

Bibliometric study of the global scientific research on pain and disability

Lin-Man Weng

Shanghai University of Sport

Yi-Li Zheng

Shanghai University of Sport

Meng-Si Peng

Shanghai University of Sport

Juan Wang

Shanghai University of Sport

Rui Wang

Shanghai University of Sport

Xue-Qiang Wang (✉ qiang897@163.com)

Shanghai University of Sport <https://orcid.org/0000-0001-5577-5231>

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Abstract

Background A growing number of relevant studies on the comorbidity of pain and disability have been published in high-quality journals; however, few studies have analysed quantitatively the characteristics of the topic via bibliometrics.

Purpose The study aims to systematically analyze various aspects of global scientific research on pain and disability comorbidity from 1980 to 2019 and determine the global research trend and knowledge structure.

Methods A collection of publications on pain and disability comorbidity between 1980 and 2019 was retrieved from the Web of Science Core Collection. CiteSpace, Microsoft Excel 2016, and IBM SPSS Statistics 25 software were used to analyze publication outputs, authors, journals, institutions, countries, subject category, types of pain, references, and keywords.

Results We collected a total of 3,570 articles in March 9, 2019. Results indicated that the publication outputs had a significant growth in the recent 40 years via the linear regression model ($P < 0.001$). The journal *Pain* had the maximum output (178), the most cited frequencies in WoS (15,418), the highest impact factor index in 2017 (5.559), and the highest H-index (68). Linear regression analysis revealed that the tendency of multiple authors' papers increased significantly ($t = 8.065$, $P < 0.001$). In accordance with the top 20 subject categories, Clinical Neurology was the most productive academic area (1095). With regard to types of pain, low back pain and headache were the most widely concerned with a total of 1,114 publications.

Conclusion The study outlines the evolution and development of comorbid pain and disability research, reflects the overall situation and lays the groundwork for future research.

1. Introduction

By almost any measure, pain is a global public health problem (1). It has multiple sequelae, including disability, low quality of life, depression and anxiety, sleep disturbances, and even suicide (1–3). Approximately 20% of adults are afflicted with pain every year (1). The weighted mean prevalence of chronic pain in adults is 20% (2), which is higher than that of diabetes (4) or asthma (5). In 2010, the totals cost in the USA ranged from \$560 to \$635 billion, and additional healthcare expenditure due to pain ranged from \$261 to \$300 billion (6). Disability is widely prevalent among adults globally, which increases with age (7). Approximately 22.2% of American adults suffer from any disability in 2013 (7), and the global morbidity of disability was 14% (8). Among eight common diseases requiring rehabilitation, stroke is the most pervasive cause of disability, followed by arthritis and back pain (9). In 2006, the annual healthcare costs associated with disability reached nearly \$400 billion in the USA (10).

In the top 10 diseases contributing to the most years lived with disability, five are defined or characterized by pain. Thereinto, low back pain (LBP) is ranked first, followed by neck pain, other musculoskeletal disorders, migraine, and falls (11). Accumulating evidence suggests that chronic pain is a serious problem for physically disabled adults (12–14). The fear avoidance model of chronic pain indicates that patients develop fear of movement, leading to activity avoidance, further increasing disability (15). One study found that the prevalence of disability was 65% among LBP patients, and among them, 80.7% had moderate to severe disability (16). Individuals who deal with pain more actively are more likely to prevent and intervene in disability (17).

A growing number of relevant studies on the comorbidity of pain and disability have been published in high-quality journals; however, few studies have explored the characteristics of the topic via bibliometrics. Bibliometrics is a cross-disciplinary science that uses statistical and mathematical methods to quantitatively analyze all knowledge carriers (18). It is commonly regarded as a useful and effective tool to evaluate developing trend and scientific productions in a specific domain (19, 20). This analysis can assess the productivity of authors, countries, and institutions; display collaborations in countries, institutions, and geographical distribution; and reveal research frontiers, hotspots, and trends (21, 22). Recently, bibliometric analysis has been widely used in different areas, such as headache (23), neuroscience (24), drug delivery (25), long noncoding RNA (26), and so forth.

The objective of the present study is to systematically analyze various aspects of global scientific research on pain and disability comorbidity from 1980 to 2019. We used CiteSpace V to analyze pertinent papers retrieved from the Web of Science Core Collection (WoSCC), determine emerging trends, extract the knowledge pattern, and capture hidden information.

2. Methods

2.1 Sources of data

The WoSCC was selected as the major database to accomplish our search. We obtained literature published between 1980 and 2019 from the Science Citation Index-Expanded and Social Sciences Citation Index. The following retrieval strategy was used: TI=(pain* or headache* or "head ache*" or head-ache* or migraine* or cephalalg* or "stomach ache*" or "tummy ache*" or "abdominal ache*" or "belly ache*" or earache* or ear-ache* or toothache* or tooth-ache* or odontalg* or dysmenorrh* or neuralgi* or cervicodyn* or analg* or nocicept* or hyperalg* or hypoalg* or fibromyalg* or radiculalg* or colic or sciatic* or arthralg* or causalg* or eudyn* or maldyn* or brachialg* or ophthalmodyn* or cephalalg* or otalg*) and TI=(disability or disabilities or Disabled or dysfunction or dysfunction* or disfunction* or Impairment* or handicap*).

2.2 Inclusion criteria

The document types were limited to articles and reviews. Other types, such as meeting abstracts, editorial materials, letters, proceedings papers, corrections, book reviews, notes, news items, discussions, correction additions, early accesses, reprints, and retracted publications, were excluded. With respect to language, we only selected literature in English. Moreover, we limited our analyses to publications related to the comorbidity of pain and disability research. No more restrictions were made.

