ORIGINAL ARTICLE

Chronology and impact of global research into chronic postoperative pain: a bibliometric analysis of 40 years of research

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ABSTRACT

Objective: To describe the chronology, evolution and impact of global research into chronic postoperative pain.
Materials and methods: A bibliometric study was conducted using the Scopus database. A structured search was designed and validated, thereby allowing the collection of metadata, which were analyzed through the Bibliometrix package of the R programming language. The study involved the description of the general characteristics, evolution and calculation of impact metrics of global research into chronic postoperative pain.
Results: The study included 1,496 documents, which spanned from 1983 to 2023. Original articles accounted for 70.7 % (*n* =1,059) of the total output, followed by reviews (*n* = 357; 23.8 %). There was an international collaboration rate of 15.6 %, and there has been sustained growth in output since 1983, with a sharp increase in the last 13 years, 2022 being the most prolific one (*n* =191 published documents). It was identified that Canada and Denmark lead the impact of global research and have the most productive authors and institutions. However, the United States is the most prolific country because it leads significant collaboration, mainly with European and Latin American countries. Neuropathic pain, risk factor assessment and pain management were identified as some of the most frequent topics. Over the past approximately 10 years, there has been persistent interest in research on quality of life, prediction, prevention, and risk factor assessment. Recently, there has been interest in studying pain in video-assisted thoracoscopic surgery and developing predictive models.
Conclusions: The study revealed sustained growth in global research on chronic postoperative pain over the past 40 years. Such growth has been mainly led by Canadian and Danish institutions, despite the United States being the most prolific country. Moreover, there has been a significant transition in the studied topics, moving from the use of drugs and identification of risk factors to the study of predictive models, data systematization, and video-assisted surgery.

Keywords: Pain, Postoperative; Chronic Pain; Bibliometrics; Biomedical Research (Source: MeSH NLM).

INTRODUCTION

Chronic pain is a noteworthy outcome in healthcare practice since it impacts multiple health outcomes, mainly morbidity, functional capacity and quality of life [(1)]. For over 10 years, it is estimated that there has been a steady increase in the burden of disease generated by chronic pain due to the increase in the prevalence and incidence of chronic non-communicable diseases and frailty in older age [(2,3)]. However, chronic postoperative pain is also a remarkable condition in the approach to chronic pain management, in addition to being a very frequent reason for consultation in surgical practice [(4)].

Currently, with the advancement of therapies and certain diagnostic tools in surgery, it has been possible to develop increasingly effective, safe and efficient strategies for managing chronic postoperative pain [(5)]. Depending on the subspecialty,

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associated surgical condition, and health phenotype, the strategy may be either invasive or noninvasive, ranging from the use of disease-specific drugs [6] to neuromodulation through intraoperative blockade [7], obtaining more than one favorable outcome concerning the same surgical intervention, reduction of healthcare costs, hospital stay, drug therapy and the need for readmission [6,7]. Even so, it is not precisely known how research into postoperative chronic pain has evolved, what the most studied topics are, gaps and pluralism in research that facilitate the critical appraisal of evidence and the design of future studies. One of the many limitations in this field is that most of the evidence comes from high-income countries [8] and refers to high-cost techniques, which hinders their reproducibility in low-resource settings.

Bibliometrics is a useful tool to quantify and describe the behavior of scientific research, with particular relevance in the field of biomedical sciences [9]. It allows for visualizing, calculating and measuring the impact, trends and frequency of studies on a topic or area of knowledge, as well as identifying gaps and directions, future research areas, oriented to the needs and missions in health [10,11]. Previously, research into postoperative chronic pain has been studied through this approach [8]. However, selective databases have been used, excluding a large amount of peer-reviewed evidence, particularly from Latin American journals. Considering the need for data and an overview of what has been studied and what remains to be studied in this field, the objective of this study was to describe the chronology, evolution and impact of global research into chronic postoperative pain.

MATERIALS AND METHODS

Study design and population

The bibliometric study was conducted using Scopus, the largest peer-reviewed database of scientific literature, which currently indexes more than 15,000 journals in biomedical sciences. Its use for this type of analysis has been previously supported and reported [9]. Moreover, compared to other databases also used in bibliometrics, such as PubMed and Web of Science, Scopus has a greater number of indexed Latin American biomedical journals, which facilitates the identification of evidence related to the research question in this region.

