CURRENT TOPIC

Recent Trends of Interventional Pain Management as Minimally Invasive Procedure

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Abstract

Interventional pain management is crucial as a minimally invasive procedure because it offers targeted therapy, reduces opioid dependence, provides rapid and long-lasting relief, is less risky, has fewer side effects, enhances function and healing and is supported by clinical evidence and guidelines. A bibliometric study in interventional pain management aimed to provide a comprehensive overview of the research landscape, highlighting trends, key topics and gaps in knowledge that can inform future studies and clinical practices. The use of bibliometric tools in pain management studies has evolved to include more advanced methodologies, increase global participation and a focus on specific pain types. The integration of software visualisation tools and the use of various bibliometric indicators have enhanced the ability to analyse and understand the utilisation of interventional pain management research landscape. The compilation of data were retrieved from *Scopus* database from 2014-2024. A total of 13,606 publications (100 % in English) with topic interventional pain management as minimally invasive procedure from 2014-2024 were retrieved covering 3,313 sources with total authors 63,460. The number of publications showed a noticeable increase starting in the early 2016 with the peak at 2022. The most relevant sources for documents include *BMJ Open* (954 documents), followed by *Archives of Physical Medicine and Rehabilitation* (353 documents), *PM and R* (264 documents) and *Pain Physician* (237 documents). Recent trends in interventional pain management, particularly focusing on minimally invasive techniques are characterised by a significant increase in publication frequency, emphasis on targeted and non-destructive treatments and improved clinical outcomes. These factors collectively highlight the importance and growing recognition of these methods in modern pain management practices.

Key words: Bibliometrics; Pain management; Minimally invasive surgical procedures; Physical and rehabilitation medicine.

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Introduction

The prevalence of pain, particularly chronic pain, is a critical issue affecting a substantial portion of the population across various demographics. Understanding these statistics is essential for healthcare providers and policymakers to develop effective interventions and allocate resources for better pain management strategies. Continued research is necessary to explore the underlying causes of disparities in pain prevalence and to improve treatment options for those affected

by chronic pain conditions.[1] Interventional pain management, also known as interventional pain medicine, is a specialised medical field focused on the diagnosis and treatment of pain-related disorders through minimally invasive techniques. Interventional pain management is a vital subspecialty that combines advanced techniques and a multidisciplinary approach to effectively diagnose and treat chronic pain, aiming to restore patients' functionality and well-being. These procedures are designed to be minimally invasive, reducing the risk of complications and promoting faster recovery times. They are often used in conjunction with other treatment modalities to provide comprehensive pain management.[1] Invasive pain procedures are generally safer and less invasive than traditional surgeries, they still carry risks that need to be carefully managed by healthcare providers to ensure the best possible outcomes for patients.[2]

Mediation analysis in the context of interventional pain management involves examining the mechanisms through which interventions exert their effects on pain-related outcomes. Mediation analysis is a quantitative method used to evaluate the mechanisms of interventions by examining the extent to which an intermediate variable (mediator) explains the effect of an intervention on an outcome.[3] This approach helps clinicians understand how or why an intervention works or does not work by estimating the extent to which interventions exert their effects on outcomes *via* mediating variables. In pain management, particularly in paediatric populations, mediation analysis has been used to investigate how interventions affect pain-relevant outcomes. For example, one systematic review investigated the mechanisms of interventions for pain in adolescents (aged 3–18 years) with acute or chronic pain.[3] The review found that several mediators were tested, with some partially mediating treatment effects and others not significantly mediating treatment effects. By integrating mediation analysis into the evaluation of interventional pain management techniques, healthcare providers can gain a deeper understanding of how these interventions work, ultimately improving treatment outcomes for patients with chronic pain.

Interventional pain management is indeed a significant issue globally, with varying rates across different countries and disease populations. Understanding these variations is crucial for developing effective global strategies to address chronic pain management.[4-6] Bibliometric analysis for interventional pain management is crucial for understanding the trends, patterns and impact of research in this field. Bibliometric analysis has indeed become an important, accessible and widely accepted method to assess various aspects of research productivity, international collaboration, citation analysis and research trends in the field of interventional pain management. Assessing research productivity on the implementation of interventional pain management through bibliometric indicators is essential for understanding the landscape of this field. It not only highlights trends and collaborative efforts but also informs funding decisions, policy development and future research directions. By leveraging these insights, stakeholders can enhance the effectiveness and relevance of pain management strategies worldwide. Bibliometric analysis is a powerful tool for assessing national and international research productivity, international collaboration, citation analysis, research trends and scientific development in interventional pain management. It provides a comprehensive understanding of the field by analysing quantitative data from various databases and visualising research networks. Bibliometric analysis has been applied to a wide range of fields, showcasing its versatility and effectiveness in assessing research productivity, collaboration and trends. Here are some specific fields where bibliometric analysis has been utilised: "virtual reality in pain medicine",[7] "knowledge management",[8] "pain research"[9] but still limited for invasive procedure such as interventional pain management. To address the query regarding the lack of bibliometric indicators specifically focused on interventional pain management as a medical concept, it is essential to note that while there is a significant body of research on pain management in general, there is indeed a need for more targeted and comprehensive bibliometric analyses specifically within the realm of interventional pain management. By conducting these specific analyses, researchers can provide more nuanced insights into the field of interventional pain management, helping to guide future research directions and improve clinical practices.

