



## Research article

# The top 100 highly cited articles on neck pain: A bibliometric analysis

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## ABSTRACT

**Objective:** Neck pain has emerged as a significant public health concern. This study is to unveil the present state of neck pain research, thereby furnishing invaluable insights for prospective research endeavours and clinical applications.

**Methods:** The study was initiated by searching the Web of Science Core Collection database, focusing on "neck pain". From the amassed results, the top 100 most cited references were imported into CiteSpace and VOSviewer, enabling a rigorous bibliometric analysis. To ensure precision, synonymous terms conveying similar meanings were harmonized. The bibliometric study encompassed countries, research institutions, authors, journals, and keyword analysis.

**Results:** The investigation centered on a curated compilation of 100 articles, disseminated across a diverse array of 36 scholarly journals. These seminal articles originated from 24 distinct countries, reflecting contributions from a wide spectrum of 188 research institutions. Impressively, a collaborative effort involving 385 authors emerged. Noteworthy core research countries included the United States and Australia, with the University of Queensland and the University of Toronto asserting notable influence. Prolific authors such as J. David Cassidy and Pierre Cote garnered attention. Present research endeavours pivot around the incidence of neck pain, the identification of risk factors, the efficacy evaluation of treatment modalities, and a pronounced focus on high-quality randomized controlled trials and systematic reviews.

**Conclusion:** The study shines a light on key research countries, influential institutions, prominent authors, and prevalent trends, effectively contributing to comprehending the knowledge landscape and research dynamics in the field of neck pain.

## 1. Introduction

Neck pain (NP) is one of the top 5 chronic pain diseases, in terms of prevalence and years lost to disability [1]. It brings serious economic and social burdens. In the United States, the annual medical expenditure on neck and low back pain reaches \$87.6 billion. However, NP has received considerably less attention and scientific research funding compared to low back pain [2]. While acute NP can often be managed with medication to alleviate symptoms, approximately 50% of cases progress to chronic NP and may develop

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into various forms of cervical spondylosis [3]. Chronic NP significantly impacts patients' quality of life, sleep patterns, and psychological well-being. A comprehensive synthesis of existing research is crucial to identify research trends and frontiers in the field of NP and to assess the current state of research.

Compared to conventional literature reviews, bibliometric analysis offers a more objective depiction of the current research landscape by analyzing the literature database within a research field. This analytical approach has been widely employed across various research disciplines such as computer science, statistics, social science, library science, and biomedicine [4]. In recent years, scholars in fields such as obstetrics and gynecology [5], orthopedics [6], neuroscience [7], and molecular biology [8] have undertaken relevant bibliometric studies. The frequency of citations is a crucial metric for evaluating the impact of academic papers in bibliometrics. Highly cited papers serve as significant indicators of well-recognized research accomplishments [9]. Therefore, analyzing citation frequency can identify the most influential academic articles within a specific domain and shed light on cutting-edge research hotspots and directions. While some scholars have reported on arthritis [10], low back pain [11], sarcopenia [12], and other topics within the top 100 cited literature. There has been no bibliometric analysis conducted on the top 100 cited literature in the field of NP. This study aims to quantitatively analyze the top 100 cited papers on NP, to elucidate global distribution patterns, research hotspots, and emerging trends in this field. Through bibliometric analysis, we can understand the historical progress of NP research and gain better insights into the contributions and differences in this field across various countries and regions. The results of this analysis can serve as valuable references for future researchers in selecting partners, references, and research methods, particularly in choosing journals and research topics.

Because of their powerful features, ease of use, flexibility and adaptability, and wide application and recognition in the academic community [13–15]. The bibliometric field commonly utilizes various software tools for analysis, among which CiteSpace and VOSviewer are frequently employed. These tools can generate visual representations of country distribution, research unit collaboration networks, author networks, keyword co-occurrence patterns, keyword clusters, and reference co-citation maps. CiteSpace, developed by Professor Chen Chaomei's team at Drexel University, automatically imports data and analyzes research trends, producing information-rich visual knowledge maps [16]. VOSviewer, jointly developed by Nees Jan van Eck and Ludo Waltman at Leiden University in the Netherlands, is characterized by its user-friendly interface, clear graphical representation, and high accuracy [17].

In this study, we primarily employed CiteSpace 6.2.R2 advanced version to detect bursts keywords, to create timezone maps and construct the dual-map overlay of journals. Additionally, VOSviewer 1.6.19 was utilized to explore co-occurrence relationships among countries, research units, authors, journals, keywords, and articles. In the visualizations generated by these tools, each node represents a research entity, with node size indicating the frequency of occurrence in research. The connections between nodes signify the strength of associations [15]. By leveraging the complementary capabilities of these two visualization tools, we refined our research findings. Furthermore, Microsoft Excel facilitated the analysis of publication counts, while Scimago Graphica 1.0.36 was used for mapping visualization.

## 2. Methods

### 2.1. Search strategy

On July 13, 2023, the medical subject term "neck pain" (MeSH) was retrieved from PubMed as a search term. In the WOS Core Collection (WoSCC), Science Citation Index Expanded (SCI-EXPANDED), the search was conditional on the title containing "neck pain" and its subheadings. To enhance research quality, the literature types were limited to "Article" and "Review," and the language was set to "English." A total of 4781 articles were retrieved. These articles were then sorted in descending order based on cited frequency, and the top 100 cited articles were selected and subsequently downloaded into both CiteSpace and VOSviewer for detailed visual analysis. This study is not based on the analysis of 4781 literature, but only includes the top 100 cited literature.

Due to limitations in the software's ability to determine the country associated with certain cities, institutions with varying names were automatically consolidated. Additionally, keywords with similar meanings were merged, and authors with different abbreviations were combined. To ensure the accuracy of visualization results, a manual disambiguation process was conducted for country, research institution, and author information. Similarly, comparable keywords were grouped. For instance, "England," "Northern Ireland," "Scotland," and "Wales" were combined under "United Kingdom." Terms like "Franklin Pierce Coll" and "Franklin Pierce Univ" were merged into "Franklin Pierce Univ." Variations like "ariens, ga" and "ariens, gam" were unified as "ariens, gam." Similarly, "low-back-pain" and "back-pain" were merged into "back pain," while "neck muscle" and "neck muscles" were consolidated as "neck muscles," and so forth.

