine journals. This may indicate that the influential articles are mainly published in subspecialty spine journals. Moreover, previous studies have suggested that impact factor should be the most important indicator of article citations, and many of the most-cited papers have been published in high-impact factor publications.<sup>16,17,95</sup> However, the present findings do not support this. *The Lancet*, which has the highest impact factor (45.217), published only one paper. *Spine*, which has a lower impact factor (2.297), published the largest number of papers (n = 23). This may

indicate that citations are not always affected by impact factor. This has been suggested by previous researchers<sup>20,34</sup> and indicates the importance of considering several factors when investigating citations in certain journals.<sup>16,34,37,93</sup>

Authors from 12 cities were responsible for the 50 top-cited articles. Beijing ranked 1st, and Shanghai ranked 2nd, suggesting that Beijing and Shanghai play an important role in Chinese spine research. This can be attributed to the large number of spine surgeons and researchers and adequate financial research funds in these cities.<sup>16,29</sup>

Of the top 50 studies, clinical studies were more popular than basic research. This finding is consistent with previous study findings on global spine research.<sup>34</sup> However, the proportion of clinical studies/basic research in mainland China is much smaller than that worldwide (29/21 versus 81/19, respectively). This suggests the need to improve Chinese spine-related clinical research. One previous study found a relatively greater number of basic research studies in current Chinese clinical research.<sup>2</sup> There are several possible reasons for this phenomenon. Clinical studies are very complicated and require long-term intervention and follow-ups. Mainland China has a large number of patients with spine-related problems and this could facilitate recruitment of greater numbers of patients in clinical studies. However, mainland China lacks a high-quality healthcare system equal to that in developed countries.<sup>9</sup> Therefore, the lower quality of health care in mainland China may hinder patient participation in clinical studies. In addition, insufficient research funds and a lack of available time have resulted in fewer clinical studies in mainland China.<sup>2,96</sup> However, these disadvantages may be reduced in the Chinese spine research field. Medical system reforms, increased experience in conducting clinical studies and greater investment in research is



likely to improve research in mainland China in future years.<sup>9–11</sup>

Some limitations of this study should be noted. First, we selected spine-related journals based on previous research.<sup>34</sup> These journals do not include all spine articles, because some basic research journals and general journals also publish spine-related articles. However, no search strategy can identify all spine articles. Generally, the articles published in journals not indexed in this study are likely to have fewer citations than those that we indexed.<sup>34</sup> Second, this was a cross-sectional study design with a single time point. The rankings identified may change if the study is replicated in the future.

## Conclusion

To the best of our knowledge, this is the first bibliometric analysis of the most-cited spine articles from mainland China. The study findings indicate an increase in the number of influential papers published by the Chinese spine research community in recent years. The present study identifies the most influential Chinese articles in global spine research, provides a general picture of Chinese historical contributions to the global spine research community and illustrates trends in spine care in mainland China. We believe that this study will help surgeons, researchers and managers to recognize the main characteristics of Chinese spine research and will form the basis of future high-impact studies.

## Declaration of conflicting interests

The authors declare that there is no conflict of interest.

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