This analysis is essential for understanding the current state of research in this field, identifying trends and guiding future investigations. This bibliometric study provides valuable insights into the literature surrounding interventional pain management as a minimally invasive procedure.

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By assessing bibliometric indicators and mapping research trends, the study highlights the importance of continued investigation in this critical area of healthcare. The aim of this study was to assess and present bibliometric indicators and mapping of the literature in interventional pain management as a minimally invasive procedure. The findings serve as a foundation for future research efforts aimed at enhancing pain management practices and outcomes for patients.

Methods

This study was grounded in a bibliometric analysis design and a retrospective search was conducted using *Scopus* (Figure 1). In this study, the published literature was analysed by employed the following indicators.
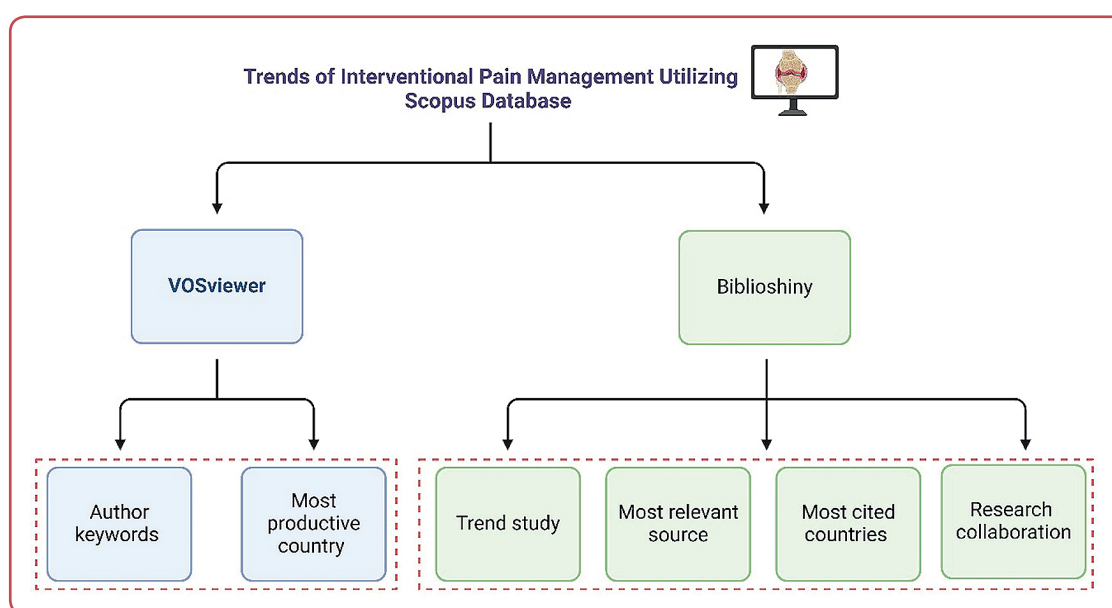

Figure 1: Flowchart of trends in inteventional pain management utilising Scopus database

Database selection

The documents form *Scopus* database were retrieved (accessed on 09/09/2024). *Scopus* database is commonly used for bibliometric analyses due to their comprehensive coverage of scientific literature. *Scopus* and *SciVerse Scopus* are powerful tools for conducting bibliometric analyses due to their comprehensive coverage of scientific literature and advanced features.[10] These resources are particularly valuable in fields like interventional pain management, where identifying trends, assessing global contributions and evaluating research impact are crucial for advancing knowledge and practice.[10, 11] *Scopus* includes titles from more than 7,000 publishers worldwide, providing a broad spectrum of research content that is essential for bibliometric studies.[11] In the document type analysis, errata documents, which are corrections to previously published articles, were excluded from the study because they do not constitute true publications. In this study, analysis was confided to research articles.

Bibliometric indicators and data visualisation

The use of bibliometric indicators and data visualisation in interventional pain management offers several strengths. These tools help identify research trends, assess global contributions, evaluate intervention techniques and improve patient outcomes. By leveraging these methods, researchers and clinicians can better understand the complex nature of pain management and develop more effective strategies for treating vari-

ous types of pain. The following bibliometric criteria were examined in this study: (1) document types and languages, (2) publication growth, (3) most frequently used author keywords, (4) citation analysis and highly cited articles, (5) the top 10 most cited countries, (6) the top 10 most active journals and (7) international collaboration. The data for the most cited publications were obtained from *Scopus*, which tracks the number of citations for each document. Additionally, data on the most active and cited countries were collected directly from *Scopus*, which annually records the number of papers and citations for each country.