### 2.2. CiteSpace and VOSviewer parameter settings were configured as follows

In CiteSpace, the settings were configured as follows: Time Slicing was set to 1 year, the association strength algorithm was determined as "Cosine," and TOP N was set to 25. The Nodes were sequentially set as Journal and Keyword, while Pruning was set to both "Pathfinder" and "Pruning to Network."

In VOSviewer, the Type of analysis was set to Co-authorship, Co-occurrence, Citation, and the Units of analysis were selected as Journals, Authors, Organizations, All Keywords, and Documents.

### 3. Results

#### 3.1. Analysis of publication year

Among the top 100 papers cited in the context of pain, there were a total of 79 articles and 21 reviews published within the timeframe spanning from 1985 to 2018. There was a noticeable concentration of articles with publication years in 2001, 2004, and 2008 (Fig. 1). Remarkably, the combined count of articles published during these three specific years constituted approximately 33% of the entire set. Particularly, in the year 2008, the volume of articles reached its zenith, primarily categorized as "Article" type publications. The publication count for 2008 exceeded that of 1996 by nearly threefold. A significant observation is that the number of articles within this dataset markedly surpasses the count of reviews. Furthermore, it's worth mentioning that the period post-2000 accounts for a substantial 75% of the entire dataset, signifying a shift in research focus and output towards more recent years.

#### 3.2. Analysis of countries and institutions

Analyzing countries as nodes reveals a total of 24 distinct nations (Fig. 2 A). The United States, Australia, and Canada collectively contribute 78% of the total output, emerging as prominent players in the field of NP research. These nations also boast the highest citation frequencies, indicating their significant influence. Moreover, the United States, Canada, and the Netherlands exhibit robust levels of international collaboration and exchange. Notably, Sweden garners the highest average citations per article, implying heightened scholarly attention and recognition for its research content (Table 1).

Turning attention to research units as nodes, a comprehensive view unveils 188 distinct research entities (Fig. 2 B). Impressively, the top 6 cited research institutions also lead in terms of published paper count, collectively accounting for 64% of the entire publication volume. Notably, three of these institutions hail from Canada, while two are based in the United States. Substantially consistent publication counts characterize these research units. Regarding the citation frequency per article, the University of Toronto secures the top rank, with an impressive value of 298.58. Institutions such as the University of Alberta, Karolinska Institute, and the University of Toronto prominently engage in collaborations with other research entities (Table 2).

#### 3.3. Analysis of journals

In terms of journals as nodes, the distribution of the top 100 cited articles was observed across 36 distinct journals (Fig. 3 A). Notably, six journals stood out with citation counts exceeding 1000. According to the Bradford Zone, we found that Spine and Pain belong to the core journals in this field. Of these, 27 articles found their place in Spine ( $IF = 3$ ), while 10 articles were published in Pain ( $IF = 7.4$ ), as indicated in Table 3 (Journal IF values are queried through Web of Science). The combined output of these six journals accounted for more than half of the total publications within the dataset. It is noteworthy that the study yielding the highest impact factor was featured in The Lancet ( $IF = 168.9$ ). This study delved into the treatment of NP using a low-level laser, comparing it with a placebo control [18]. Conversely, the article with the lowest impact factor was published in Oral Surgery Oral Medicine Oral Pathology Oral Radiology and Endodontics ( $IF = 1.457$ ). This specific paper was titled "Myofascial Pain Syndrome of the Head and Neck - Review

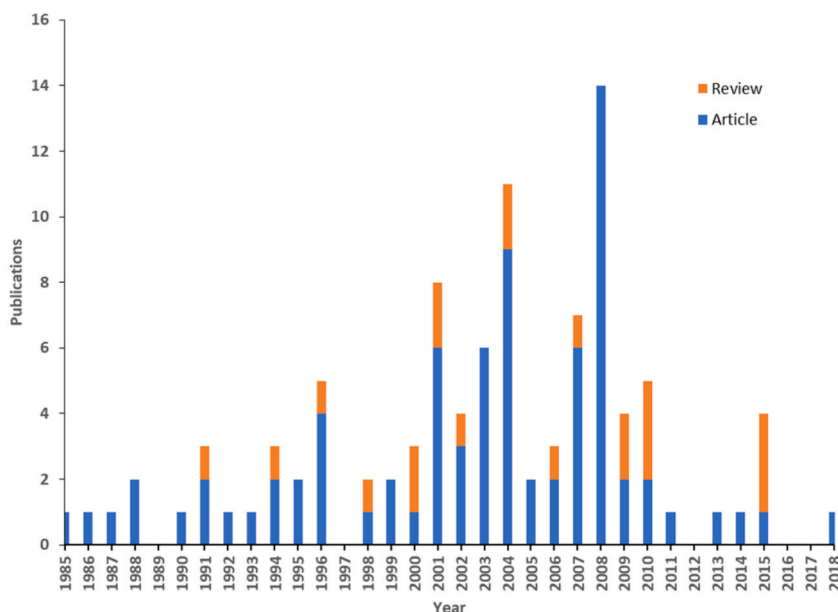


Fig. 1. Trends in the annual publication of articles on NP Top 100 cited articles.

