REVIEW

Bibliometric Analysis of Research on the Comorbidity of Cancer and Pain

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Background: Pain is the most common symptom in patients with neoplasm. It is a distressing experience that seriously destructs the quality-of-life of patients, with a high prevalence in clinical observations. However, only a few studies have applied bibliometric methods to analyze systematic works on the comorbidity of cancer and pain.

Purpose: The aim of this work was to conduct a systematic analysis of the scientific studies worldwide on the comorbidity of cancer and pain in 2010–2019.

Methods: The Web of Science databases were searched for publications related to the comorbidity of cancer and pain from 2010 to 2019.

Results: A total of 3,423 papers met the inclusion criteria in this research. The increase in the quantity of papers presented a significant growth from 2010 to 2019 ($P<0.001$) by linear regression analysis. The research subject categories of the 3,423 papers mainly concentrated on oncology (28.57%), clinical neurology (25.62%), and healthcare science services (15.89%). The US had the highest number of published papers, followed by the People's Republic of China, and England. According to scientific statistics, breast cancer (20.36%) was by far the most predominant topic in the papers related to the comorbidity of cancer and pain.

Conclusion: This bibliometric research provided a framework for visual and quantitative research to management scholars in favor of exploring a potential field related to hot issue and research frontiers.

Keywords: global trend, pain, CiteSpace, cancer

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Introduction

Cancer is a common disease, with more than 14 million cases worldwide annually (as reported by Cancer Research UK). It affects physical and emotional functions, making everyday activities and social interactions challenging.[1,2] In 2018, there were 18.1 million new cases of cancer and 9.6 million cancer deaths.[3,4] The most common symptoms that routinely damage the quality-of-life of cancer patients include pain, anxiety, depression, and fatigue.[1] As the study by Mariotto et al[5] predicted, in the US, if incidence, survival, and cost remain the same, there would be 13.8 and 18.1 million cancer patients in 2010 and 2020, respectively, and the associated cancer treatment costs would be 124.57 and 157.77 billion 2010 US dollars.

Pain is a common distressing symptom associated with cancer, and it may be due to tissue destruction and sensory and emotional discomfort.[1,6,7] According to the 2016 National Health Interview Survey data, approximately 20.4% (50.0 million) of the population in the US have chronic pain, and 8.0% of the

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population (19.6 million) have severe chronic pain.[8] Despite advances in cancer therapies, nearly one out of two cancer patients remain undertreated for pain.[9] Up to 3% of the gross domestic product of European countries has been spent on pain treatment, which exceeds the expenditure on cancer and heart disease.[10] Evidence suggests that adequate pain treatment results in clinically relevant improvements in health-related quality-of-life.[11]

Cancer pain destroys the quality-of-life of patients and is linked with multiple psychosocial disorders. Previous studies found that moderate-to-severe pain was reported by 38.0% of patients and 51.9% in patients with advanced stage cancer.[12] Compared with the tradition view, wherein cancer pain is associated with the physical effects of the growing neoplasm, count in the tissue destruction, and the immediate compression of serve fibers exist in the situation.[13] Brown and Ramirez[14] showed that common signaling pathways, mediators, and immune cell types are involved in the generation of pain as a result of cancer and its treatment and distinct alterations in central and peripheral neuronal functions occur in multiple forms of cancer pain.

Bibliometrics is a statistical analysis and quantitative tool to study publications. Although research on cancer and pain is extensively available worldwide, to our knowledge studies using bibliometric methods to analyze the overall aspects of our study topic are limited. Bibliometric refers to methods that use the quantitative analysis of published research and statistics to confirm the trends of scientific research.[15] In the past 10 years, bibliometric analyses have been conducted on other cancer research hotspots, such as the application of medicine,[16] cancer rehabilitation,[17,18] immunotherapy,[19] risk of infection,[20] medical literature,[21] and public policy.[22]

As we all know, with relatively few quantitative analyses of the comorbidity of cancer and pain, the purpose of this study is to methodically offer overall scientific analysis of published research within the past 10 years. CiesSpace (5, 5, R2), which was created by Professor Chaomei Chen in 2004, is designed to facilitate the detection of emerging trends and abrupt changes in scientific literature. To conduct a bibliometric research, we researched the Web of Science databases for publications related to the comorbidity of cancer and pain from 2010 to 2019 and used CiteSpace (5, 5, R2) to map the co-occurrence network

map of countries, institutions, authors, keywords, and subject categories, as well as the co-citation networks of references, journals, authors, and citation burst analysis of keywords.[23]

Materials and Methods
Source of Data
We used the Web of Science database as the basic retrieval tool. We also chose the Science Citation Index Expanded (SCI-Expanded) database of Web of Science (WoS) as the source of available databases. Published papers from 2010 to 2019 were retrieved. We set the record content terms as the title=(pain* or headache* or "head ache*" or head-ache* or migraine* or cephalalgi* or "stomach ache*" or "tummy ache*" or "abdominal ache*" or "belly ache*" or earache* or earache* or toothache* or tooth-ache* or odontalgi* 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 title=(cancer or tumor or tumour or neoplasia or neoplasms or tumors or tumours or cancers).

Inclusion Criteria
Articles and reviews related to the comorbidity of cancer and pain in different academic journals were included. We excluded letters, meeting abstracts, published editorial materials, book reviews, conference presentations, news items, and corrections. Language was unrestricted, and no restrictions on the species were specified.

Data Extraction
Cheng-Cheng Wu researched and extracted the publications related to the comorbidity of cancer and pain from the Web of Science databases from 2010 to 2019. EndNote X7 and Microsoft Excel 2016 were used for the statistical analysis of downloaded published research data. Information including the number of published papers was extracted and recorded as bibliometric indicators. We classified involved research in several ways: 1) types of cancer, 2) Web of Science subject category, and 3) single- or multiple-authored article (authors≥2). The author selected and evaluated the top 10 types of cancer (eg, breast cancer) according to involved studies. Given that certain publications focused on more than one type of cancer, the total of papers can reach more

than 3,423. For instance, the studies of Agarwal et al[24] and Altundag et al[25] focused on breast cancer and bone cancer.

Statistical Methods

We used CiteSpace (5, 5, R2) and Microsoft Excel 2016 for statistical analysis and obtained 1) the distribution of years/journals/authors/institutions/countries, 2) cooperation among authors/countries/institutions, 3) quantity of citations and value of the H-index, and 4) co-citation reference and keywords with the strongest citation bursts. To evaluate whether the percentage statistically decreased or increased from 2010 to 2019, we used IBM SPSS Statistics 18.0 software for linear regression analysis with the percentage of each category (as the dependent variable) and the year (as the independent variable), such as the percentage of publication count per year of types of cancer. $P<0.05$ was considered to indicate statistical significance.