The bibliometric analysis was conducted using *VOSviewer* version 1.6.16[12] and the *Biblioshiny R* package.[13] *VOSviewer* tool is specifically designed for constructing and visualising bibliometric networks. It can handle large datasets and provides various visualisation options such as network visualisation, overlay visualisation and density visualisation. These visualisations help researchers identify clusters of highly cited papers, prominent authors and institutions, thereby revealing the intellectual structure of the research field. *Biblioshiny R* package integrates bibliometric analysis with the powerful R programming language, offering enhanced visualisation capabilities. It provides functions for creating various types of bibliometric plots, including co-authorship networks, citation networks and keyword co-occurrence maps. The interactive nature of these visualisations makes it easier for researchers to explore complex data sets and extract meaningful insights. *VOSviewer* and *Biblioshiny* are two free software programs designed for creating and viewing bibliometric maps. Tools like *VOSviewer* were used to visualise co-occurrence networks of keywords. This helps in identifying tightly interconnected themes and understanding how different concepts are related within the literature. The retrieved data were visualised using the *VOSviewer* program, a software tool designed for visualising bibliometric networks. Using *VOSviewer* version 1.6.16 and the *Biblioshiny R* package for bibliometric analysis offers several strengths that enhance research productivity and collaboration. These tools provide robust visualisation capabilities, facilitate the identification of research trends and hot topics and enable the analysis of co-authorship and citation networks. By leveraging these tools, researchers can gain a deeper understanding of the scientific landscape, identify areas for further investigation and foster collaborations that drive innovation in various fields. In the visualisation techniques, maps could be presented as density maps or network visualisations, where parameters such as colour, circle size, font size and the thickness of connecting lines were utilised to represent specific characteristics.

Keywords and search strategy

Using effective keywords and a structured search strategy is vital for conducting bibliometric analyses in interventional pain management. By selecting appropriate keywords that represent core themes and employing strategic searching techniques across multiple databases, researchers can uncover valuable insights into current trends, treatment efficacy and collaborative efforts in this important field of study. This approach not only enhances the efficiency of literature retrieval but also contributes to a deeper understanding of research developments in interventional pain management. Extract keywords related to interventional pain management was searched using the keywords "interventional pain management AND rehabilitation medicine" to discover all documents related to the study. For each method, the time frame was set from 2014 to 2024 and the source type was restricted to research articles. The number of documents retrieved using each approach is presented in Table 1.

To ensure that time period accurately represents the trends that are analysed, particularly for annual growth, the data as the number of retrieved documents in each year are presented. This approach allows us to visualise and quantify the annual growth of publications over the specified period, typically from 2014 to 2024. Quote marks were used to find the exact phrase in *Scopus,* while asterisks were used as a wildcard to find all possible related keywords. "A title/abstract/keywords" strategy was devised that incorporated all potentially relevant terms and phrases. By combining these search techniques, a robust and comprehensive strategy for identifying relevant publications in *Scopus* was possible thereby enhancing the accuracy and thoroughness of bibliometric analysis. Finally, the results were saved in CSV format and organised into tables based on different categories to facilitate the calculation of each index. The relevant retrieval of results was presented as a content schema with texts, figures and tables using *Excel. Excel* was integrated with other data visualisation tools to create reusable and visually appealing reports. This can enhance data-driven insights and make it easier to update reports when data changes.

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Results

Main information of interventional pain management

The application of bibliometric tools in pain management research has progressed to incorporate more sophisticated methodologies, greater global involvement and a focus on specific pain conditions. The integration of software visualisation tools and the utilisation of various bibliometric indicators have significantly improved the analysis and comprehension of the pain research landscape. Authors have used 22,743 unique keywords in their documents. These keywords provide insights into the themes and topics covered in the research papers, helping to identify trends and areas of focus within the field. The data compilation, which included publications retrieved from the *Scopus* database between 2014 and 2024, yielded a total of 13,606 documents (all in English). These documents, which cover interventional pain management as a minimally invasive procedure, were sourced from 3,313 sources and the total authors of single-authored docs was 516 and total number of authors was 63,460. The majority of documents were articles at 13,606 documents. This indicates that articles were the primary form of publication within this dataset. The main information about the data set provided included several key metrics that offer insights into the scope, growth and characteristics of the documents analysed.

The data spans a decade, from 2014 to 2024. This timeframe allows for the analysis of trends and developments over a significant period, providing a comprehensive view of the research landscape. There was a total of 63,460 authors involved in the creation of these documents. Out of these authors, 516 have authored single-authored documents. The large number of authors indicates significant collaboration within the research community. The main information about the data set provides a comprehensive overview of research activity over a decade. It highlights trends such as declining document numbers, recent publication ages, high citation rates, extensive cross-referencing, diverse keywords usage by authors, significant collaboration among researchers both domestically and internationally and predominantly article-based publications. This analysis can be used to understand research dynamics better and make informed decisions regarding future studies or funding allocations in related fields.