2.3 Data extraction

We collected a total of 3,570 articles in March 9, 2019. The publications were extracted and downloaded as text- and table-based documents, with some basic information presented intuitively through various charts. The bibliometric indicators were classified into two categories: (i) Publicity indicator: annual publication outputs, distribution of journals, countries, institutions and authors, subject category distribution, and pain type distribution. (ii) Impact indicator: H-index of each journal or researcher, citation counts that papers received, IF of the journals, and relative citations per paper. The relative citations of top articles were calculated as follows: (the number of citations that a paper received in WoS)/(2019-the year that the paper was published).

2.4 Statistical methods

We used Microsoft Excel 2016 to process the information extracted from WoSCC. By integrating various categories of data, Microsoft Excel 2016 can clearly display (i) the time trend of publication and annual citation frequency; (ii) the distribution of output by countries, institutions, journals, authors, subject categories, and types of pain; (iii) the comparison of the sum of citation, average citation, open access, and H-index between different categories. It also arranged significant and basic information of authors and references.

CiteSpace V was applied to (i) show collaborations between authors, countries, and institutions; (ii) analyze the co-cited situation of authors and references; (iii) extract crucial information on citing periodicals and cited periodicals; and (iv) capture burst keywords by generating visualizations.

IBM SPSS Statistics 25 software could perform linear regression analysis. The year was the independent variable, and different categories were the dependent variables. To assess whether a quantitative relationship of interdependence exists between two variables and reflect the trend of time-series data in 40 years, we analyzed the changes in citations or outputs of multiple authors, single author, and types of pain. When the P value is less than 0.05, the results were considered statistically significant.

3. Results

3.1 Publication outputs and growth trends

We collected a total of 5,569 papers at first and excluded 1,885 non-article or non-review papers and 114 non-English papers. Eventually, a total of 3,570 papers met the inclusion criteria (Figure 1A). Figure 1B shows the trend of annual publication steadily growing over time with minimal fluctuations. Compared with 22 publications in 1980, the number of published papers in 2018 showed an approximately 10-fold increase. Trends in annual output were analyzed via the linear regression model, indicating significant growth in the past 40 years ($t=10.612$, $P<0.001$). The 3,570 papers were altogether cited 118,362 times, with 33.15 average citations and 140 H-index. As shown in Figure 1C, the trends in cited frequency per year exhibited a smooth upward curve. Similarly, the result displayed increased significance over time through linear regression analysis ($t=10.638$, $P<0.001$). We divided

the period studied into eight time partitions, 1980–1984, 1985–1989, 1990–1994, 1995–1999, 2000–2004, 2005–2009, 2010–2014, and 2015–2019 (Figure 1D). The period of 1990–1994 had the most number of published papers (1,920), the period of 2005–2009 had the most cited frequencies (27,829), the period of 1995–1999 received the maximum number of citations per paper (67.84), the period of 2015–2019 had the most open access articles (347), the period of 2000–2004 had the maximum value of H-index (91), and the period of 2010–2014 had the most cited frequencies in 2019 (479). Overall, the six aspects showed an increasing trend.

3.2 Distribution by journals

The 844 journals published 3,570 articles on comorbid pain and disability research (Additional file 1). *Pain* accounted for the maximum output (178), followed by *Spine* (163), *Clinical Journal of Pain* (96), *Headache* (92), and *Cephalalgia* (76). Only *Pain* and *Spine* had more than 100 publications, with over 4.50% of the total. As shown in Table 1, *Pain* had the most cited frequencies in WoS (15,418), the highest impact factor index in 2017 (5.559), and the highest H-index (68). The *Journal of Rheumatology* had the maximum number of citations per paper (94.85), whereas *BMC Musculoskeletal Disorders* had the most open access articles (60). Among the 20 journals with the most publications, 11 were in the first quartile of WoS, 7 were in the second quartile of WoS, and 1 was in the third and fourth quartiles.

The dual-map overlay of journals presented the distribution of journals across subject and paths of citation (Figure 2). The citing pattern was on the left, and the cited pattern was on the right with labels regarded as the disciplines involved in corresponding periodicals. The citation line was connected from the citing periodicals to the cited periodicals. Notably, these articles were mainly published by journals in the field of neurology, sports and ophthalmology, and a majority of them cited psychology, education and social journals.

3.3 Distribution by countries and institutions

The 3,570 papers on pain and disability comorbidity were contributed by 82 countries (Additional file 2, Figure 3A). In terms of publications, USA was the most prolific country (1,267), followed by England (315), Canada (278), Australia (275), and the Netherlands (202). The proportion of USA (35.490%) was approximately four times higher than England (8.824%). Figure 3B shows the basic situation of the top 10 countries via the maximum number of publications. The USA had the most cited frequencies (53,247), open access articles (339), and maximum value of H-index (113). England received the maximum number of citations per papers (5,479). In the country collaboration map, England and Australia both had the highest value of centrality (0.59), followed by Taiwan (0.58), Germany (0.57), and Switzerland (0.57) (Figure 3C).

A total of 3,252 institutions contributed to the 3,570 papers on pain and disability comorbidity (Additional file 3). Harvard University was the leading institution (100), with the largest proportion (2.802%), followed by the University of Washington (87, 2.437%), the University of Washington Seattle (87, 2.437%), the University of Texas System (67, 1.877%), and the University of Sydney (60, 1.681%). Three institutions showed proportions of more than 2%. As shown in Figure 3D, the most cited frequencies and maximum number of citations per paper corresponded to Maastricht University (4,034, 69.55), and the most open access articles were from Harvard University (37). The top three institutions, including Harvard University, the University of Washington, and the University of Washington Seattle, had the same highest value of H-index (33). Moreover, the University of South Australia had the maximum centrality (0.28), followed by the University of Alabama Birmingham (0.22), Vrije Universiteit Amsterdam (0.19), the University of Copenhagen (0.19), and Aalborg University (0.19) (Figure 3E).