Results

Paper Analysis

In total, 3,423 papers met the inclusion criteria. Figure 1A shows that the general trend of publications increased from 259 in 2010 to 452 in 2019. According to the feedback of linear regression results, the percentages had a remarkable growth from 2010 to 2019 ($t=10.91$, $P<0.001$). The total number of publications on the comorbidity of cancer and pain reached up to 47,566-times (4,756.6-times annually, H-index value=83). The percentages also revealed a remarkable growth from 2010 to 2019 ($t=46.83$, $P<0.001$), as presented in Figure 1B. In detail, papers related to the comorbidity of cancer and pain were cited the most in 2011, which was up to 8,649-times, followed by 2010. The highest H-index value (50) and largest number of citations per paper (33.4) were presented in 2011. The highest number of papers was published in 2019
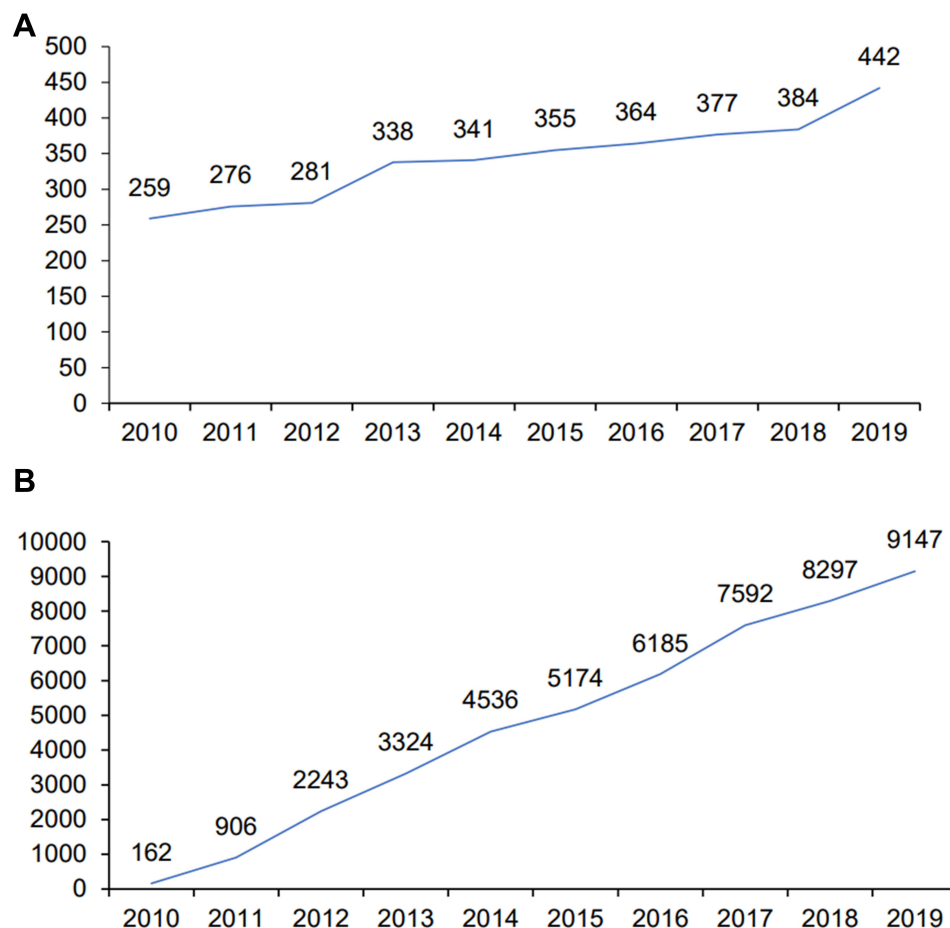

Figure 1 Number of publications and citations. (**A**) The number of annual publications on cancer and pain research from 2010–2019; (**B**) the number of annual citations on cancer and pain research from 2010–2019.
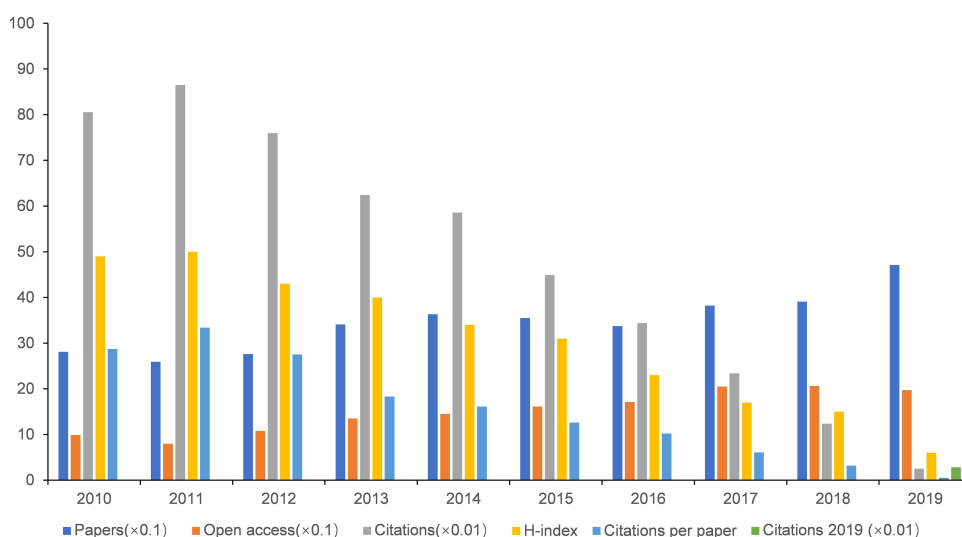
Figure 2 Number of papers, citations, citations per paper, open access paper, H-index, and citations in 2019 for each year time period.

(471), and the highest number of open access papers was observed in 2018 (206), as shown in Figure 2.

Analysis of Journals

The publications searched was published in 841 academic journals, as shown in Supplementary Table 1. We selected and recorded the top 20 journals according to the quantity of papers, as shown in Table 1. The academic journal *Supportive Care in Cancer* with impact factor (IF) 2018 of 2.754 had the highest number of papers on the comorbidity of cancer and pain (139 publications, 4.03%), followed by the *Journal of Pain and Symptom Management* (IF 2018, 3.378; 134 publications; 3.89%), *Pain* (IF 2018, 6.029; 93 publications; 2.70%), and *Pain Medicine* (IF 2018, 2.764; 82 publications; 2.38%). In detail, the academic journal *Pain* had the highest H-index value, which reached up to 33. *Clinical Oncology* had the largest quantity of citations per paper (57.48) and highest 2018 IF, of 28.349.

As shown in Figure 3, CiteSpace (5, 5, R2) was used to gain a dual-map overlay of the journals. Interpreting the construction of a dual-map base, the left of the dual-map is the citing journals and the right of the dual-map is the cited journals. The labels of the dual map were considered as the discipline of the journals, and the lines were recognized as the connections of citation, that is, always beginning from the citing journals to the cited journals. As a result, the majority of publications were published in neurology, sports, and ophthalmology journals, which mostly cited journals from health, nursing, and medicine.