Trend study of interventional pain management

To conduct a trend study annually using a bibliometric approach, the specific area of interest within interventional pain management was identified. The trend study of interventional pain management as a minimally invasive procedure from 2014 to 2024 highlights the significant developments and shifts in this field over the past decade (Figure 2). The trend study from 2014 to 2024 shows a clear trajectory of growth and innovation in interventional pain management as a minimally invasive procedure. The advancements in technology, increased adoption, favourable regulatory changes and positive pa-
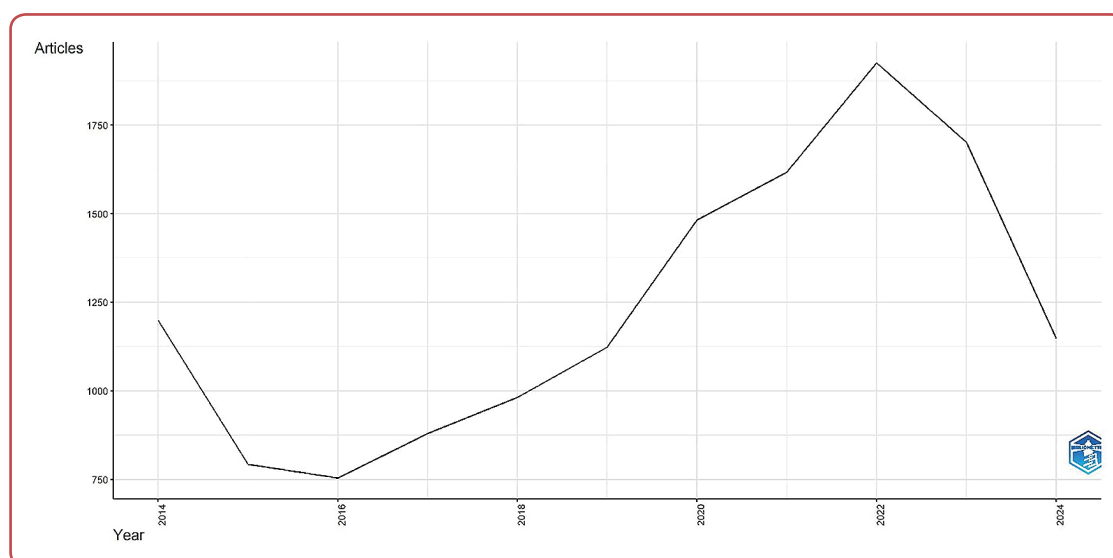

Figure 2: Study trend of interventional pain management as minimally invasive procedure from 2014-2024

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tient outcomes all point to a bright future for interventional pain management. Continued evolution in this field, with further integration of new technologies and treatment modalities can be expected. As showed in the following result, the trend of study of interventional pain management has growing in every year. The highest number of publications occurred in 2022 with a total of 1.926 documents, while 2024 (1.148 documents), 2023 (1.617 documents), 2020 (1.482 documents), 2018 (982 documents). Summarise that the year 2022 saw a significant increase in publications related to interventional pain management, indicating heightened research activity and interest in this field.

The significant increase in publications related to interventional pain management in 2022 can be attributed to a combination of these factors. Emergence of new journals which were providing more platforms for researchers to publish their findings. Advancements in technology and techniques. Enhancing the safety and efficacy of interventional procedures. These factors collectively contribute to the observed increase in publications related to interventional pain management in 2022.

Most relevant source of documents of interventional pain management

To describe the most relevant sources of interventional pain management as minimally inva-