3.4 Distribution by authors

Included papers on pain and disability comorbidity were distributed over 12,200 authors. Figure 4A shows that the node representing Lipton RB was the largest in terms of maximum publications (37), followed by Bussone G (28), Jensen MP (26), D'Amico D (23), and Grazzi L (20). Only the proportion of Lipton RB was more than 1% (1.036%). It also outlined the cooperation between different authors. From the data generated by CiteSpace V, the value of every author centrality was 0, indicating that collaboration among these authors was not sufficient and frequent. The author's co-citation map demonstrated that Waddell G had the largest node with 386 citation counts, followed by Turk DC with 302 citation counts, Jensen MP with 300 citation counts, Deyo RA with 299 citation counts, and Ware JE with 277 citation counts (Figure 4B, Table 3). Figure 4C shows the trends in percentage of multiple- and single-authored articles for each 5-year period. The percentage of multiple-authored articles grew from 73.74% in

1980–1984 to 98.80% in 2015–2019 with the percentage of single-authored articles gradually reducing from 26.26% in 1980–1984 to 1.20% in 2015–2019. Furthermore, linear regression analysis also revealed the tendency of papers with multiple authors increased significantly under the studied period ($t=8.065$, $P<0.001$).

3.5 Subject categories of WoS

All journals contributing to the 3,570 papers on pain and disability comorbidity were involved in 109 subject areas of WoS. Some related data of the top 20 subject categories in accordance with publication are shown in Figure 5A. *Clinical Neurology* was the most productive academic area (1,095), followed by *Rehabilitation* (628), *Neurosciences* (564), *Orthopedics* (523), and *Anesthesiology* (443). *Clinical Neurology* received the largest number of cited frequencies (51,214), open access articles (203), and maximum value of H-index (107). The subject area with the highest number of citations per paper was *Anesthesiology*.

3.6 Types of pain

As depicted in Figure 5B, LBP (1,114) was the most widely concerned type of pain, with almost twice the number of publications than the second pain type (headache: 506). The next popular topics were postsurgical cancer (403), neck pain (316), and neuropathic pain (315). In addition, LBP also had the most cited frequencies (42,732), open access articles (311), and maximum value of H-index (100). Arthritis was the topic that received the highest number of citations per paper. All top 10 types of pain increased significantly in publication over time through linear regression analysis.

3.7 Analysis of references

The co-citation reference map presented clear scientific relevance of pertinent literature (Figure 5C). These references were divided into separate categories and arranged by timeline, which were labeled with title terms extracted from themselves. The modularity Q score was 0.9157 (close to 1), indicating that the map had a good and reasonable clustering effect and distinctive knowledge feature. The “pain lead” was the largest cluster #0 with most papers on the topic, “affecting pain” was the second largest cluster #1, and “predicting disability” was the third largest cluster #2. Apparently, the node marked as “Fear-avoidance and its consequences in chronic musculoskeletal pain: a state of the art,” belonging to cluster #21 (pain-related fear), was the largest. The next most cited were “Pain-related fear is more disabling than pain itself: evidence on the role of pain-related fear in chronic back pain disability” and “The fear-avoidance model of musculoskeletal pain: Current state of scientific evidence” (Table 2). References published in the past several years were commonly concentrated in cluster #0 (pain lead), cluster #4 (subtle objective), and cluster #17 (patient-reported outcome instrument).

3.8 Analysis of keywords

A total of 68 keywords with the strongest citation bursts were obtained (Figure 6). Some keywords, including behavior, arthritis, health status, rheumatoid arthritis, fibrositis, illness, compensation, and sickness impact profile, were the first cited frequently in 1991. Basically, the citation burst continued until around the year 2000. Rheumatoid arthritis had the longest citation burst time and maximum strength. Disease, association, women, people, and children were all cited until 2019 and will likely to last over the coming years. Table 3 shows the top 20 keywords with the maximum number of citation counts and centrality. The most frequently cited term was LBP (694), followed by disability (647), pain (533), prevalence (427), and reliability (387). Validity garnered the highest value of centrality (0.32), followed by rheumatoid arthritis (0.29), depression (0.25), belief (0.25), and health (0.24).

3.9 Characteristics of the top 10 most frequently cited papers

Table 4 lists the top 10 papers by citation frequency on pain and disability comorbidity. The citation counts of the top 10 papers represented 7.83% of the total (9,271). The article by Roland, M et al. entitled “A study of the natural-history of back pain .1. development of a reliable and sensitive measure of disability in low-back pain”, was published in *Spine*, 1983 and received the maximum number of citation (2,066). A paper in *Cephalalgia* entitled “The global burden of headache: a documentation of headache prevalence and disability worldwide” was cited the most per year (90.00). Among the 10 papers, three were published in *Pain*, and two were published in *Spine*. “Burden of migraine in the United States - Disability and economic costs” was the only article published in *Archives of Internal Medicine* with impact factor of over 10 (17.333). Three types of journals with $5 \leq IF < 10$, $3 \leq IF < 5$, and $1 \leq IF < 3$ published three papers each.

4. Discussion

4.1 General data and global trends

The present work demonstrated some features of the comorbidity of pain and disability research between 1980 and 2019. In light of the publication outputs, we could divide the publication year into two phases: the first phase ran from 1980 to 1998, and the second phase ran from 1999 to 2018. The period from 1980 to 1998 was a slow and steady growth period. The number of published papers in 1998 was twice higher than that in 1980. This period could be regarded as the initial stage where interest in the comorbidity of pain and disability grew. A dramatic growth was noted in the second period. The number of published papers in 2018 was four times higher than that in 1999. Thus, the research attracted increasing attention, and the second period could be regarded as the golden stage. Similar to the annual outputs, the trend of annual cited frequency could also be divided into the initial stage (1980–1998) and golden stage (1999–2018), indicating the increased popularity over the ensuing years.