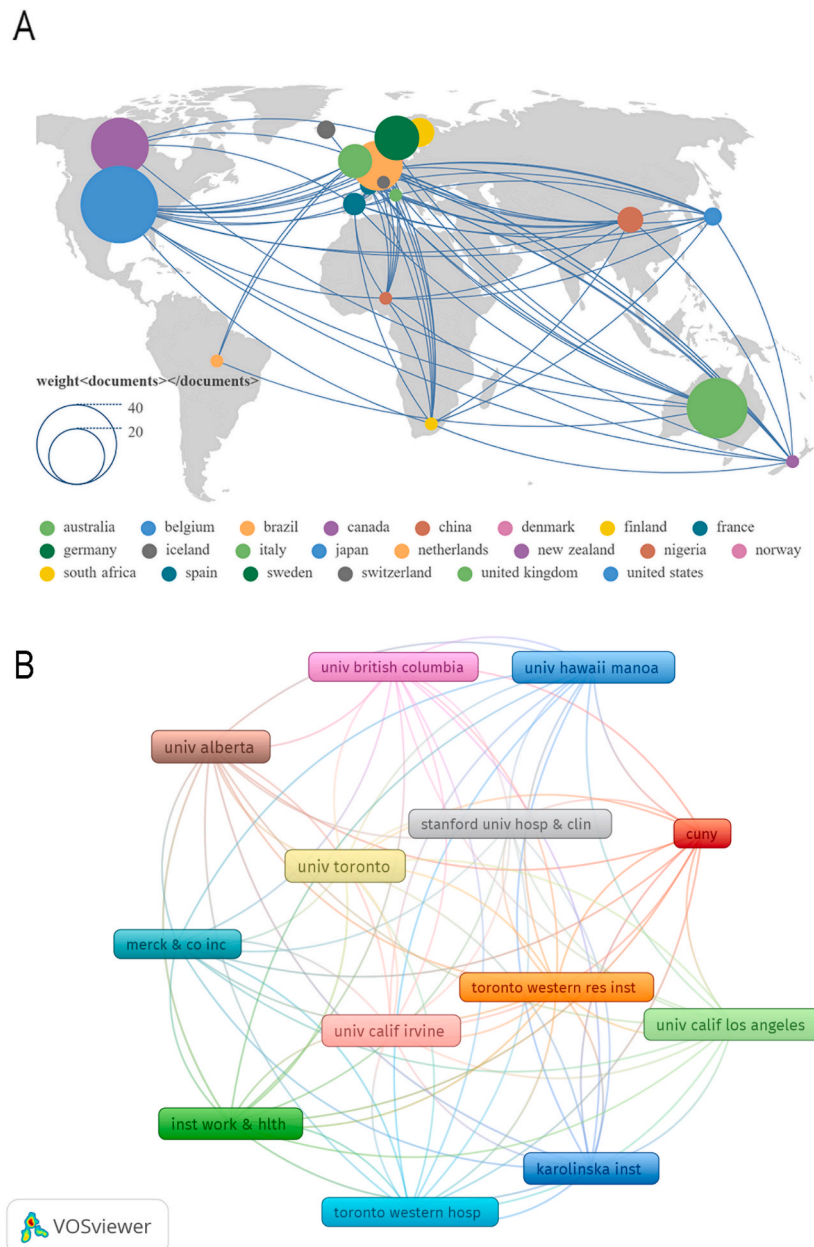


Fig. 2. Countries and institutions analysis: A Countries/regions cooperative network. B Institutions cooperative network.

Table 1  
Top 10 Countries of top 100 most cited articles on NP.

Rank	Countries	Citations	Documents	Average citations per article
1	United States	9204	36	255.67
2	Australia	6111	22	277.73
3	Canada	5580	20	279.00
4	Sweden	4019	12	334.92
5	Netherlands	3808	15	253.87
6	United Kingdom	2103	7	300.43
7	Denmark	1844	7	263.43
8	China	991	4	247.75
9	Germany	814	3	271.33
10	Spain	767	3	255.67

**Table 2**

Top 6 institutions of top 100 most cited articles on NP.

Rank	Institutions	Countries	Citations	Documents	Average citations per article
1	Univ Queensland	Australian	3750	14	267.86
2	Univ Toronto	Canada	3583	12	298.58
3	Univ Alberta	Canada	3031	11	275.55
4	Inst Work & Hlth	Canada	2596	9	288.44
5	Univ Calif Los Angeles	USA	2511	9	279.00
6	Univ Calif Irvine	USA	2461	9	273.44

of Clinical Characteristics of 164 Patients" [19].

### 3.4. Analysis of authors

Considering authors as nodes, a total of 385 distinct authors are discernible (Fig. 3 B). According to Lotka's Law, the threshold for core authors to publish papers is 2. This means that authors who have published at least 2 papers can be considered core authors. In the study, there are 59 authors whose publication count exceeds this threshold, out of a total of 385 authors, and these 59 authors can be classified as core authors. An interesting observation is that the average citation frequency for the top 10 authors closely aligns with their respective publication counts, underscoring their impactful contributions (Table 4). Among these top authors, a notable pattern emerges, half originate from Canada, three come from the United States, and two share affiliations with the University of Toronto. Moreover, Pierre Cote, Scott Haldeman, and L.M. Bouter share the distinction of having the highest publication count (8) and commanding the highest citation frequency (2246). The H-index, serving as an indicator of researchers' influence, further underscores their scholarly impact [20]. The H-index, which retrieved from Google Scholar limited author names and units. J. David Cassidy, affiliated with the University of Toronto, boasts the highest H-index of 69. Subsequently, Pierre Cote from the University of Ontario Institute of Technology follows closely, with an H-index of 64.

### 3.5. Analysis of keywords

Using keywords as nodes, a total of 474 keywords were displayed, and only keywords that appeared more than 5 times were shown (Fig. 4 A). Notably, 'neck pain' (47 occurrences), 'back pain' (36 occurrences), and 'prevalence' (31 occurrences) were keywords that exceeded 30 occurrences. The green cluster encompasses epidemiological information about NP, covering aspects such as prevalence, incidence, disability, outcome measures, and more. The blue cluster includes terms related to assessment and evaluation, such as 'questionnaire,' 'reliability,' 'validity,' and other evaluation indices. In contrast, the red cluster predominantly showcases treatment methods, including 'manual therapy,' 'physical therapy,' and other rehabilitation approaches.