sive procedures from 2014 to 2024, the journals which were published during 10 years were evaluated (Figure 3). The most relevant sources for documents of interventional pain management as a minimally invasive procedure from 2014 to 2024 include *BMJ Open* (954 documents), followed by *Archives of Physical Medicine and Rehabilitation* (353 documents), *PM and R* (264 documents), *Pain Physician* (237 documents). The highly relevant source that provided comprehensive insights into interventional pain management was Giuliano Lo Bianco et al "Interventional Pain Procedures: A Narrative Review Focusing on Safety and Complications".[1] This narrative review provides a detailed analysis of the safety and complications associated with commonly performed image-guided interventional pain procedures. It highlights the importance of careful patient selection, proper techniques and close monitoring to minimise risks and ensure the best possible outcomes, besides minimally-invasive pain management techniques in palliative care.[1, 14] This article presents options for minimally invasive techniques used in palliative care to alleviate pain from a head-to-toe approach. It discusses the use of image guidance (ultrasound or fluoroscopy) and the importance of considering patient safety and contraindications for these procedures.[14] Yingjie Hua et al[15] minimally invasive interventional therapy for pain reviews various minimally invasive pain interventional therapy techniques such as neuroregulation, spinal cord stimulation, intervertebral disc ablation. It highlights their effectiveness in treating conditions like post-herpetic neuralgia
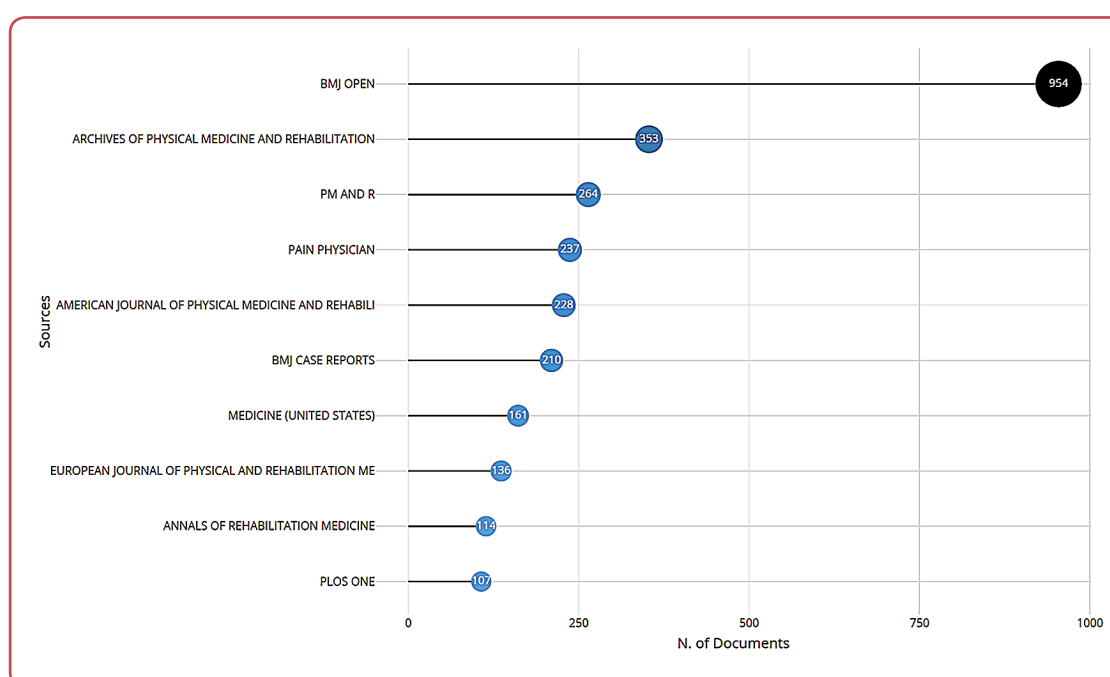

Figure 3: Most relevant sources of interventional pain management as minimally invasive procedure from 2014-2024

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and refractory cancer pain.[15] These sources offer comprehensive insights into the field of interventional pain management, making them essential for understanding the trends and best practices from 2014 to 2024.

Most frequently used author keywords of interventional pain management

To visualise the most frequently encountered author keywords related to "interventional pain management AND rehabilitation medicine", a bibliometric analysis approach was used (Figure 4). By using those keywords, 13,606 documents were retrieved from *Scopus* database. *Scopus* is an ideal choice for bibliometric studies due to its comprehensive coverage, high-quality curated data, advanced profiling algorithms, extensive quality assurance processes and trustworthiness. These features make it a robust tool for analysing research productivity, identifying trends and evaluating the impact of publications in fields like interventional pain management. Top 5 keywords which were related to the application of interventional pain management were rehabilitation (1890 keywords), rehabilitation medicine (1006 keywords), stroke (619), pain management (378 keywords) and pain (335 keywords). The appli-

cation of interventional pain management techniques remains crucial today due to the ongoing need for effective pain management strategies in various fields. The field continues to evolve with technological advancements, evidence-based practices and a multidisciplinary approach, ensuring that patients receive comprehensive and personalised care. The most frequently used author keywords in interventional pain management reflect a focus on managing postoperative pain, chronic pain and low back pain through various interventional techniques. These keywords also highlight the importance of pain relief and functional outcomes in research studies. By understanding these keywords, researchers can identify current trends and emerging areas of focus within the field of interventional pain management.

Top 5 most cited papers related to interventional pain management

The most cited papers among the top 5 cited articles related to the recent trends of interventional pain management as minimally invasive procedure from 2014-2024 were research articles/original articles. The article from *Osteoporosis International Journal* entitled "Clinician's Guide to

Figure 4: Visualisation of most frequent author keywords (minimum occurrences of 50 times) related to interventional pain management as minimally invasive procedure from 2014-2024

Table 1: Top 5 cited articles related to the recent trends of interventional pain management as minimally invasive procedure from 2014-2024

Authors	Year	Journals	PMID	TC	TC / year
Cosman et al	2014	*Osteoporosis International Journal*	25182228	2389	217,18
McAlindon et al	2014	*Osteoarthritis Cartilage*	24462672	2196	199,64
Devlin et al	2018	*Critical Care Medicine*	30113379	2008	286,86
Simons et al	2018	*Hernia*	29330835	1246	178,00
Macfarlane et al	2017	*Ann Rheum Dis*	27377815	913	114,13

PMID: PubMed Identifier; TC: Total citation;