Subject Categories of WOS Analysis

The researched areas were distributed to 72 subject categories of WOS. We listed the top 20 subject categories according to the quantity of papers, as shown in Figure 4. In detail, *Oncology* had the largest quantity of papers (978), number of citations (12,839), number of open access papers (410), and value of H-index (53). Neurosciences subject category had the largest number of citations per paper (19.37). According to the feedback of linear regression analyses, the percentages had a remarkable increase in the last 10 years in the top 20 categories (Oncology, Health Care Sciences Services, Pharmacology Pharmacy, Neurosciences, Rehabilitation, Medicine Research Experimental, Radiology Nuclear Medicine Medical Imaging, Integrative Complementary Medicine) ($P<0.05$).

Analysis of Types of Cancer

According to the quantity of publications, we listed the top 10 types of cancer (Figure 5), the papers with breast cancer published quantity was the most in the top types researching on the comorbidity of cancer and pain (697, publications), which accounted for 20.36% of the total quantity of papers, followed by bone cancer (642

Table I The Top 20 Journals of Origin of Papers in the Cancer and Pain Research

Journals	Papers	Citations (WoS)	Citations per Paper	Open Access	WoS Categories	IF 2018	Quantile	H-Index
Supportive Care in Cancer	139	1,382	9.94	29	Health Care Science & Services; Oncology; Rehabilitation	2.754	Q2; Q3; Q1	20
Journal of Pain and Symptom management	134	2,791	20.83	60	Anesthesiology; Clinical Neurology; Neurosciences	3.378	Q1; Q1; Q1	29
Pain	93	2,944	31.66	37	Anesthesiology; Clinical Neurology; Neuroscience	6.029	Q1; Q1; Q1	33
Pain Medicine	82	1,203	14.67	79	Medicine, General & Internal	2.764	Q2	22
Pain Physician	52	1,425	27.40	–	Anesthesiology; Clinical Neurology	2.942	Q2; Q2	20
Journal of Pain Research	49	244	4.98	49	Clinical Neurology	2.236	Q3	9
Pain Practice	46	588	12.78	5	Anesthesiology; Clinical Neurology	2.486	Q3; Q3	13
American Journal of Hospice Palliative Medicine	44	403	9.16	5	Health Care Science & Services	1.655	Q3	27
Journal of Pain	44	1,399	31.80	18	Clinical Neurology; Neurosciences	5.424	Q1; Q1	20
Journal of Palliative Medicine	42	366	8.71	2	Health Care Science & Services	2.477	Q2	11
Molecular Pain	42	471	11.21	42	Neurosciences	2.756	Q3	11
European Journal of Pain	41	554	13.27	8	Anesthesiology; Clinical Neurology; Neurosciences	3.188	Q2; Q2; Q2	13
Cochrane Database of Systematic Reviews	39	703	18.03	35	Medicine, General & Internal	7.755	Q1	18
Journal of Clinical Oncology	37	2,126	57.46	18	Oncology	28.349	Q1	25
Clinical Journal of Pain	36	512	14.22	10	Anesthesiology; Clinical Neurology	2.893	Q2; Q2	13
Palliative Medicine	36	1,014	28.17	7	Health Care Science & Services; Medicine, General & Internal; Public, Environmental & Occupational Health	4.956	Q1; Q1; Q1	19
PLoS One	35	364	10.40	35	Multidisciplinary Sciences	2.776	Q2	9
Current Pain and Headache Reports	32	455	14.22	5	Clinical Neurology	2.767	Q2	14
Medicine	30	48	1.60	30	Medicine, General & Internal	1.870	Q2	4
Pain Management Nursing	29	132	4.55	7	Nursing; Nursing	1.455	Q2; Q2	27

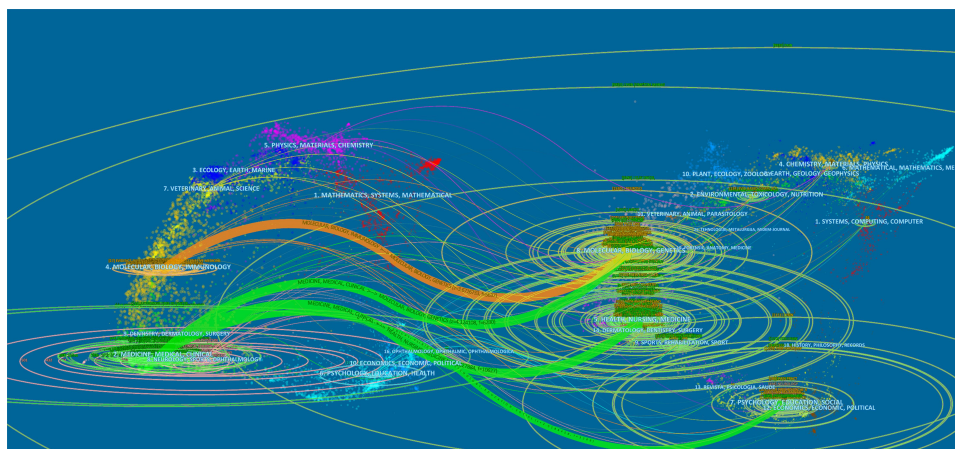**Abbreviations:** WoS, Web of Science; IF, impact factor.

Figure 3 The dual-map overlay of journals related to cancer and pain research.
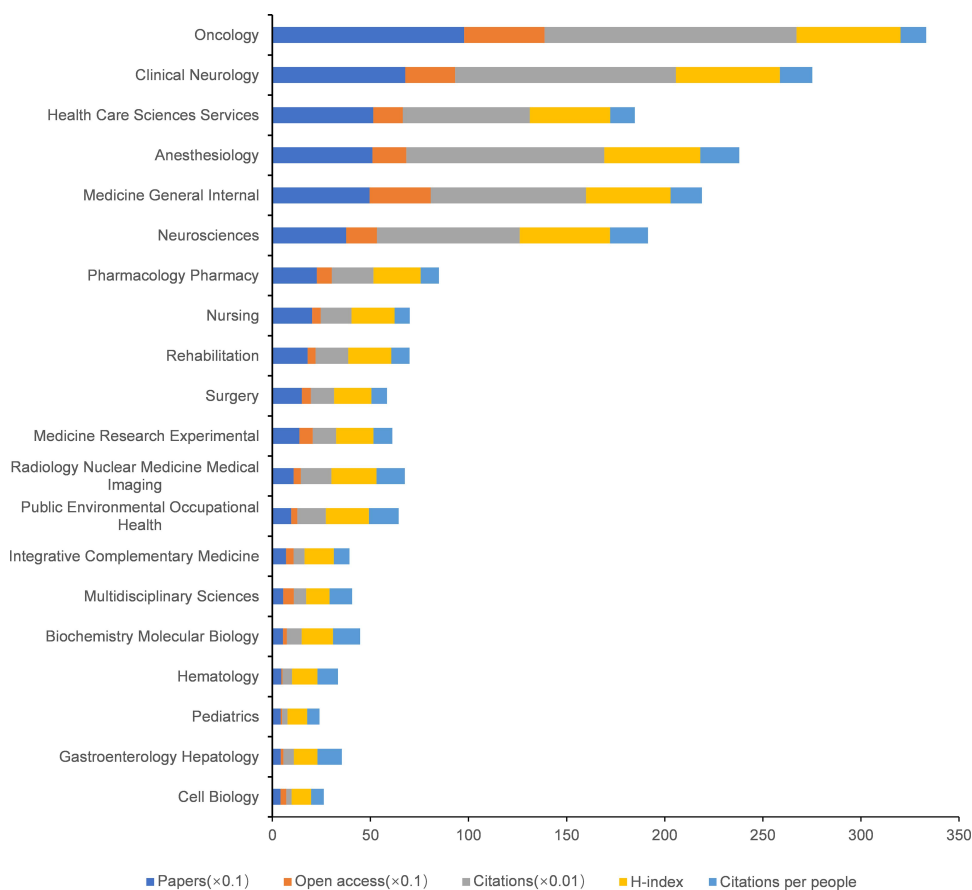