The research hotspots in this field are evident from the keyword density map (Fig. 4 B), which highlights 'neck pain,' 'low back pain,' 'prevalence rate,' 'whiplash injury,' and 'risk factors.' The current focus of attention, as indicated by the time zone view (Fig. 5), centres around 'outcome indicators,' 'minimum clinical differences,' and 'randomized controlled studies.' Based on the insights gained from the keyword burst graph (Fig. 6), the blue line denotes the timeline, and the red sections denote the burst interval, respectively, showing the beginning and end of the year, and the burst duration. Primary research methods include 'questionnaire,' 'randomized clinical trial,' and 'systematic review.' It is notable that 'prevalence' stands out prominently, suggesting an escalating concern regarding the prevalence of NP between 1999 and 2003.

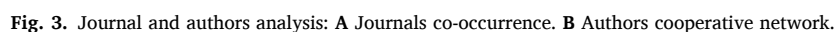
### 3.6. Analysis of articles

The most cited paper, authored by Linton, Steven J. from Orebro Medical Center, garnered 1168 citations. This paper was a review [21] and was published in Spine (IF = 3) in 2000 (Table 5, Fig. 7 A). The findings of this study concluded that stress, pain, anxiety, and other emotional factors significantly contribute to neck and low back pain. The second most cited article (cited 689 times) comprises a systematic review focusing on the prevalence of NP [22]. This study indicates a higher prevalence of NP in women compared to men. The article was published in the European Spine Journal (IF = 2.8). In the density view (Fig. 7 B), the highlighted sections reveal the ongoing research hotspots. Prominent research directions within the NP field encompass the prevalence of NP [23], the prevalence of NP after whiplash injury [24], the correlation between head posture and the severity and disability of NP [25], the NP assessment scale [26], neck deep flexor electromyography [27], and the exploration of complementary and alternative therapies [28].

## 4. Discussion

Compared to conventional literature reviews, bibliometric analysis offers a more objective depiction of the current research landscape by analyzing the literature database within a research field. Traditional reviews often incorporate subjective evaluations, leading to some degree of heterogeneity. In contrast, bibliometrics relies on the frequently used index of citation frequency, which is linked to factors like paper content, research quality, journal reputation, and publication year [29]. Consequently, the top 100 cited papers can be considered seminal studies within the field [10]. NP, a prevalent musculoskeletal ailment, is often accompanied by





In this study, we have compiled the top 100 cited papers in the realm of NP, with the lowest citation frequency at 168 and an

**Table 3**

Top 6 journals of top 100 most cited articles on NP.

Rank	Journal	Citations	Documents	IF ( 2022)
1	Spine	8562	27	3.0
2	Pain	2955	10	7.4
3	Manual Therapy	1962	9	2.6
4	Journal of Orthopaedic & Sports Physical Therapy	1367	5	6.1
5	Archives of Physical Medicine and Rehabilitation	1277	5	4.3
6	European Spine Journal	1135	3	2.8

**Table 4**

Top 10 of top 100 most cited authors on NP.

Rank	Authors	Institutions	Countries	H-index	Citations	Documents	Average citations per article
1	Cote, Pierre	University of Ontario Institute of Technology	Canada	64	2246	8	280.75
2	Haldeman, Scott	Southern California University of Health Sciences	United States	12	2246	8	280.75
3	Bouter, Lm	University of Amsterdam	Netherlands	50	2129	8	266.13
4	Carroll, Linda j.	University of Alberta	Canada	55	1993	7	284.71
5	Cassidy, J. David	University of Toronto	Canada	69	1993	7	284.71
6	Guzman, Jaime	University of British Columbia	United States	2	1993	7	284.71
7	Hogg-Johnson, Sheilah	Canadian Memorial Chiropractic College	Canada	42	1993	7	284.71
8	Holm, Lena W.	Karolinska Institutet	Sweden	40	1993	7	284.71
9	Nordin, Margareta	New York University	United States	39	1993	7	284.71
10	Van Der Velde, Gabrielle	University of Toronto	Canada	33	1993	7	284.71

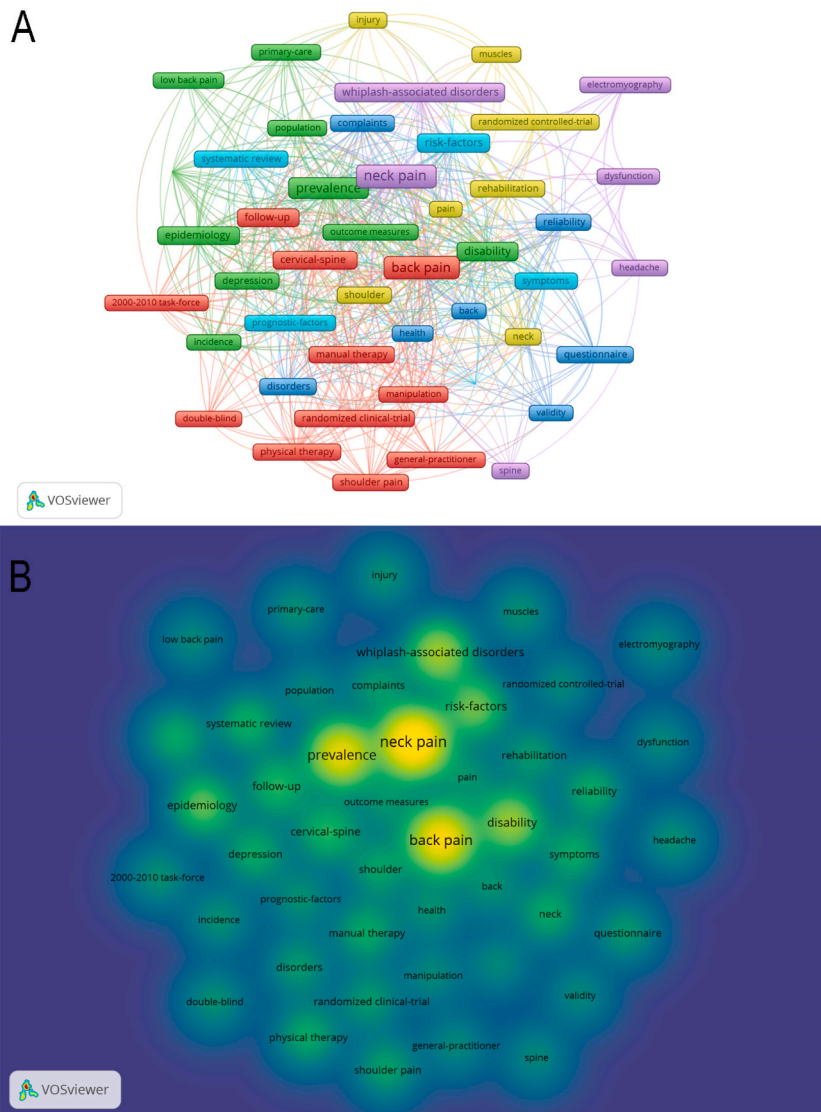
average of 273.18 citations per paper. Furthermore, the average impact factor of the journals referenced in these top 100 papers stands at 13.27, underscoring the significant research value of NP [7]. This wide recognition is evident in the considerable attention scholars have accorded to this topic, as reflected in the frequent citations of research findings. The substantial citation of NP research papers can be attributed to their direct or indirect relevance to the work of many scientists and scholars in the same field.