Prevention and Treatment of Osteoporosis", had the highest number of citations[16] the total number of citations was 2,389 citations. The second article with entitled "OARSI guidelines for the non-surgical management of knee osteoarthritis" published in *Osteoporosis Cartilage* with total number of citations 2,196.[17] A third article, which was published in *Critical Care Medicine*, entitled "Clinical Practice Guidelines for the Prevention and Management of Pain, Agitation/Sedation, Delirium, Immobility and Sleep Disruptions in Adult Patients in the ICU" was cited 2,008 times.[18] International guidelines for groin hernia management published in *Hernia* were cited 1.246 times[19] and for "the EULAR revised recommendations for the management of fibromyalgia" total number of citations was 913 (Table 1).[20] The top 5 most cited papers in the field of interventional pain management provide valuable insights into the most impactful research and trends in the field. By understanding the most cited papers, researchers and clinicians can better address the complexities of interventional pain management, leading to more effective treatments and improved patient outcomes.

Research collaboration among countries related to interventional pain management

International collaboration is crucial in the scientific field, enabling researchers worldwide to share and exchange information related to their field. Each author can collaborate with colleagues from other countries within the same field. The urgency of research collaboration among countries in the field of interventional pain management stems from the need to address global health disparities, standardise practices based on evidence, address chronic pain effectively, transfer technological advancements and ensure ethical considerations. By working together, countries can enhance capacity-building efforts, develop standardised guidelines, improve patient outcomes and ensure safer treatments. This collaborative approach is essential for advancing the field of interventional pain management globally.
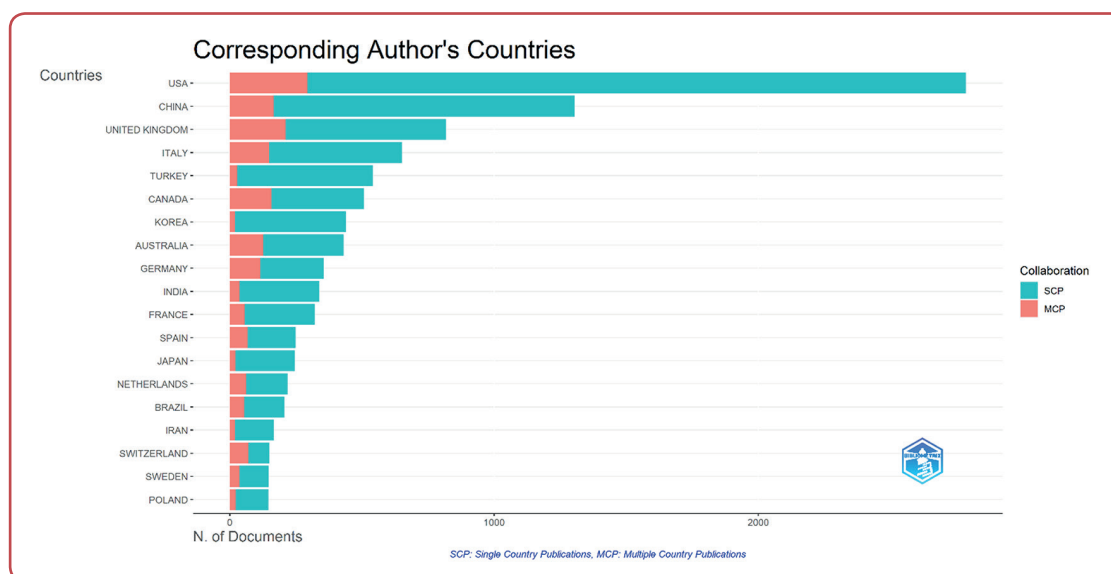

Figure 5: Research collaboration among countries related to interventional pain management as minimally invasive procedure from 2014-2024