The top 20 journals accounted for 36.05% of the total quantity of publications. *Pain* was the most prolific journal, followed by *Spine*, *Clinical Journal of Pain*, *Headache*, and *Cephalalgia*. The *Journal of Rheumatology* received maximum number of citations per paper, followed by *Pain*, *Spine*, *Archives of Physical Medicine and Rehabilitation*, and *Cephalalgia*. It could be noted that relative higher-productive journals had higher ratio of citations per paper. In accordance with the number of publication, citations per paper, IF, and H-index, *Pain* and *Spine* showed the strongest influence and predominated the development of the field. One journal had an IF between 0 and 1, contributing to 1.064% of the 3570 papers; 11 journals had an IF between 1 and 3, contributing to 17.367%; 7 journals had an IF between 3 and 5, contributing to 12.633%; and 1 journal had an IF between 5 and 10, contributing to 4.986%. Most of the papers were published in the journals ($1 \leq IF < 3$), reflecting that it was challenging to publish in journals with high impact factors.

Among the top 10 countries, two were in North America, six were in Europe, one was in Oceania, and one was in Asia. Only Turkey was the developing country, which revealed that developed countries were on a leading position and accomplished quite a few research achievements in the field. The USA had a prominent scientific research strength with the maximum number of publications. Figure 3C shows that England had comparably strong and extensive international cooperation compared with others. The closest partnership was identified in England, Scotland, Canada, Turkey, Finland, Sweden, and Germany. Taking into account publications and centrality, England and Australia were the main core power in the comorbidity of pain and disability research. The USA was the most productive country, but its value of centrality was 0. From the perspective of academic exchanges and research quality, the USA was in the marginal position.

Among the top 10 institutions, six were from the USA, which is why the country had significant advantage in the quantity of publication. Harvard University made great research progress with the maximum number of publications. Figure 3E shows that the University of South Australia had relatively stronger and broader cooperation compared with others. The strongest collaboration identified was among the University of South Australia, University of Sydney, University of Alabama Birmingham, Vrije Universiteit Amsterdam, and Neuroscience Research Australia. Compared with the map of national cooperation, the institutions were less sufficient.

4.2 Citation data and research focuses

Among the top 10 authors according to publications and co-cited counts, Jensen MP, who published several high-quality papers and promoted the progress of the comorbidity of pain and disability research, could be regarded as the most influential researcher. He and his team mainly studied the influence of psychological intervention, cognitive restructuring intervention, psychosocial factors for chronic pain in individuals with disabilities, the associations between chronic pain and disability, and the assessment of function and psychology of chronic pain patients with disabilities (12, 13, 27-29). However, most prolific authors did not have corresponding high co-citation frequency, indicating that their research results did not make a great difference on the development of this field and that they still need to further improve article quality. Waddell G, who had the maximum number of co-cited rates, analyzed the influence of fear-avoidance beliefs on chronic LBP (CLBP) and disability, explored the association between LBP and disability, and effectively evaluated physical impairment due to CLBP (30-32). In Figure 4A, we could plainly identify that the network was very loose, hinting that the authors seldom communicated and cooperated with each other. Through analysis of

multiple- and signal-authored articles, the proportion of collaboration among multiple authors gradually rose, and the network also became denser.

According to the top 20 subject categories, *Clinical Neurology* was the most popular research field with the maximum number of publications, cited frequencies, open access articles, and maximum value of H-index. This field contributed 30.672% of the total quantity of published papers and was far ahead from the second place (17.591%). With regard to types of pain, the research contents of 1,114 papers were about the comorbidity of LBP and disability. This was the research hotspots that people with LBP had possibilities to get disability, pain, depression and low quality of life (33). A significant increase on articles concerning the top 20 subject categories and top 10 types of pain was noted.

In the timeline map of co-citation reference, cluster #0 (pain lead) was the largest, revealing that several articles cited references related to "pain lead." The period from 1998 to 2016 contained several influential references with highly cited frequencies, tallying with the golden stage between 1999 and 2018 in terms of publications (as mentioned earlier). The reference entitled "Fear-avoidance and its consequences in chronic musculoskeletal pain: a state of the art" was cited the most; it mentioned that fear and avoidance caused by pain was a reason for some patients with musculoskeletal pain to develop chronic pain disability (34). In the last 40 years, the focus on comorbid pain and disability research gradually transformed from characteristics to application.

The top 10 papers were selected according to citation counts in WoS. "A study of the natural-history of back pain .1. development of a reliable and sensitive measure of disability in low-back pain" had the maximum number of citations, which provided a questionnaire for assessing disability due to back pain (35). "Burden of migraine in the United States - Disability and economic costs," with the highest value of impact factor, quantified the economic costs of migraine in the USA, which caused a loss of approximately \$13 billion to the employers and cost around \$1 billion of treatment per year (36). "The global burden of headache: a documentation of headache prevalence and disability worldwide" received the largest number of relative citations. In the article, [Stovner, LJ](#) reported that headache disorders would be one of the 10 most disabling reasons in the whole crowd, and one of the five most disabling reasons among females (37). A number of articles published in *Pain* attracted widespread attention. These high-impact articles were the knowledge base in the research. Analysis of the top 10 papers revealed popular topics covered in the past 40 years, including i) LBP/headache/migraine/neck pain, ii) Disability, iii) economic burden, iv) questionnaire, v) treatment, and vi) pain-related fear.