Highly cited papers have two characteristics, one is that they usually cover basic research, and the other is that they provide completely new research methods and new ideas for future research [31]. "A review of psychological risk factors in back and neck pain," published in 2000 and cited 1168 times to date. This paper summarizes the aetiology and research status of psychological variables in NP and low back pain before 2000 and points out that there are great differences in the development of methodology in this field, so the future research direction should focus on developing a unified assessment method to improve the quality of research [21]. In 2008, Cleland, J. A. and colleagues published a study titled "Psychometric properties of the Neck Disability Index and Numeric Pain Rating Scale in patients with mechanical neck pain" in the Archives of Physical Medicine and Rehabilitation. To date, this study has been cited 442 times. The research comprehensively evaluated the validity and reliability of two methods, the Neck Disability Index (NDI) and the Numeric Rating Scale (NRS), for assessing functional impairment and NP level in patients with mechanical NP [32]. Furthermore, gaining a deeper understanding of the potential limitations of these assessment tools is also a direction for future research. Through ongoing studies, we can continually enhance our ability to assess and intervene in NP patients, ultimately improving their quality of life and the rehabilitation process.

#### 4.1. Basic information

The 100 highly cited articles examined in this study were published across 36 journals, originating from 24 countries. The collective efforts of 188 research institutions and 385 authors contributed to this body of work. A temporal analysis of article publications reveals a certain lag in article citations, with the most frequently cited articles dating back to 2008. As the field continues to evolve, newer research gradually supplants earlier studies. Recognizing and citing emerging research takes time.

Among countries contributing significantly, the United States and Australia emerge as leaders in NP research. As developed countries, residents in both the United States and Australia have access to high-quality healthcare. However, they also face common health issues such as NP, making the need for NP research particularly urgent in these nations. With abundant research resources and renowned universities and research institutions, they have allocated substantial funding and support for NP research. Furthermore, their advanced medical facilities and healthcare systems provide a wealth of clinical data and cases, offering valuable experimental conditions for NP research. These factors have led to the presence of numerous distinguished scientists and researchers, driving continuous advancements in the field of NP. The active engagement and high output of both countries in NP research contribute significantly to the global understanding and treatment of NP.



**Fig. 4.** Analysis of keywords: **A** Keyword co-occurrence. **B** Keywords density visualization.

In the United States, there have been endeavours to establish guidelines for NP physical therapy and epidemiological studies on NP [1,3,33,34]. While Australia focuses mainly on physical therapies, encompassing manual therapy, low-level laser treatments, and exercise therapy [18,35–38]. The main research units in this field are the University of Queensland and the University of Toronto. The Neck and Head Research Unit at the University of Queensland focuses on pain processing, motor and sensory functions in head, neck and jaw pain, including whiplash injuries and hidden NP [39,40]. The University of Toronto focuses on identifying the red flags of neck and low back pain and developing an initial management plan, including preventive measures, drug treatment, and non-drug treatment [41,42].

#### 4.2. Research hotspots

Notable contributions reflecting academic influence include Roberta T Chow et al., 's 2009 publication in *The Lancet* [18]. Their systematic review explored low-level laser treatment for NP, establishing its efficacy lasting up to 22 weeks. Furthermore, a randomized controlled study by Susan M. Lord et al., published in the *New England Journal of Medicine*, demonstrated that percutaneous radiofrequency neurotomy effectively alleviates chronic pain arising from cervical facet joints after whiplash injury [43].

Of the top 100 cited articles in the field of NP, 37% were published in journals with Impact Factors of 3 (Spine) and 7.4 (Pain). Cassidy, J. David from the University of Toronto, researches the epidemiology and risk factors of NP [44]. Cote Pierre, from the University of Ontario Institute of Technology, investigates the prevalence of NP, the efficacy of manual interventions, and the relationship between NP, depression, and anxiety [34,45,46]. Disc degeneration's association with NP [47], as well as the prevalence of



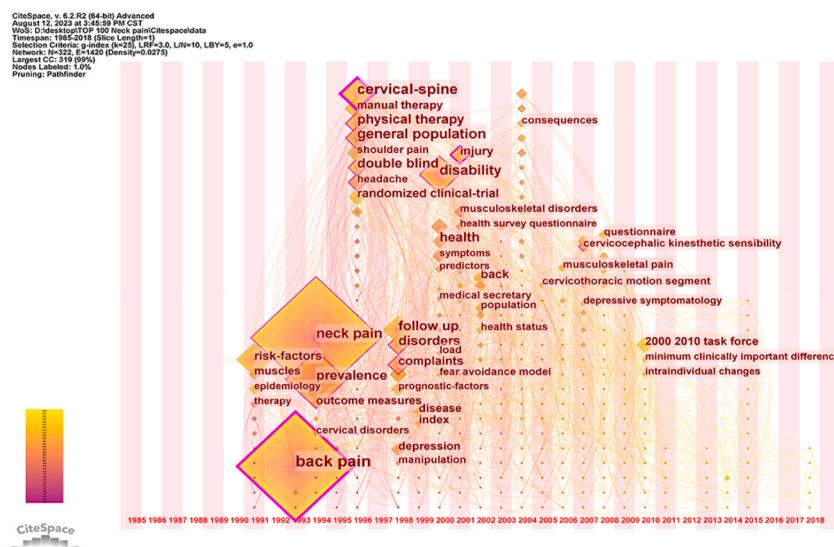


Fig. 5. Keywords Time zone chart.