Figure 4 The number of papers, citations, citations per paper, open access papers, and H-index of the top 20 subject categories of Web of Science.

publications) and oral cancer (397 publications). Regarding the topics that had the highest number of citation frequency, the largest quantity of citations per paper, and highest value of H-index, breast cancer ranked the first, with 9,715 citations, 346 open access papers, 14 citations per paper, and an H-index value of 51, followed by bone cancer (7,555 citations, 315 open access papers, 14 citations per paper, and an H-index
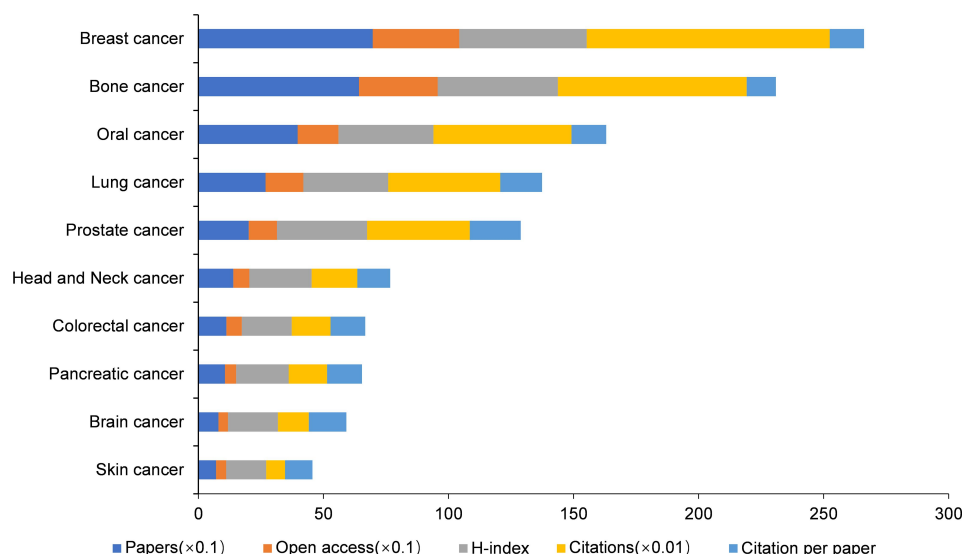
Figure 5 The number of papers, citations, citations per paper, open access papers, and value of H-index of the top 10 types of cancer.
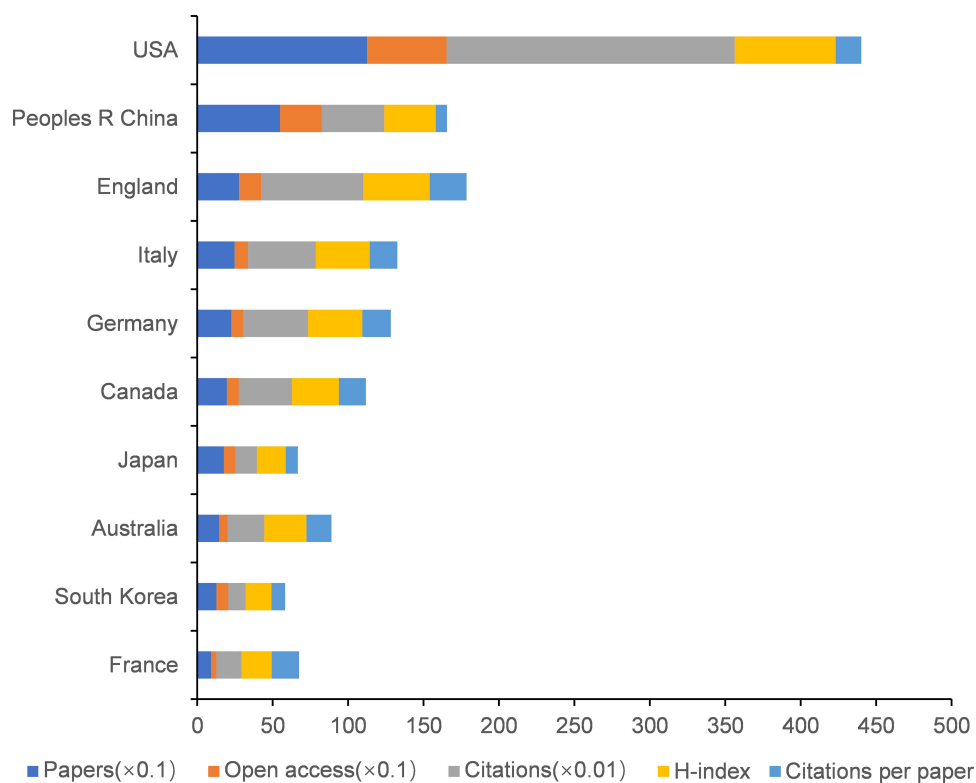

Figure 6 The number of papers, citations, citations per paper, open access papers and H-index of the top 10 countries.

value of 48). The feedback indicated that the percentages of the annual publication count had a remarkable increase from 2010 to 2019 (*P*<0.001) in breast cancer, bone cancer, spinal cancer, lung cancer, colorectal cancer, brain cancer, and skin cancer.