Burst keywords, which were suddenly cited frequently for some time, could predict future development direction on comorbid pain and disability research. The words related to research frontiers were as follows: children, people, women, association, and disease. The risk of pain and disability increases with age (7, 38). Compared with males, females showed higher prevalence (2, 7). Patients with comorbid pain and disability are accompanied by many other diseases. In terms of co-occurrence counts and centrality, depression and validity could be considered as the core keywords reflecting research focuses and hotspots, which implies that psychosocial factor plays a significant role in the development of comorbid pain and disability.

4.3 Strengths and limitations

This is the first bibliometric study to assess the state and developing trends of pain and disability comorbidity research during the last 40 years. WoS was chosen as the database to extract abundant information, covering not only publications, citations, authors, countries, institutions, journals, and IF but also contained abstracts, references, subject categories, and so forth. On this basis, we could make an in-depth analysis and excavate valuable information hidden in the original data. Furthermore, our research was not limited to the last 20 years or a single country or journal, which provides more reliable and complete analysis.

Notwithstanding these strengths, some limitations of the study should be considered. First, we only retrieved relevant papers in WoS; other databases (e.g., PubMed, Scopus, Embase, and Ovid) were not analyzed. Second, we excluded some non-English papers, which may have high quality and impact. Third, these data are constantly changing because the WoS database updates regularly. Lastly, some potential influential papers were not outstanding with few cited frequencies due to time lag. These biases generated differences between theoretical analysis and actual scientific condition.

Despite these limitations, we believe our conclusion could reflect the overall and comprehensive situation, laying the groundwork for future research.

5. Conclusions

Overall, on the basis of bibliometric analysis, this study outlines the evolution of comorbid pain and disability research from 1980 to 2019. The period of 1999–2018 was considered as the golden age for the development of the study, with lots of influential papers. Pain and Spine were the core journals, making a great contribution on disseminating research findings and attracting researchers' attention. The proportion of multi-author articles has increased significantly, but the collaboration between authors is not very sufficient. In addition, researchers expressed much interest on low back pain and headache according to the type of pain. This study helps relevant researchers to pioneer directions for future new research in the coming years.

Abbreviations

LBP: low back pain; WoSCC: Web of Science Core Collection; CLBP: chronic LBP

Declarations

Ethics approval and consent to participate

Not applicable.

Consent for publication

Not applicable.

Availability of data and materials

All data generated or analysed during this study are included in this published article [and its supplementary information files].

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

Lin-Man Weng and Xue-Qiang Wang conceived and designed the study. Lin-Man Weng, Yi-Li Zheng, Meng-Si Peng, Juan Wang, and Rui Wang collected and analysed data. Lin-Man Weng was the major contributor in writing the manuscript. All authors read and approved the final manuscript.

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Tables

Table 1. Top 20 journals in comorbid pain and disability research.

Journals	Papers	Citations WoS	Citations per paper	Open access	WoS categories	IF 2017	Quartile	H- index
Pain	178	15418	86.62	21	Anesthesiology; Clinical Neurology; Neurosciences	5.559	Q1; Q1; Q1	68
Spine	163	12138	74.47	11	Clinical Neurology; Orthopedics	2.792	Q2; Q1	58
Clinical Journal of Pain	96	3592	37.42	5	Anesthesiology; Clinical Neurology	3.209	Q2; Q2	36
Headache	92	3178	34.54	11	Clinical Neurology	3.091	Q2	33
Cephalalgia	76	4096	53.89	1	Clinical Neurology; Neurosciences	3.886	Q1; Q2	29
European Journal of Pain	69	2222	32.2	7	Anesthesiology; Clinical Neurology; Neurosciences	2.991	Q2; Q2; Q3	28
BMC Musculoskeletal Disorders	60	1368	22.8	60	Orthopedics; Rheumatology	1.998	Q2; Q3	21
Disability and Rehabilitation	57	1234	21.65	0	Rehabilitation	2.042	Q2 (SCIE); Q1 (SSCI)	22
Archives of Physical Medicine and Rehabilitation	56	3139	56.05	7	Rehabilitation; Sport Sciences	3.077	Q1 (SCIE); Q1	26
Journal of Manipulative and Physiological Therapeutics	49	914	18.65	3	Health Care Sciences & Services; Integrative & Complementary Medicine; Rehabilitation	1.426	Q3; Q3; Q3 (SCIE)	17
Journal of Pain	49	1705	34.8	10	Clinical Neurology; Neurosciences	4.859	Q1; Q1	25
Manual Therapy	46	1949	42.37	3	Rehabilitation	2.33	Q1 (SCIE)	21
Journal of Orthopaedic Sports Physical Therapy	41	1487	36.27	15	Orthopedics; Rehabilitation; Sport Sciences	3.09	Q1; Q1 (SCIE); Q1	19
Journal of Rheumatology	41	3848	93.85	0	Rheumatology	3.47	Q2	29
Pain Medicine	41	526	12.83	35	Anesthesiology; Medicine, General & Internal	2.782	Q2; Q1	16
European Spine Journal	40	1075	26.88	27	Clinical Neurology; Orthopedics	2.634	Q3; Q2	20
Journal of Back and Musculoskeletal Rehabilitation	38	156	4.11	0	Orthopedics; Rehabilitation	0.982	Q4; Q4 (SCIE)	7
PLoS One	33	446	13.52	33	Multidisciplinary	2.766	Q1	9

					Sciences			
Journal of Occupational Rehabilitation	31	1212	39.1	2	Rehabilitation; Social Issues	1.858	Q1 (SSCI); Q2	17
Journal of Oral Rehabilitation	31	658	21.23	2	Dentistry, Oral Surgery & Medicine	2.051	Q2	17

Table 2. Top 10 authors, co-cited authors, and co-cited references in comorbid pain and disability research.