NP, whiplash injury, physical therapy, manual therapy, randomized controlled studies, and systematic reviews, are important keywords in this field. The connection between intervertebral disc degeneration and NP, along with the associated risk factors, represents a significant focus of attention in the research.

From Fig. 6, it is discernible that the research emphasis has transitioned from conventional domains such as the general population, prevalence, and primary care to more contemporary areas such as clinical trials and manual therapy. From a treatment perspective, current approaches to managing NP primarily involve non-drug therapies, including manual therapy, exercise therapy, and physical modalities. A study by Jinho Lee [48], involving a multicenter randomized controlled trial, demonstrated that even after one year of treatment, manual therapy remained more effective than conventional physiotherapy and medication in terms of pain reduction and restoration of cervical function. Notably, manual therapy exerts a significant impact on patients with chronic NP [49]. This effect could potentially be attributed to the modulation of NP via peripheral mechanisms that regulate inflammatory responses [50]. Moreover, combining exercise therapy with manual therapy enhances treatment efficacy and proves advantageous in alleviating muscle stiffness, enhancing cervical mobility, and ameliorating psychological anxiety in patients [51].

#### 4.3. Future directions

Future research should focus on the molecular mechanisms of NP to unravel its complex pathophysiology. The overlay dual-map depicting various journals (Fig. 8) reveals an intriguing pattern. Journals in clinical medicine, neuroscience, ophthalmology, and kinesiology on the left are referencing studies from fields such as economics, medical nursing, exercise, rehabilitation, and psychology on the right. Notably, NP remains a focal point in areas as diverse as animal science, mathematics, and immunology. This serves as a harbinger for forthcoming research into underlying mechanisms. Delving deeper into these studies promises to illuminate the origins of NP and establish a theoretical foundation for prevention and intervention.

At present, the pathogenesis of NP remains incompletely elucidated. Contributing factors include genetics and occupational aspects [52]. Prolonged biomechanical stress on the joint capsule culminates in microscopic tissue damage, ligament calcification, and other outcomes, setting off an inflammatory response [53]. This in turn triggers nociceptive receptors to penetrate degenerating intervertebral discs, leading to the onset of NP [54]. Intriguingly, research points to mitogen-activated protein kinase kinase 6 (MAP2K6) and Ras homology-related BTB domain containing 2 (RHOBTB2) as potentially pivotal in cervical disc degeneration [55]. Moreover, NP might also correlate with the dysregulation of glycosaminoglycan (GAG) biosynthesis or its diminished expression [56]. Hua Jiang et al.'s findings suggest that MicroRNA-338-3p influences the proliferation and apoptosis of nucleus pulposus cells through extracellular matrix gene modulation, offering a fresh avenue for NP therapeutics [57]. However, the comprehensive comprehension of NP's molecular-level mechanisms remains an ongoing endeavour.

In the realm of clinical trials, enhancing the quality and scope of studies is imperative to strengthen the evidence base for treatment methods. Future research endeavours should strive to delve deeper into the pathogenesis of NP, foster a multidisciplinary integrated treatment model, and tailor interventions to individual patients. Concurrently, the impact of NP on patients' psychological and emotional well-being deserves attention. The impact of NP on patients' psychological and emotional well-being is a critical area for further exploration. Acknowledging the intrinsic connection between physical health and mental equilibrium, integrating psychological facets into treatment regimens holds the potential for pain reduction. Leveraging the continued advancement of medical science and technology, cross-collaboration between biology, neurology, psychology, and other disciplines promises to unravel the complexities of NP and offer patients precise diagnoses and more effective treatment options.