Analysis of Countries and Institution Distribution

The results were contributed by 68 countries/territories, as shown in Supplementary Table 2. Considering the quantity of papers, we listed the top 10 countries/
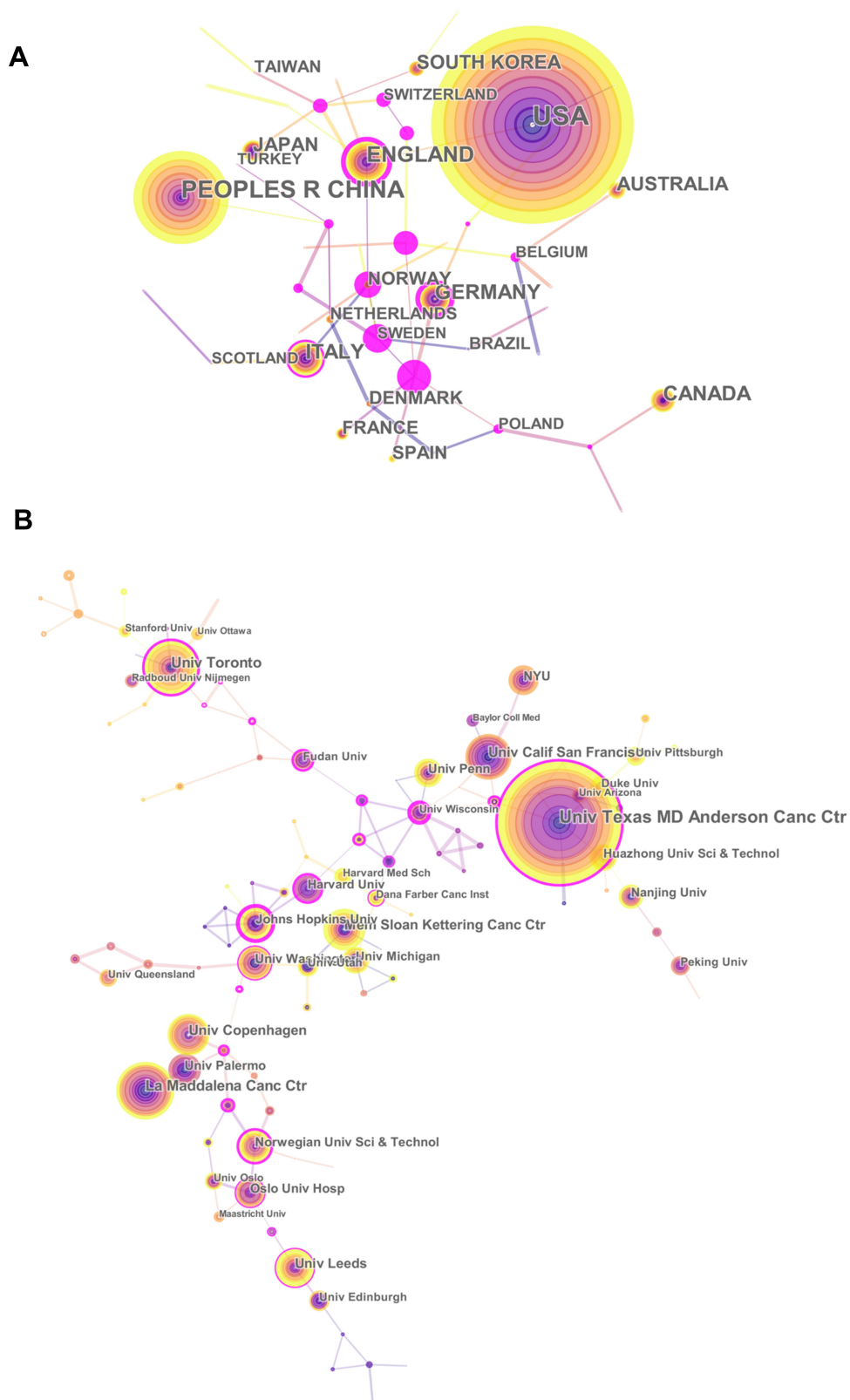
Figure 7 The analysis of countries and institutions. (**A**) Network map of countries/territories engaged in cancer and pain research. (**B**) Network map of institutions engaged in cancer and pain research.
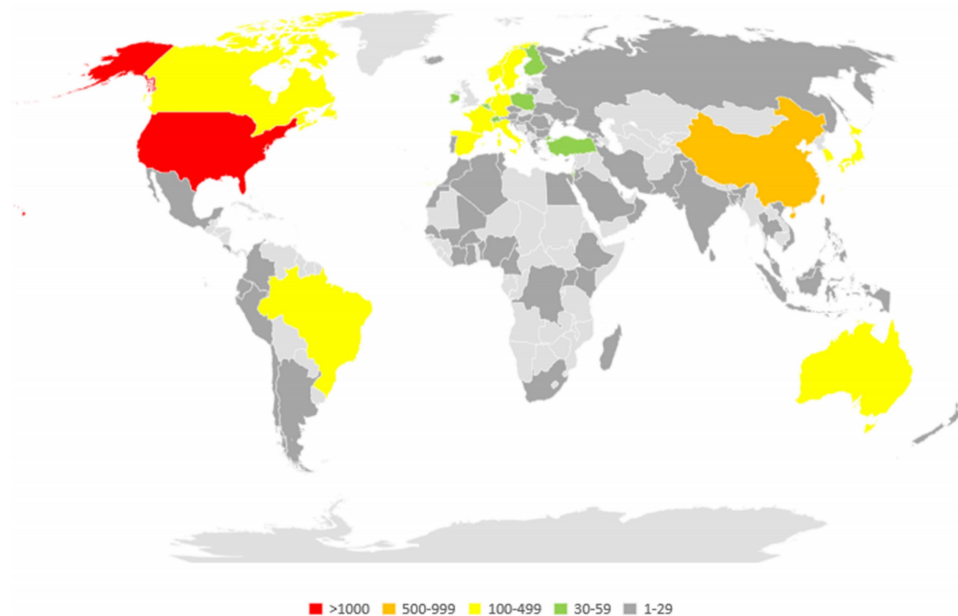
Figure 8 World map of total country output based on cancer and pain research.

territories (Figure 6). As a result, the US has made the highest contribution regarding the comorbidity of cancer and pain, which had the largest quantity of papers (1,126), largest number of citations (19,097), largest quantity of open access papers (526), and highest H-index value (67), followed by China (549 papers, 4,146 citations, 276 open access papers, and H-index value of 34), England (276 papers, 6759 citations, 148 open access papers, and an H-index value of 44), and Italy (247 papers, 4,488 citations, 88 open access papers, and an H-index value of 36). And the expansive co-operation of the countries/institutions is shown in Figure 7. We also mapped the world map to present the overview of all countries according to published quantity, as shown in Figure 8. The top 10 institutions were selected and listed by the number of publications from 3,749 institutions (Supplementary Table 3) that contributed to the comorbidity of cancer and pain (Supplementary Figure 1), and the proportion of contributions reached up to 16.77%. In detail, The University of Texas MD Anderson Cancer Center had the highest quantity of papers (121), citations (2,971), open access papers (50), and H-index value (31). The University of Leeds made the highest contribution in the quantity of citations per paper (28.9).