A structured search was designed and executed to identify articles on chronic postoperative pain with basic, translational, clinical, experimental, or other research approaches. The search strategy was constructed using MeSH terms as well as synonyms in English since—in a standardized manner—metadata is published in this language. Prior to executing the final strategy, a pilot test was conducted. It comprised to assess which tags yielded the highest number of results and the most accurate ones. “TITLE”, “TITLE-ABS” and “TITLE-ABS-KEY” were compared together with the keywords. It was identified that the use of TITLE-ABS-KEY yielded a higher number of results related to the topic of interest. Thus, an example of a conducted search was TITLE-ABS-KEY(“Chronic Postoperative Pain”) OR TITLE-ABS-KEY (“Chronic Post-surgical Pain”) OR TITLE-ABS-KEY(“Chronic Post surgical Pain”) OR TITLE-ABS-KEY(“Chronic Postsurgical Pain”) OR TITLE-ABS-KEY(“Chronic Postsurgical Pains”) OR TITLE-ABS-KEY(“Persistent Postsurgical Pain”) OR TITLE-ABS-KEY(“Chronic Post-operative Pain”) OR TITLE-ABS-KEY(“Chronic Post operative Pain”).

Variables and measurements

Once the search was carried out, the database yielded results involving variables such as year of publication, article title, journal details, article type, keywords, affiliations, author details, citations, scientific collaboration, and details about the editorial process and publication. This search was conducted up to November 22, 2023, and was filtered with the tags “Human” and “Journals”. Thus, papers that do not follow the regular peer-review process for publication in scientific journals (e.g., books, book series, abstracts, and proceedings of scientific events) were excluded. Considering that the analysis was historical, there was no restriction on the publication time window.

After exporting the data, two authors performed a manual review to remove duplicates and verify the inclusion of papers related to the topic of interest, based on the title, abstract and keywords, in Microsoft Office Excel 2016. Subsequently, three authors carried out an additional manual review in order to standardize the data for the variables of interest and reduce discrepancies in how the metadata were originally recorded. In this way, categories were regrouped. For example, in the case of article typology, all original articles, regardless of observational or experimental design, were categorized as “Articles”; likewise, all reviews, regardless of their approach (narrative, systematic or meta-analysis), were categorized as “Reviews”; case series and case reports were categorized as “Case report”; and editorials, letters to the editor, comments, etc., were categorized as “Correspondences”.

Statistical analysis

To determine and evaluate the evolution, characteristics and impact of global research into chronic postoperative pain, network metrics were constructed, and bibliometric calculations were performed. All the papers that met the inclusion criteria were included in the global analysis. For this analysis, the bibliometrix R package was used, which allowed for the calculation of quantitative bibliometric indicators and the visualization of the results (version 4.3.1) [12]. Synonyms, errors, plurals and variants were rigorously grouped to carry out a homogeneous analysis. In this way, keywords, authors and institutions were standardized.

Thus, the descriptive analysis and characterization of the identified scientific output was performed. The *h*-index, *g*-index and *m*-index metrics as well as the absolute value of accumulated citations were used to measure the impact of authors, institutions and countries. The definitions and specifications for the use of these metrics in bibliometric studies have been previously described [13,14]. Frequencies and percentages were calculated using Microsoft Office Excel 2016.

Ethical considerations

This study did not require approval by an ethics committee as it did not involve research in humans, biological models, or the use of medical records.