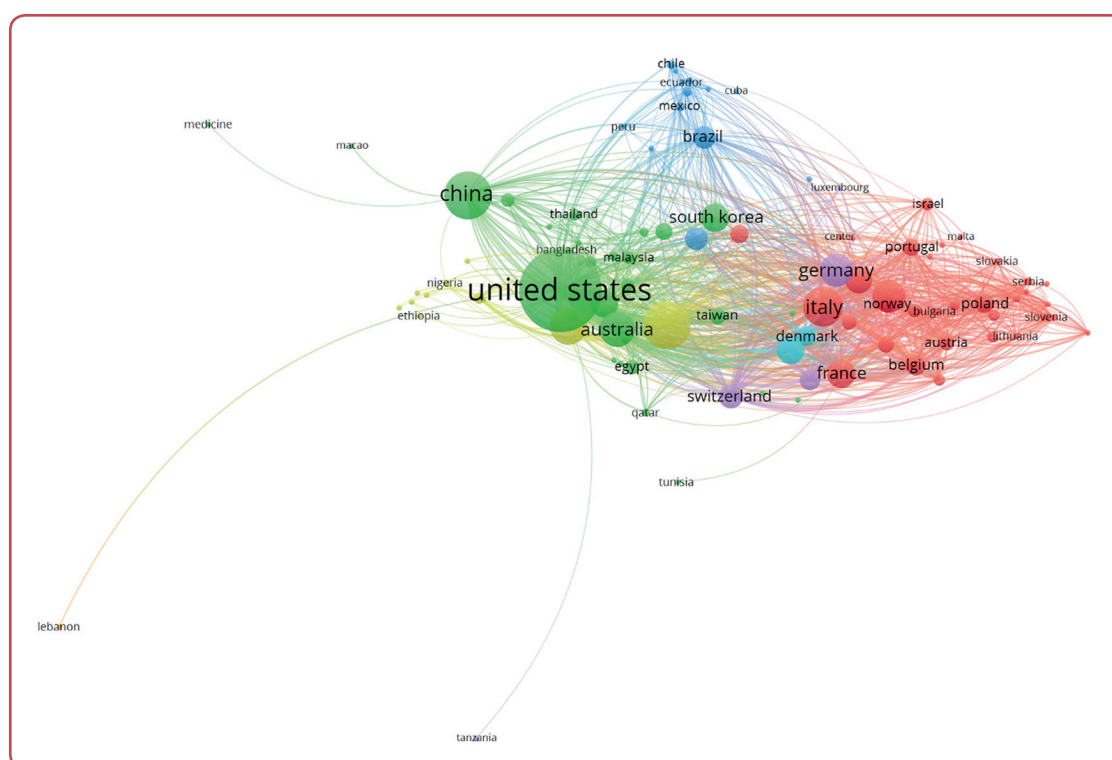■ Philothra and Irham. Scr Med. 2025 Mar-Apr;56(2):369-81.

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Figure 6: Countries related to interventional pain management as minimally invasive procedure from 2014-2024

Figure 5 illustrates the single country publication (SCP) and multiple country publication (MCP) related to interventional pain management as a minimally invasive procedure. Findings indicate that the USA has the highest number of collaborating countries, followed by China and the UK in second and third places, respectively. The visualisation of international collaboration among countries is depicted in Figure 5. Results highlight the importance and effectiveness of international collaboration in advancing the field of interventional pain management as a minimally invasive procedure.

The most productive country publication related to interventional pain management

The urgency of the most productive country's publication related to interventional pain management lies in its potential to address global health disparities, advance technological innovations, standardise practices through evidence-based medicine, facilitate collaborative research and develop comprehensive treatment guidelines. By leveraging these contributions, patient outcomes can be approved and the overall effectiveness of pain management strategies worldwide can be enhanced. The most productive countries in terms of publication related to interventional pain management were the United

States, the United Kingdom and Italy, based on the number of documents retrieved. With 3,932 documents, the USA was the leading country in terms of publication output in the field of interventional pain management. Closely followed by the United Kingdom with 1,317 documents, indicating a significant contribution to the literature on this topic. Italy ranked third with 937 documents, demonstrating a notable presence in the field of interventional pain management research. These findings highlight the substantial research activity and interest in interventional pain management across these countries, reflecting their commitment to advancing knowledge and treatments in this critical area of healthcare (Figure 6).

Discussion

Recent trends in interventional pain management, particularly focusing on minimally invasive techniques, have been increasingly emphasised due to their efficacy and safety compared to traditional methods. Studies have shown that minimally invasive interventional pain management techniques can provide significant pain relief for various conditions, including post-herpetic neuralgia, stroke,

complex regional pain syndrome and refractory cancer pain.[15] High patient satisfaction rates and rapid recovery times further underscore the importance of these methods. Advancements in imaging technologies like ultrasound and fluoroscopy have improved the accuracy and safety of these procedures. The use of advanced imaging guidance ensures precise placement of injections and minimises the risk of complications.[14] Minimally invasive pain management techniques are not only more economical compared to traditional surgical methods but also offer a better quality of life for patients. By reducing dependence on opioids and minimising adverse drug reactions, these procedures contribute to improved patient outcomes and reduced healthcare costs.[15] The aim of this study was to provide a comprehensive overview of recent trends in interventional pain management as a minimally invasive procedure. By focusing on effectiveness, technological advancements, challenges and future research directions, we hope to contribute valuable insights that can enhance patient care and outcomes in this evolving field. Understanding these trends is essential for improving treatment options available to patients suffering from chronic pain conditions. The landscape of interventional pain management is evolving rapidly, driven by technological advancements, a focus on personalised care and an increasing understanding of chronic pain mechanisms. These trends underscore the importance of continued innovation and research in improving patient outcomes in the field of pain management. This finding highlights the recent trends in interventional pain management based on the provided search results, emphasising the critical developments shaping this area of healthcare.

Recent trends in interventional pain management as a minimally invasive procedure are characterised by several advancements and evolving strategies. Global health initiatives aimed at improving access to healthcare services often include training programs for healthcare professionals in interventional pain management techniques. This enhances the availability of these services worldwide, particularly in rural areas where access to specialised care remains a concern.[4] Interventional pain management is a rapidly evolving field that has garnered significant attention in recent years. Bibliometric trend studies provide valuable insights into the research landscape, highlighting key trends, authors and publications. A comprehensive overview of the current state of interventional pain management research based on bibliometric analyses from 2014-2024.