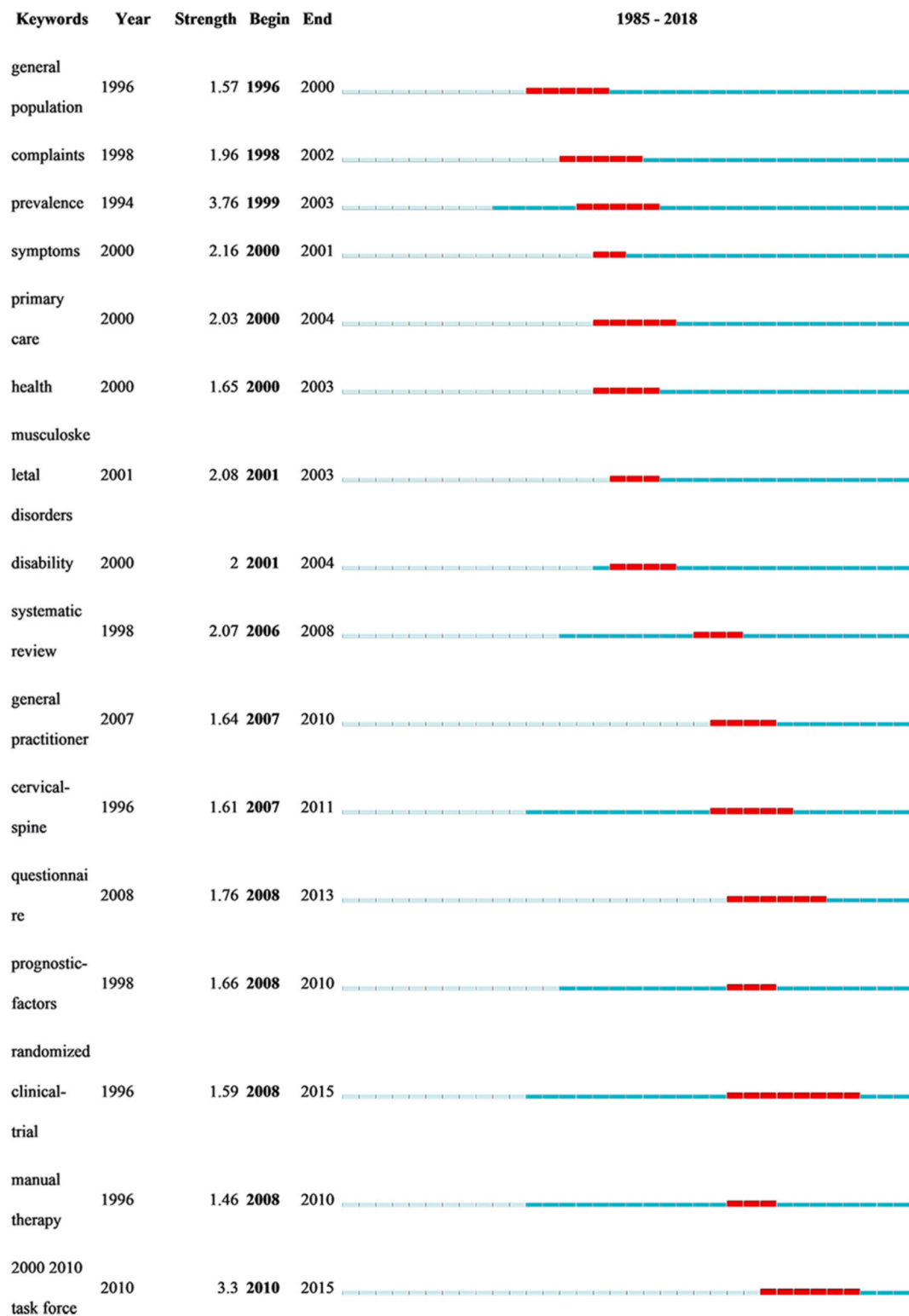


Fig. 6. Top 16 keywords with the strongest citation bursts.

Through bibliometric analysis of literature on NP treatment over the past decade, significant research gaps and potential duplication issues have been identified. Zhichao Gong conducted a bibliometric analysis of the literature about the treatment of NP using massage manipulation over the past decade, encompassing 505 articles [58]. Similarly, Jaehyeon Park undertook a review of

**Table 5**  
Top 10 cited articles on NP.

Rank	Article	Journal	Citation	IF (2022)	Publication year
1	A review of psychological risk factors in back and neck pain	Spine	1168	3	2000
2	The prevalence of neck pain in the world population: a systematic critical review of the literature	European Spine Journal	689	2.8	2006
3	The Saskatchewan Health and Back Pain Survey - The prevalence of neck pain and related disability in Saskatchewan adults	Spine	552	3	1998
4	The burden and determinants of neck pain in the general population - Results of the bone and joint decade 2000–2010 task force on neck pain and its associated disorders	Spine	513	3	2008
5	Percutaneous radio-frequency neurotomy for chronic cervical zygapophyseal-joint pain	New England Journal of Medicine	467	158.5	1996
6	The global burden of neck pain: estimates from the Global Burden of Disease 2010 study	Annals of the Rheumatic Diseases	451	27.4	2014
7	Psychometric properties of the neck disability index and numeric pain rating scale in patients with mechanical neck pain	Archives of Physical Medicine and Rehabilitation Spine	442	4.3	2008
8	Neck pain in the general-population	Spine	439	3	1994
9	The epidemiology of neck pain	Best practice & Research in Clinical Rheumatology	429	5.2	2010
10	Neck pain: Clinical practice guidelines linked to the international classification of functioning, disability, and health from the orthopaedic section of the American physical therapy association	Journal of Orthopaedic & Sports Physical Therapy	409	6.1	2008

acupuncture treatment for NP over the past two decades, examining 325 papers [59]. Although these studies have significantly contributed by summarizing treatment methodologies within the NP domain, they did not undertake disambiguation during the data-cleaning phase. This omission leaves room for potential duplications or confusion in research outcomes, which can affect result reliability and interpretation.

In summary, this study delved deeply into the analysis of the top 100 highly cited works within the field of NP. This comprehensive exploration offers valuable insights for the field's development and future research. By scrutinizing contributing countries, research institutions, authors, and research focal points, this amalgamation of quantitative and qualitative analysis aids researchers in comprehending the present state and future trajectory of NP research. Furthermore, it guides research directions and clinical applications.

## 5. Limitations

The study's scope was constrained by software limitations, preventing simultaneous analysis of literature from different databases. Consequently, the document database considered was limited to WoSCC, potentially excluding literature from alternate databases like Scopus. Moreover, citation frequency, while correlated with research content, authorship, research institutions, publication years, and journals, might not entirely reflect the research's academic influence. The fixed retrieval period restricts updates in citation frequency post-retrieval, introducing a potential bias.

## 6. Conclusion

Presently, research endeavours within the NP field centre around establishing high-quality, evidence-based medical support for treatment. Subsequent research should spotlight NP prevalence, the efficacy and safety of physical therapy, placebo establishment, therapeutic dosage determination, and the biological underpinnings of NP. This collective pursuit aims to advance the field's understanding and improve its clinical practices.

## Ethics approval and consent to participate

This metrological analysis study does not require ethical review or patient consent for clinical trials.