Distribution by Authors

As many as 14,646 authors have contributed to the comorbidity cancer and pain. To determine the collaboration among authors, we mapped the network map (Figure 9). As shown in Table 2, S. Mercadante had the highest number of publications (69) and citations (717). The author with the highest citation frequency was A. Caraceni. The general trend of the percentages of single-authored papers decreased from 7.18% in 2010 to 4.12% in 2019, as shown in Figure 10. According to the feedback of the linear regression analyses, the percentage trend of single-authored papers significantly decreased. Meanwhile, the percentage trend of multiple-authored papers (≥ 2) significantly increased from 2010 to 2019 (t=2.808, *P*<0.05).

Analysis of References

The concept of co-citation references is utilized as a research method to assess the degree of relationship between publications and considered as an important indicator in bibliometric studies. The scientific correlation of the published papers was presented in the co-citation map of the references (Figure 11). All 13 major clusters had a mean silhouette of 0.9593, which was higher than 0.5. This result indicated a high-quality
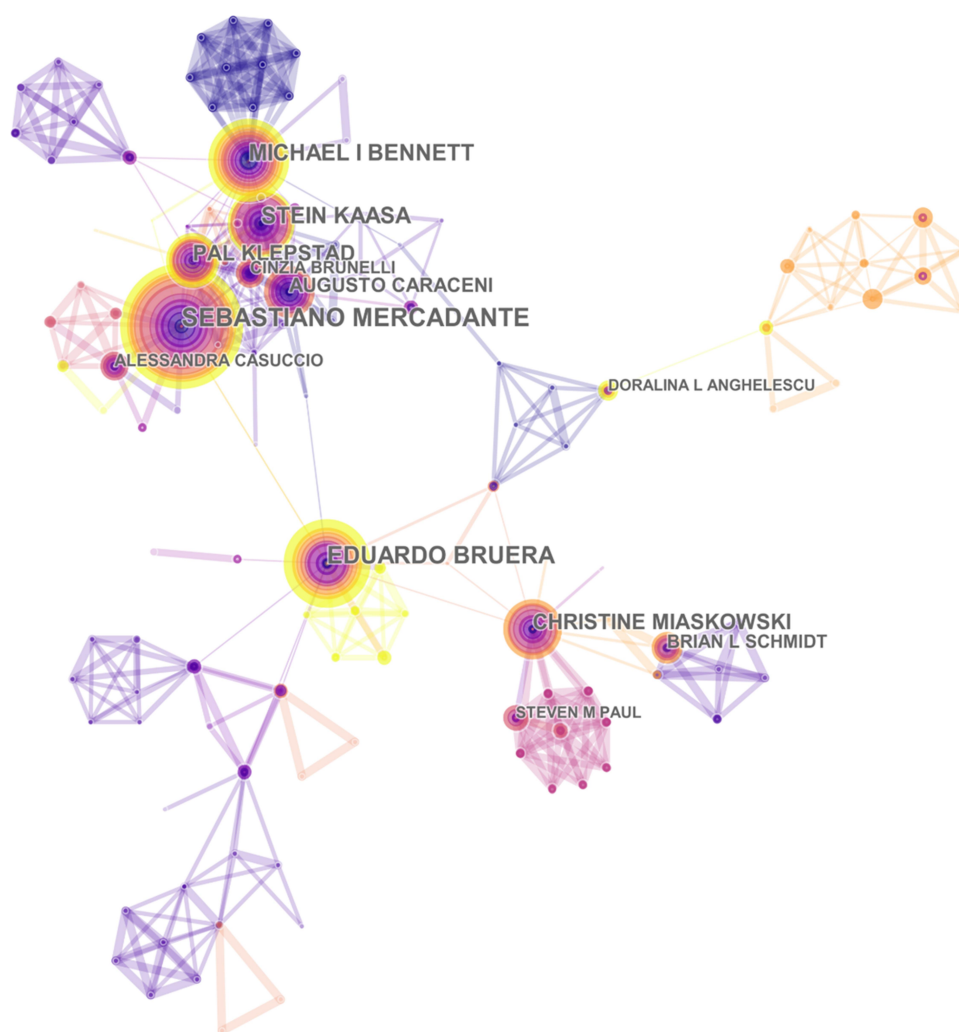
Figure 9 The analysis of authors. Network map of active authors that contributed to cancer and pain research.

cluster analysis of the network map. Figure 12 shows 13 major clusters presented in a time view. The cluster that ranked first was neoplasms (#0), followed by neoplasm pain.[26] These clusters contained neoplasms that are predominant in studies on the comorbidity of cancer and pain over time. The cluster that ranked third was bone cancer.[27]

Analysis of Keywords

We used CiteSpace (5, 5, R2) to extract the keywords on the comorbidity of cancer and pain. As shown in Figure 12, the top 36 keywords with the strongest citation bursts by the start of 2011 were as follows: "TNF-α", "Pharmacokinetics", "Transdermal fentanyl", and "Lung cancer", and the keywords ending in 2019 included "Outcome" (2017–2019),

"Oncology" (2017–2019), "Activation" (2017–2019), and "Inflammation" (2017–2019).

Analysis of Highest Number of Citation Frequency of Papers

The top 10 papers with the highest citation frequency on the comorbidity of cancer and pain are shown in Table 3. According to the quantity of citations of publications on the achievements of the comorbidity of cancer and pain, the top 10 papers with the largest number of citations accounted for 31.55%. The proportion of the number of citations of the top 10 papers in the total number of citations was up to 5.37%. The article entitled "Use of opioid analgesics in the treatment of cancer pain: evidence-based recommendations from the EAPC," which was written by Caraceni et al[28] and

Table 2 The Top 10 Authors, Co-Cited Authors, and Co-Cited References in the Anxiety and Pain Research

Author	Published Articles	Co-Cited Author	Cited Times	Co-Cited Reference	Cited Times
Mercadante S	69	Mercadante S	717	Caraceni A, 2012 Lancet Oncol, V13, P0	220
Bruera E	45	Portenoy RK	547	Everdingen M, 2007, Ann Oncol, V18, P1437	210
Kaasa S	45	Caraceni A	492	Deandrea S, 2008, Ann Oncol, V19, P1985	169
Bennett Mi	43	Cleeland CS	484	Breivik H, 2009, Ann Oncol, V20, P1420	143
Klepstad P	37	Everdingen M	425	Van Den B, 2016, J Pain Symptom Manag, V51, P1070	119
Caraceni A	36	Anonymous	379	Davies An, 2009,Eur J Pain, V13, P331	109
Miaskowski C	33	Deandrea	291	Portenoy RK, 2011, Lancet, V377, P2236	94
Radbruch L	24	Breivik H	281	Andersen KG, 2011, J Pain, V12, P725	91
Schmidt BL	24	Bruera E	244	Ripamonti CI, 2012, Ann Oncol, V23, P139	84
Zhang J	23	World Health Organization	229	Greco MT, 2014, J Clin Oncol, V32, P4149	72

published in *Lancet Oncology*, had the highest number of citation frequencies (585 citations). Table 3 shows that six reports[28–33] were published in journals with IF≥10 (*Lancet Oncology, Lancet, Annals of Oncology*), two papers[34,35] in journals with 3≤IF<5 (*Journal of Pain and Symptom Management, Current Medical Research*), and two works[36,37] in a journal with 1≤IF<3 (*Pain Physician and Current Medical Research and Opinion*). The data sources are from *Journal Citation Reports* (2018 edition).