Author	Count	Co-cited Author	Count	Co-cited Reference	Count
LIPTON RB	37	WADDELL G	386	VLAEYEN JWS, 2000, PAIN, V85, P317	58
BUSSONE G	28	TURK DC	302	CROMBEZ G, 1999, PAIN, V80, P329	45
JENSEN MP	26	JENSEN MP	300	LEEuw M, 2007, J BEHAV MED, V30, P77	44
D'AMICO D	23	DEYO RA	299	ROLAND M, 2000, SPINE, V25, P3115	41
GRAZZI L	20	WARE JE	277	VOS T, 2012, LANCET, V380, P2163	41
JULL G	20	ROLAND M	255	LINTON SJ, 2000, SPINE, V25, P1148	36
STEWART WF	20	VLAEYEN JWS	245	OSTELO R, 2008, SPINE, V33, P90	32
FERNANDEZ-DE-LAS-PENAS C	18	LINTON SJ	225	WOLFE F, 1990, ARTHRITIS RHEUM-US, V33, P107	29
USAI S	18	SULLIVAN MJL	219	STEWART WF, 1999, CEPHALALGIA, V19, P107	29
VLAEYEN JWS	18	WOLFE F	205	STEWART WF, 1999, NEUROLOGY, V53, P988	29

Table 3. Top 20 keywords in terms of frequency and centrality.

Ranking	Counts	Keyword	Centrality	Keyword
1	694	low back pain	0.32	validity
2	647	disability	0.29	rheumatoid arthriti
3	533	pain	0.25	depression
4	427	prevalence	0.25	belief
5	387	reliability	0.24	health
6	374	quality of life	0.17	epidemiology
7	347	depression	0.17	impairment
8	344	questionnaire	0.17	muscle strength
9	264	validity	0.16	back pain
10	254	validation	0.15	arthriti

Table 4. Top 10 papers with the most citation counts in comorbid pain and disability research.

Title	First Author	Journal	Impact factor (2017)	Year	Citations WoS	Relative citations	WoS categories	Category ranking
A study of the natural-history of back pain .1. development of a reliable and sensitive measure of disability in low-back pain	Roland, M	Spine	2.792	1983	2066	57.39	Clinical Neurology; Orthopedics	87/197; 15/77
A fear-avoidance beliefs questionnaire (FABQ) and the role of fear-avoidance beliefs in chronic low-back pain and disability	Waddell, G	Pain	5.559	1993	1585	60.88	Anesthesiology; Clinical Neurology; Neurosciences	3/31; 21/197; 35/261
The global burden of headache: a documentation of headache prevalence and disability worldwide	Stovner, LJ	Cephalalgia	3.886	2007	1080	90.00	Clinical Neurology; Neurosciences	43/197; 76/261
The dimensions of health outcomes - the health assessment questionnaire, disability and pain scales	Fries, JF	Journal of Rheumatology	3.47	1982	1068	28.86	Rheumatology	11/30
Pain-related fear is more disabling than pain itself: evidence on the role of pain-related fear in chronic back pain disability	Crombez, G	Pain	5.559	1999	914	45.70	Anesthesiology; Clinical Neurology; Neurosciences	3/31; 21/197; 35/261
The pain disability index - psychometric properties	Tait, RC	Pain	5.559	1990	552	19.03	Anesthesiology; Clinical Neurology; Neurosciences	3/31; 21/197; 35/261
Burden of migraine in the United States - Disability and economic costs	Hu, XH	Archives of Internal Medicine	17.333	1999	546	27.30	Medicine, General & Internal	6/154
A comparison of a modified Oswestry Low Back Pain Disability Questionnaire and the Quebec Back Pain Disability Scale	Fritz, JM	Physical Therapy	2.587	2001	506	28.11	Orthopedics Rehabilitation	23/77; 13/65
The Saskatchewan Health and Back Pain Survey - The prevalence of neck pain and related disability in Saskatchewan adults	Cote, P	Spine	2.792	1998	487	23.19	Clinical Neurology; Orthopedics	87/197; 15/77
Treatment of painful pseudoparesis due to	Werner, CML	Journal of Bone and	4.583	2005	467	33.36	Orthopedics; Surgery	3/77; 11/200

irreparable rotator
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shoulder prosthesis

Joint Surgery-
American
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Figures