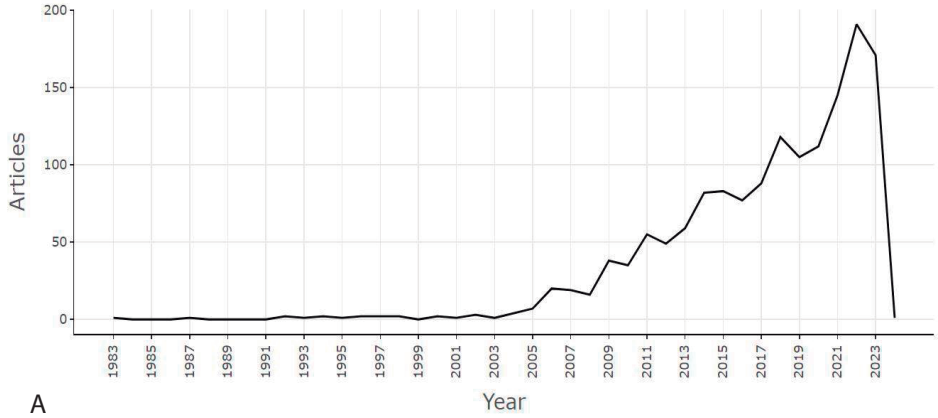
RESULTS

Initially, 1,519 papers were identified, and after applying the inclusion criteria, 1,496 were selected, with a time window between 1983 and 2023. Of the total output, 70.7 % (*n* = 1,059) were original articles, followed by reviews (*n* = 357; 23.8 %). A total of 5,832 authorships were identified, 125 (8.3 %) sole-authored papers, and 15.6 % of articles involved international collaboration (Table 1). Since 1983, there has been a sustained growth in scientific output, with a marked increase over the last 13 years, with year 2022 being the most prolific (*n* = 191 published papers) (Figure 1A). In contrast, the evolution of citations has been fluctuating: 2006 had the highest number of citations, followed by a sustained decline over the past five years (Figure 1B).

Table 1. General characteristics of global research into chronic postoperative pain (*N* = 1,496)

	n	%
Type of article		
Original article	1,059	70.70
Review article	357	23.80
Correspondences*	80	5.50
Authors		
Authorship	5,832	-
Authors of sole-authored papers (*N* = 5,832)	103	1.76
Collaboration		
Sole-authored articles	125	8.30
Co-authorship per article (mean)	5.59	-
Internacional co-authorship	234	15.64
Keywords	2,268	-
Journals	516	-
Average age of article (years)	5.83	-
Average citations per paper	28	-

*Includes letter to the editor, editorials, comments, etc.



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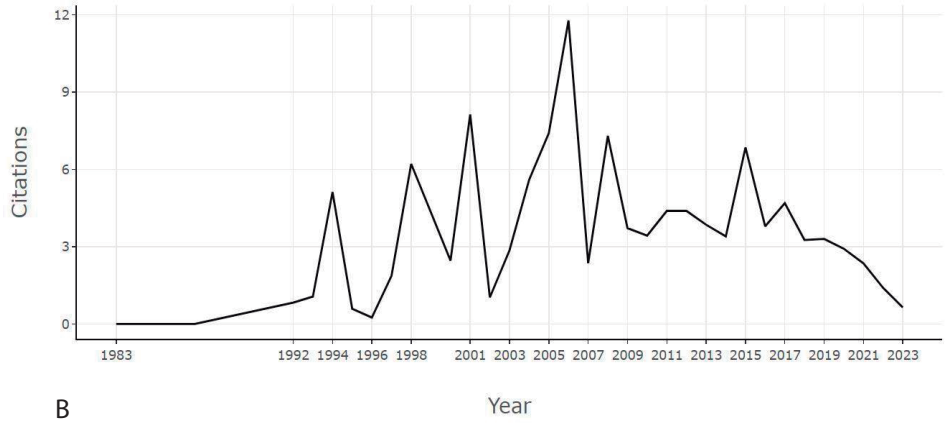

Figure 1. Annual scientific growth in global research into chronic postoperative pain
A. Annual output volume. B. Annual average of citations received.

Regarding journals, it was observed that the highest number of papers have been published in high impact journals, such as *Pain* (*n* = 53; SJR: Q1), *Journal of Pain Research* (*n* = 38; SJR [SCImago Journal Rank]: Q2) and *British Journal of Anaesthesia* (*n* = 35; SJR: Q1) (Figure 2A). When assessing the impact, according to the h-index, the journal *Pain* (*h*-index = 28) leads this metric, followed by *Anesthesiology and Current Opinion in Anaesthesiology* (*h*-index = 19 for both cases) (Figure 2B). According to the *g*- and *m*-indices, *Pain* (*g*-index = 53) and Journal of *Pain* (*m*-index = 1.38) are the journals with the highest impact (Figures 2C and 2D). However, *Pain* and *Lancet* are the journals that have received the highest number of citations over time (5,375 and 2,844 citations, respectively) (Figure 2E). Nevertheless, the highest growth in publication volume has been observed in the journals *Pain* and *Journal of Pain Research*, particularly over the past 10 years (Figure 2F).