Discussion
Global Potential and Achievement
This bibliometric study presented a visual and systematic review of the comorbidity of cancer and pain with every

Figure 10 Trends in the percentage of single- vs multiple-authored articles per years.

related article from WOS from 2010–2019. In the last 10 years, the global trends of the number of publications has been growing continually year by year. Four stages were presented on the development trend of quantity of papers on the comorbidity of cancer and pain studies: two slow increase speeds were observed from 2010–2012 and from 2013–2018, and two remarkable increases were shown from 2012–2013 and from 2018–2019. In 2019, the quantity of papers reached up to 442, the number of citations reached up to 8,649, and the H-index value was 50. On the basis of the quantity of papers on the achievements of the comorbidity of cancer and pain, the top 20 journals with the largest number of publications accounted for 31.55%. *Supportive Care in Cancer* had the largest quantity of papers (4.03%), followed by *Pain and Symptom Management* (3.89%), *Pain* (2.70%), and *Pain Medicine* (2.38%). Among the top 20 journals with IF>10 (*Oncology*, IF: 28.349), six had 1≤IF<3, two had 3≤IF<5, and two had 5≤IF<10. According to the quantity of papers, the US ranked first in the quantity of papers (1,126), followed by China (543), England (276), and Italy (247). Among the top 10 countries/territories, four were located in Europe, three in Asia, two in North America, and one in Oceania. The clear expansive co-operation of countries/institutions is presented in Figure 7. Based on the top 10 institutions with the highest number of publications, five were from the US, one from England, one from Italy, one from Norway, one from Denmark, and one from Toronto.
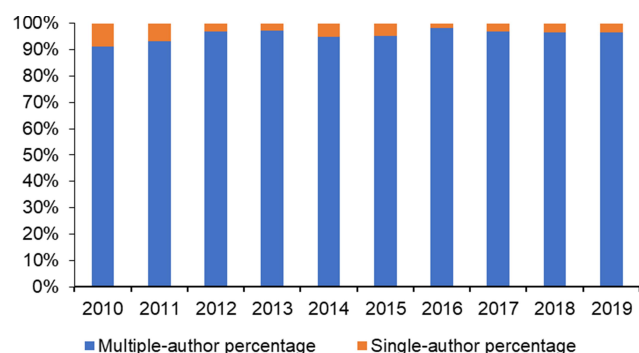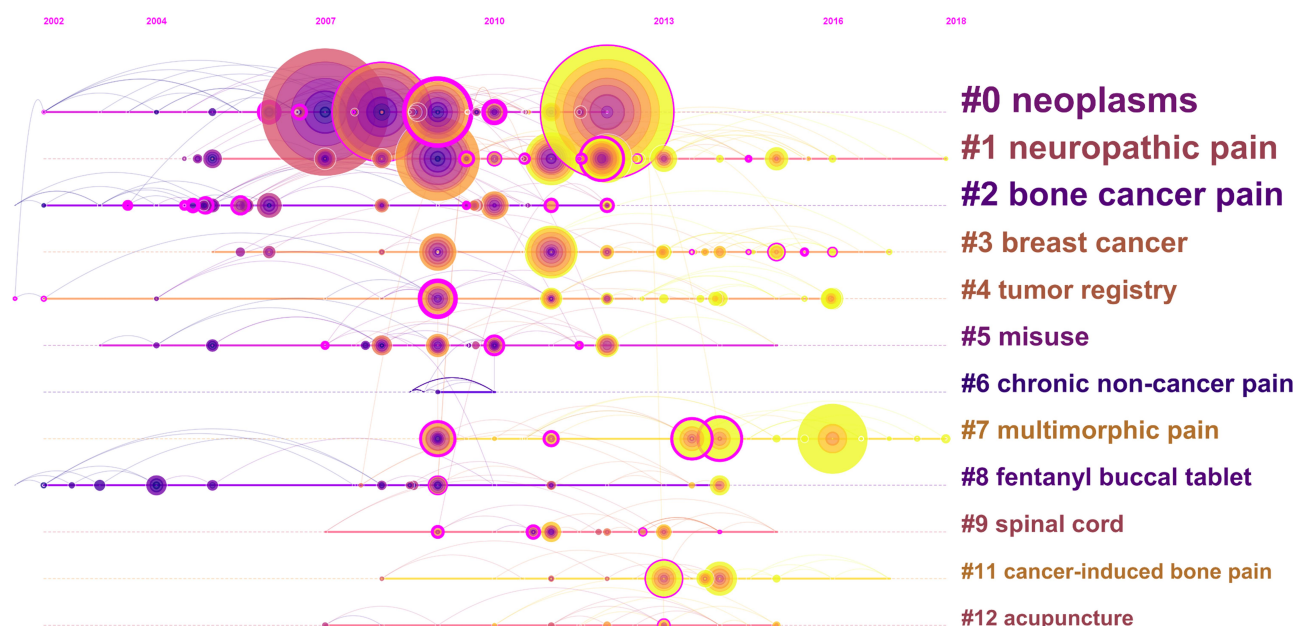
Figure 11 The analysis of references. Co-citation map (timeline view) of references from publications on to cancer and pain research.

Research Energy and Potential

In the last decade, in terms of the popularity of research subject categories of WOS, the comorbid cancer and pain research has mainly concentrated on Oncology (978, publications), followed by Clinical Neurology (877, publications), Health Care Sciences Services (514, publications), Anesthesiology (510, publications), and Surgery. In terms of research topics, 697 papers focused on breast cancer, which accounted for 20.36% of the 3,423 publications that are related to the comorbidity of cancer and pain. The top 10 types of cancer were breast cancer, bone cancer, oral cancer, lung cancer, prostate cancer, colorectal cancer, brain cancer, and skin cancer. According to the co-citation map of references, in the past 10 years, the majority of research mainly focused on "neoplasms" (#0) and "neoplasm pain".[26] Meanwhile, "bone cancer pain"[27] and "breakthrough pain"[38] have drawn considerable attention. The study of Zhu et al[39] focused on the progress of cancer pain from bone metastasis, mechanisms involved in cancer pain, and drug treatment of cancer pain in animal models. Breakthrough cancer pain (BTcR) refers to high-intensity, short-duration pain that occurs several times a day without effective

therapy.[40] Meanwhile, the study of Hagen et al[41] showed novel approaches to pain management to identify several innovative strategies for BTcR. The research of Furio et al[40] shared that a reasonable synthesis of the unremitting BTcP scientific discussed by clinicians and practitioners and a basis for optimal clinical approach. According to the top 36 keywords with the strongest citation bursts, the results in 2010 were as follows: "TNF-alpha," "Pharmacokinetics", "Transdermal fentanyl", and "Lung cancer". The keywords at the end of 2019 were as follows: "Survival" (2015–2019), "Recommendation" (2017–2019), "Persistent pain" (2016–2019), "Survivor" (2016–2019), "Meta-analysis" (2016–2019), "Outcome" (-2017–2019), "Oncology" (2017–2019), "Activation" (2017–2019), and "Inflammation" (2017–2019). In the last 10 years, with the technological developments in cancer diagnosis and therapy, the rates of survivors with cancer are increasing The issue of making certain how to improve the life quality of patients with cancer has aggregated a number of common concerns. In terms of an effective method to relieve cancer pain, Gong et al[42] demonstrated that 3-elemene has an ideal effect in relieving pain behavior in a rat model of BCRP.