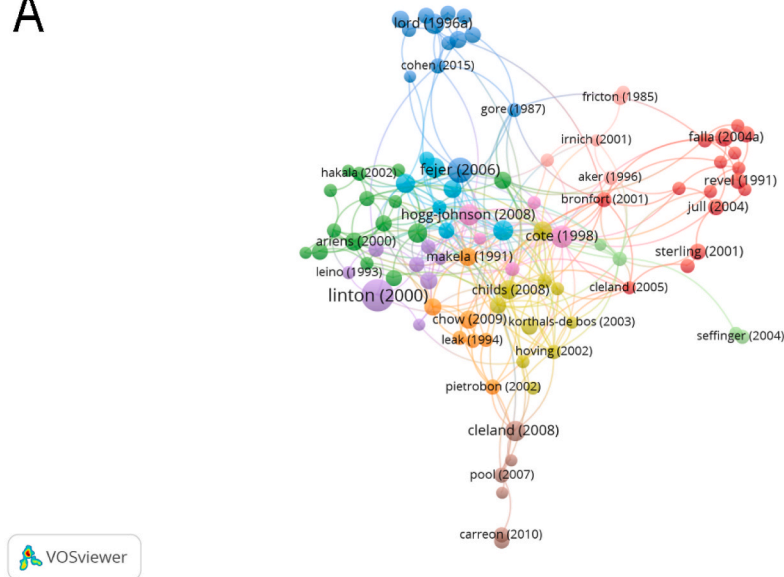
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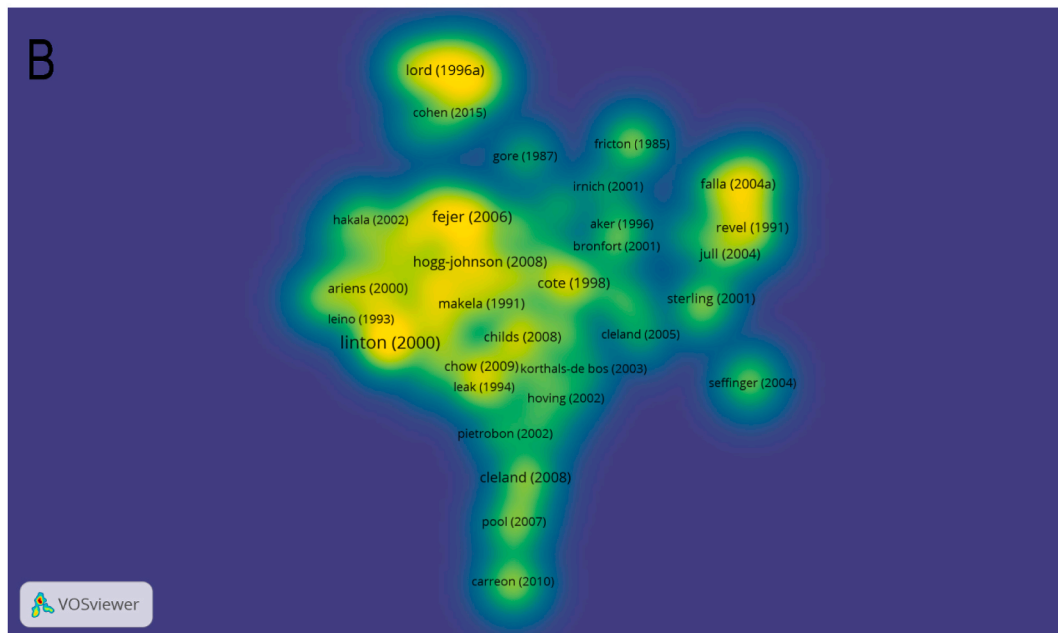
## Availability of data and materials

Not applicable.

A



B



**Fig. 7.** Analysis of articles: **A** Articles co-occurrence. **B** Articles density visualization.

#### Data availability statement

Data included in article/supplementary material/referenced in article.

#### CRediT authorship contribution statement

**Lele Huang:** Writing – original draft, Software, Methodology, Formal analysis, Data curation, Conceptualization. **Min Cao:** Writing – original draft, Software, Resources, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Baiyang Xiao:** Writing – original draft, Software, Resources, Methodology, Data curation. **Heng Wu:** Software, Methodology, Investigation, Formal analysis. **Lei Shi:** Writing – review & editing, Writing – original draft, Methodology, Funding acquisition, Formal analysis, Conceptualization. **Fanfu Fang:** Writing – review & editing, Writing – original draft, Supervision, Software, Resources, Project administration, Funding acquisition, Data curation, Conceptualization.

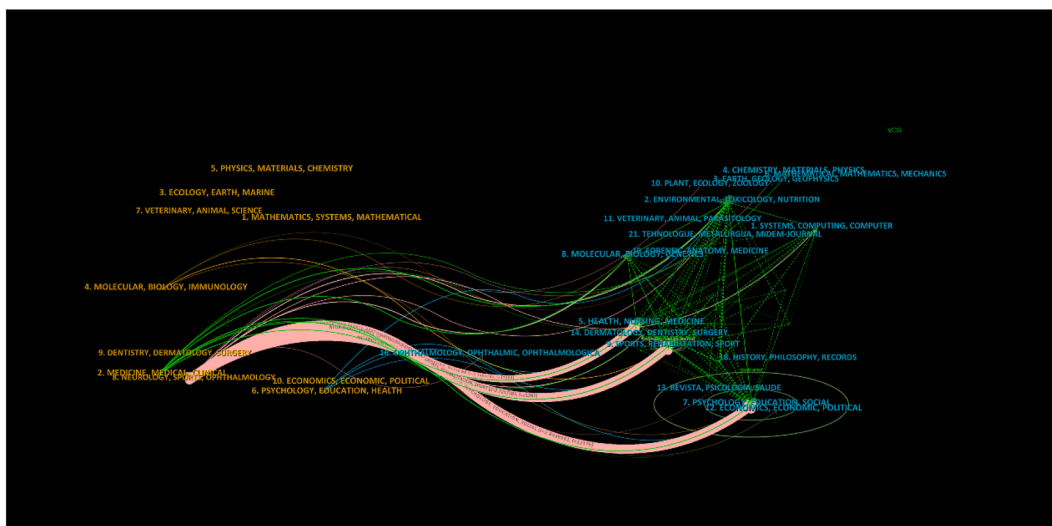


Fig. 8. Dual-map overlay of journals.

### Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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