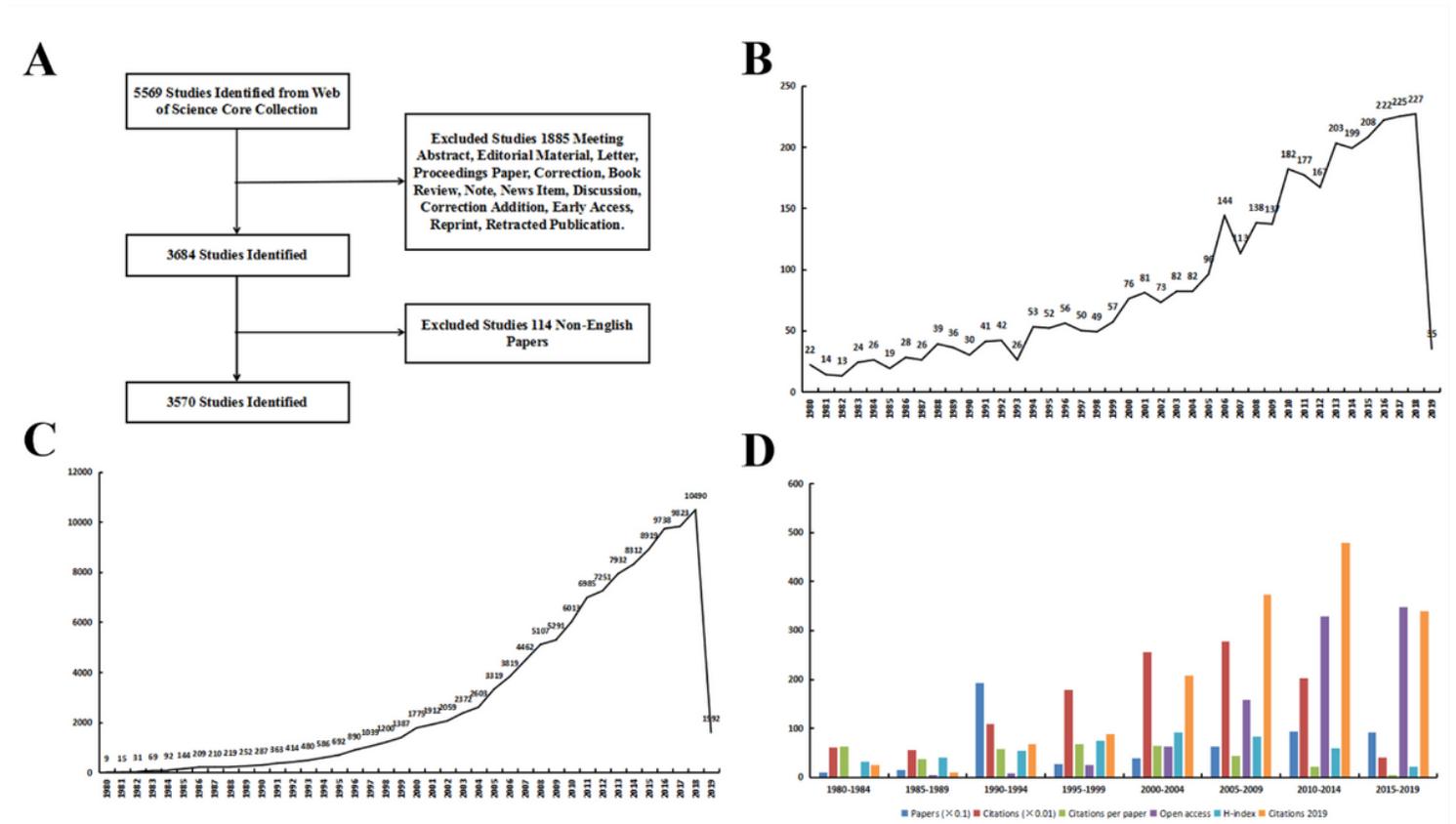


Figure 1

General data on comorbid pain and disability research from 1980 to 2019. (A)Flow chart of paper selection. (B)Annual publications on comorbid pain and disability research from 1980 to 2019. (C)Annual citations on comorbid pain and disability research from 1980 to 2019. (D)The analysis of eight 5-year period.

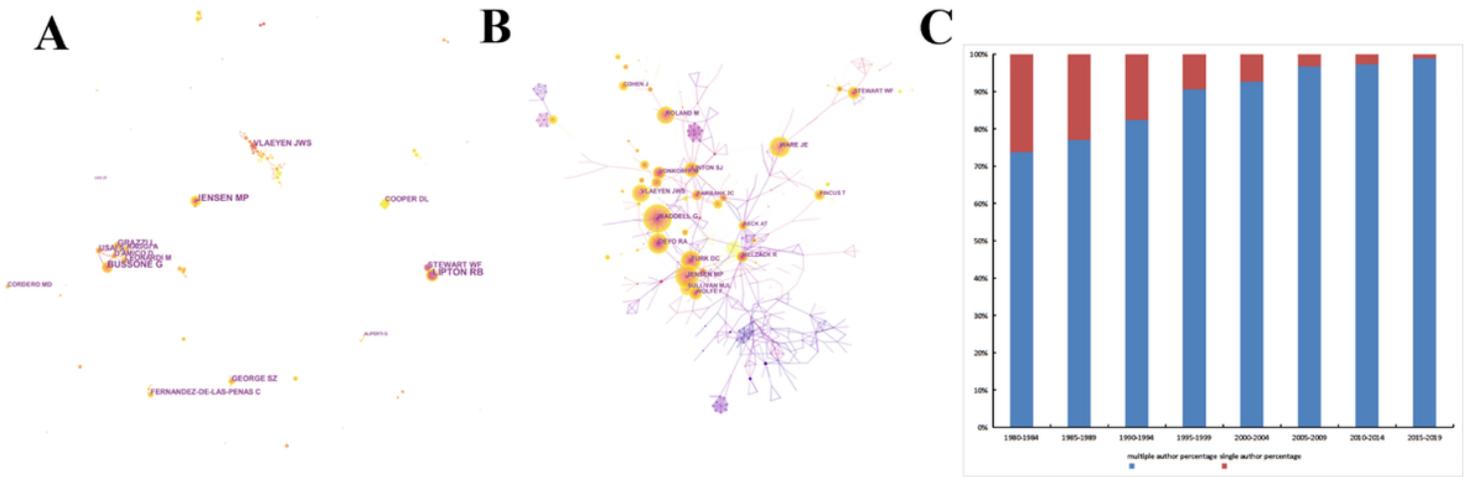


Figure 4

The analysis of authors. (A) Network map of author cooperation in comorbid pain and disability research. (B) Network map of co-cited authors in comorbid pain and disability research. (C) Trends in the percentage of single- vs multiple-authored articles per 5 years.