Top 36 Keywords with the Strongest Citation Bursts

Keywords	Year	Strength	Begin	End	2010 - 2019
TNF alpha	2010	8.9666	2010	2011	
Pharmacokinetics	2010	10.0241	2010	2011	
Transdermal fentanyl	2010	9.4953	2010	2011	
Lung cancer	2010	6.5577	2010	2011	
Health	2010	8.2209	2010	2013	
Murine model	2010	9.5958	2010	2013	
Breakthrough pain	2010	3.7264	2010	2011	
Receptor	2010	3.4911	2010	2012	
Neoplasm	2010	12.67	2010	2011	
Open label	2010	7.5922	2011	2012	
Randomized trial	2010	8.9681	2011	2012	
Disease	2010	10.0257	2011	2012	
Oxycodone	2010	10.5547	2011	2012	
Bone metastasis	2010	9.3629	2011	2014	
Low back pain	2010	9.7745	2011	2013	
Rat model	2010	9.2403	2012	2016	
Safety	2010	10.0254	2013	2016	
Fentanyl	2010	6.9628	2013	2015	
Hyperalgesia	2010	5.2761	2014	2015	
Model	2010	7.0674	2014	2015	
Attitude	2010	11.4752	2014	2015	
Multicenter	2010	10.2264	2014	2016	
Outpatient	2010	8.8284	2014	2015	
Survival	2010	6.4941	2015	2019	
Chemotherapy	2010	6.9991	2015	2017	
Questionnaire	2010	5.8072	2015	2017	
Recommendation	2010	3.4307	2016	2019	
Persistent pain	2010	12.988	2016	2019	
Prostate cancer	2010	4.5116	2016	2017	
Survivor	2010	16.9702	2016	2019	
Meta-analysis	2010	16.9878	2016	2019	
Outcome	2010	7.921	2017	2019	
United States	2010	13.2697	2017	2019	
Oncology	2010	4.8224	2017	2019	
Activation	2010	7.5705	2017	2019	
Inflammation	2010	13.0688	2017	2019	

Figure 12 The keywords with the strongest citation bursts of publications on cancer and pain research.

Strengths and Limitations

The main strength was that this bibliometric study assessed the global trends on the study on the comorbidity of cancer and pain between 2010 and 2019. The data of this bibliometric study were extracted from the SCI-Expended of Web of Science Core database, which is highly credible and reliable. The above results indicated that the publications retrieved were published in more than 841 academic journals, which contributed to the abundance of the centralized publications. Given that other electronic databases were not retrieved, a research bias may be present. Given that various potential influential publications have been published recently, a comparatively small number of citations of papers can be as important as large citations of papers. Finally, the inherent limitations of bibliometric tools in the assessment of research output and/or impact should be considered.

Table 3 The Top 10 Papers with the Largest Citation Frequency in the Cancer and Pain Research

Title	First Author	Journal	Impact Factor	Year	Citations (WoS)	WoS Categories	Category Ranking
Use of opioid analgesics in the treatment of cancer pain: evidence-based recommendations from the EAPC.[28]	Caraceni, A	Lancet Oncology	35.386	2012	585	Oncology	3/230
Treatment of chronic non-cancer pain.[33]	Turk, DC	Lancet	59.102	2011	280	Medicine, General & Internal	2/160
Management of cancer pain: ESMO clinical practice guidelines.[32]	Ripamonti, C. I.	Annals of Oncology	14.196	2012	247	Oncology	9/230
Treatment of cancer pain.[31]	Portenoy, Russell K.	Lancet	59.102	2011	228	Medicine, General & Internal	2/160
American Society of Interventional Pain Physicians (ASIPP) guidelines for responsible opioid prescribing in chronic non-cancer pain: part 2-guidance.[36]	Manchikanti, Laxmaiah	Pain Physician	2.942	2012	227	Anesthesiology; Clinical Neurology	12/31; 79/199
Update on prevalence of pain in patients with cancer: systematic review and meta-analysis.[35]	van den Beuken-van Everdingen, Marieke H. J.	Journal of Pain and symptom Management	3.378	2016	215	Health Care Sciences & Services; Medicine, General & Internal; Clinical Neurology	63/199; 19/98; 31/160
Balloon kyphoplasty versus non-surgical fracture management for treatment of painful vertebral body compression fractures in patients with cancer: a multicentre, randomised controlled trial.[30]	Berenson, James	Lancet Oncology	35.386	2011	207	Oncology	3/230
Multicenter, double-blind, randomized, placebo-controlled, parallel-group study of the efficacy, safety, and tolerability of THC:CBD extract and THC extract in patients with intractable cancer-related pain.[34]	Johnson, Jeremy R.	Journal of Pain and Symptom Management	3.378	2010	206	Health Care Sciences & Services; Medicine, General & Internal; Clinical Neurology	63/199; 19/98; 31/160
Postoperative pain and quality of life after lobectomy via video-assisted thoracoscopic surgery or anterolateral thoracotomy for early stage lung cancer: a randomized controlled trial.[29]	Bendixen, Morten	Lancet Oncology	35.386	2016	200	Oncology	3/230
Epidemiology of chronic non-cancer pain in Europe: narrative review of prevalence, pain treatments and pain impact.[37]	Reid, Kim J.	Current Medical Research and Opinion	2.345	2011	199	Medicine, General & Internal; Medicine, Research & Experimental	51/160; 77/136

Conclusion

The area of the comorbidity cancer and pain is rich in potential and energy, and this paper provides an insight into this promising research field. Meanwhile, this paper has various limitations. The quantity of papers related to the comorbidity of cancer and pain showed a remarkable growth over time (from 259 in 2010 to 452 in 2019). According to the co-citation map of the reference, the research was primarily focused on neoplasms, neoplasm pain, bone cancer pain, and breakthrough pain, which were in favor of offering knowledge to relevant founding agencies and policymakers. The finding of this paper lays the framework for future development of research on the comorbidity of cancer and pain.

Funding

Disclosure

The authors report no conflicts of interest in this work.

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