Data compiled from the *Scopus* database for the period of 2014 to 2024 revealed a total of 13,606 publications (all in English) related to interventional pain management as a minimally invasive procedure, sourced from 3,313 different publications and authored by a total of 63,460 individuals. The publication count exhibited a significant rise beginning in early 2016, reaching its peak in 2022. We highlighted that the peak in publications related to interventional pain management in 2022 reflects a convergence of increased chronic pain prevalence, technological advancements, personalised medicine trends, multidisciplinary approaches, efforts to reduce opioid dependence, emerging research initiatives and growing industry interest. Collectively, these factors have created a fertile environment for research activity and publication in this critical area of healthcare. The recent trends in interventional pain management—especially those emphasising minimally invasive techniques—are marked by a substantial increase in publication frequency, a focus on targeted and non-invasive treatments and enhanced clinical outcomes. These elements collectively underscore the growing importance and recognition of these methods within contemporary pain management practices.

The prevalence of publications from *BMJ Open*, *Archives of Physical Medicine and Rehabilitation*, *PM&R* and *Pain Physician* in the field of interventional pain management reflects their strong reputations, focus on evidence-based practices, growing interest in innovative treatment techniques, support for multidisciplinary research and accessibility features. These factors collectively contribute to their status as leading sources for research on minimally invasive procedures in pain management. *BMJ Open* known for its rigorous peer-review process and high impact factor, publishes a wide range of medical research, including studies on interventional pain management. Its reputation attracts researchers aiming to reach a broad audience. *Archives of Physical Medicine and Rehabilitation* is highly regarded journal in the field of rehabilitation medicine and often features studies on pain management techniques, making it a preferred outlet for related research. *PM&R* journal as a leading journal in physical medicine and rehabilitation, it focuses on evidence-based practices in pain management, which aligns well with the interests of research-

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ers in this area. *Pain Physician* journal specialises in interventional pain management topics, providing a dedicated platform for practitioners and researchers to publish their findings. Based on the provided sources, the top 5 keywords related to the application of interventional pain management in the context of stroke are: Rehabilitation (1890 keywords), Rehabilitation medicine (1006 keywords), Stroke (619 keywords), Pain management (378 keywords), Pain (335 keywords). These keywords reflect the focus on rehabilitation and pain management strategies specifically for stroke patients, which is crucial for addressing the complex pain issues that often arise post-stroke.

The countries that contributed the most to research in interventional pain management were the United States, the United Kingdom and Italy, as indicated by the volume of published documents. The United States is the most productive and active collaborator in research of interventional pain management due to its robust funding mechanisms for medical research, interdisciplinary collaboration models, advanced technological capabilities, extensive clinical trial activities and the development of professional guidelines that standardise best practices.[21] Despite challenges related to funding priorities, the US continues to be a hub for innovative research in this critical field.

Presented study had several limitations inherent to the database used and the search query developed by the authors. These limitations are similar to those encountered in previously published bibliometric studies. Specifically, the use of a single database like *Scopus* may not capture all relevant publications and the specificity of the search query could potentially miss some related articles. Additionally, the reliance on English-language publications might limit the scope of the study, as non-English sources may also contribute valuable insights. These challenges are common in bibliometric analyses and highlight the need for careful consideration of these limitations when interpreting the results. Besides, the compilation of data from *Scopus* highlights the substantial growth in research related to interventional pain management as a minimally invasive procedure. The increasing number of publications, particularly in the latter half of the period studied, underscores the significance of this field and the ongoing efforts to develop more effective and less invasive treatments for pain management. This analysis provides a comprehensive overview of the current state of research in interventional pain management, emphasising the importance of minimally invasive techniques and the growing recognition of their efficacy in modern pain management practices.

Despite the limitations inherent to the database used and the search query developed by the authors, study was the first to analyse bibliometric indicators specifically focused on interventional pain management. This pioneering effort aimed to provide a comprehensive understanding of the research landscape in this field, leveraging various bibliometric techniques to highlight key points and methodologies used in the literature. By examining the evolution of pain research over the past 30 years, presented study contributed to the knowledge of pain and its diffusion beyond classical scientific publishing, while also acknowledging the challenges and anomalies encountered in the field.[9] This analysis helps in better appreciating the content of these studies and prepares readers for future bibliometric studies on pain and related literatures.

Conclusion

The recent trends in interventional pain management, particularly those that are minimally invasive, are crucial for advancing the field of pain research. The growing body of literature, technological advancements and global impact of these techniques underscore their importance. Bibliometric analyses have provided valuable insights into the evolution of pain research, highlighting the need for ongoing research to develop more effective pain management strategies and improve patient outcomes.

Ethics

This study was a secondary analysis based on the currently existing data and did not directly involve with human participants or experimental animals. Therefore, the ethics approval was not required in this paper.

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Conflicts of interest

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Data access

The data that support the findings of this study are available from the corresponding author upon reasonable individual request.

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