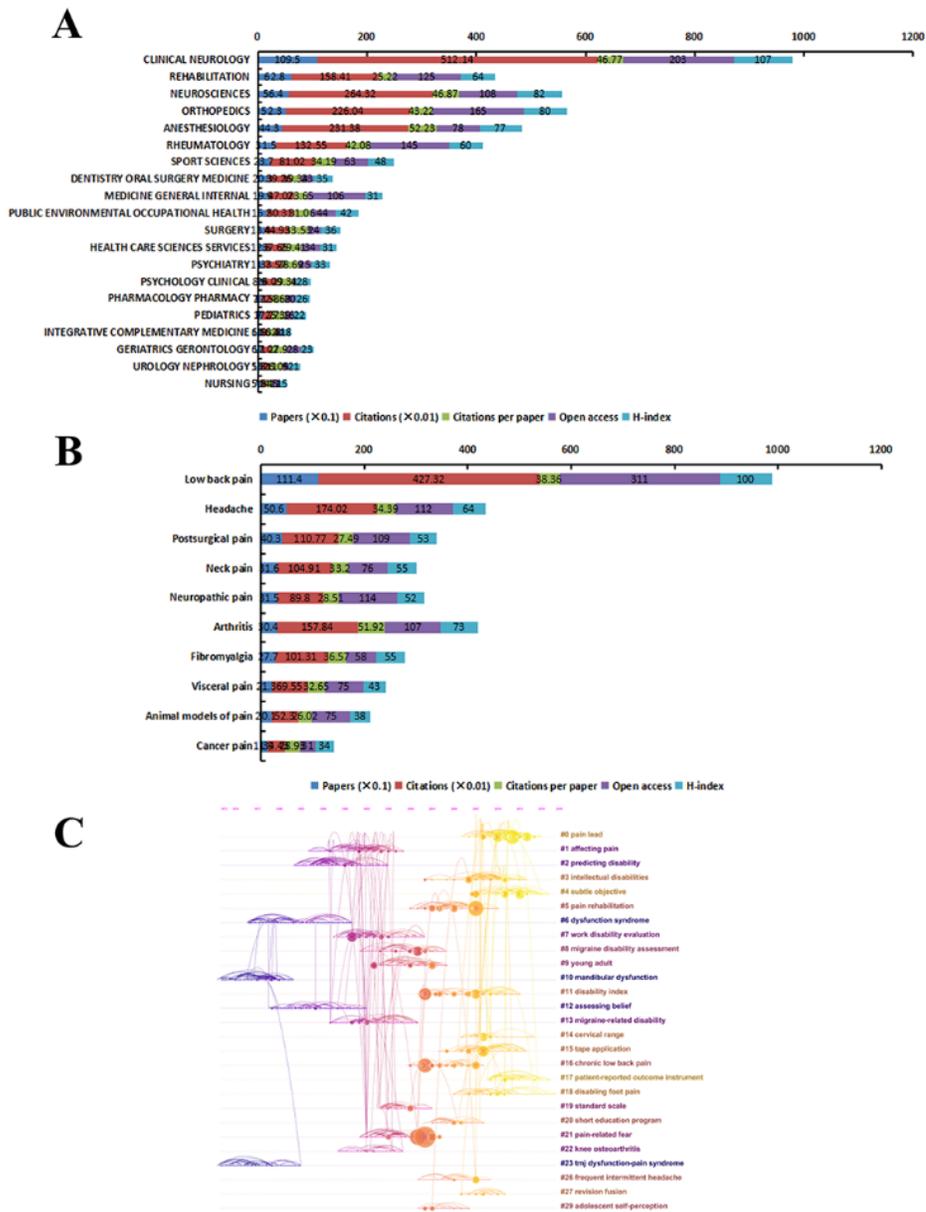


Figure 5

The analysis of subject categories, types of pain and references. (A) The analysis of the top 20 subject categories of WoS. (B) The analysis of the top 10 types of pain. (C) Co-citation map (timeline view) of references of comorbid pain and disability research.

Top 68 Keywords with the Strongest Citation Bursts

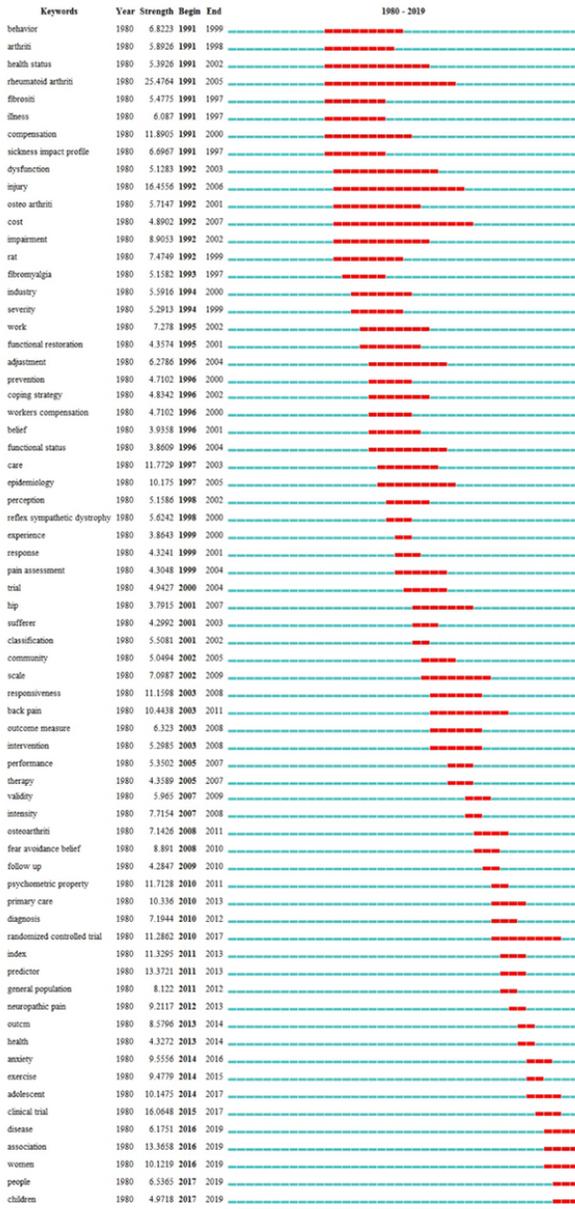


Figure 6

Top 68 keywords with the strongest citation bursts.

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