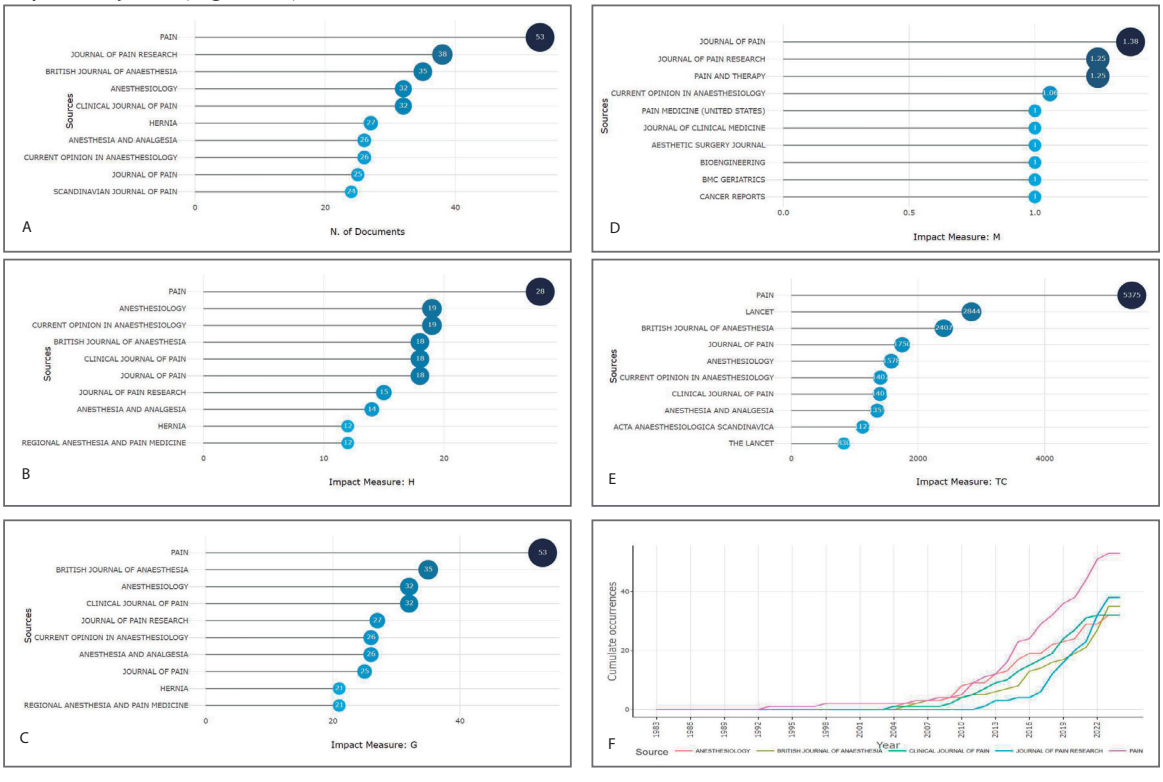

Figure 2. Evolution and impact of with the journals with the highest number of articles published on research into chronic postoperative pain
A. Frequency of published articles. B. *H*-index of articles. C. *G*-index of articles. D. *M*-index of articles. E. Total accumulated citations and those derived from articles on research into chronic postoperative pain. F. Annual frequency of published articles.

https://doi.org/10.24265/horizmed.2024.v24n2.05

When constructing and visualizing the collaboration networks, it was demonstrated that, with regard to the authors, there is significant institutional endogamy, since the strength of collaboration is weak (Figure 3A). A similar trend is evident in the analysis of affiliations, where collaboration seems to be predominantly national and within a defined network of institutions (Figure 3B). When the collaboration between countries is observed, the leadership of the United States stands out, showing close collaboration with some European and Latin American countries (Figure 3C). Finally, as to the frequency of collaboration, there is a higher frequency of collaboration between the United States and Canada, as well as with certain European countries such as the United Kingdom and Denmark (Figure 3D).

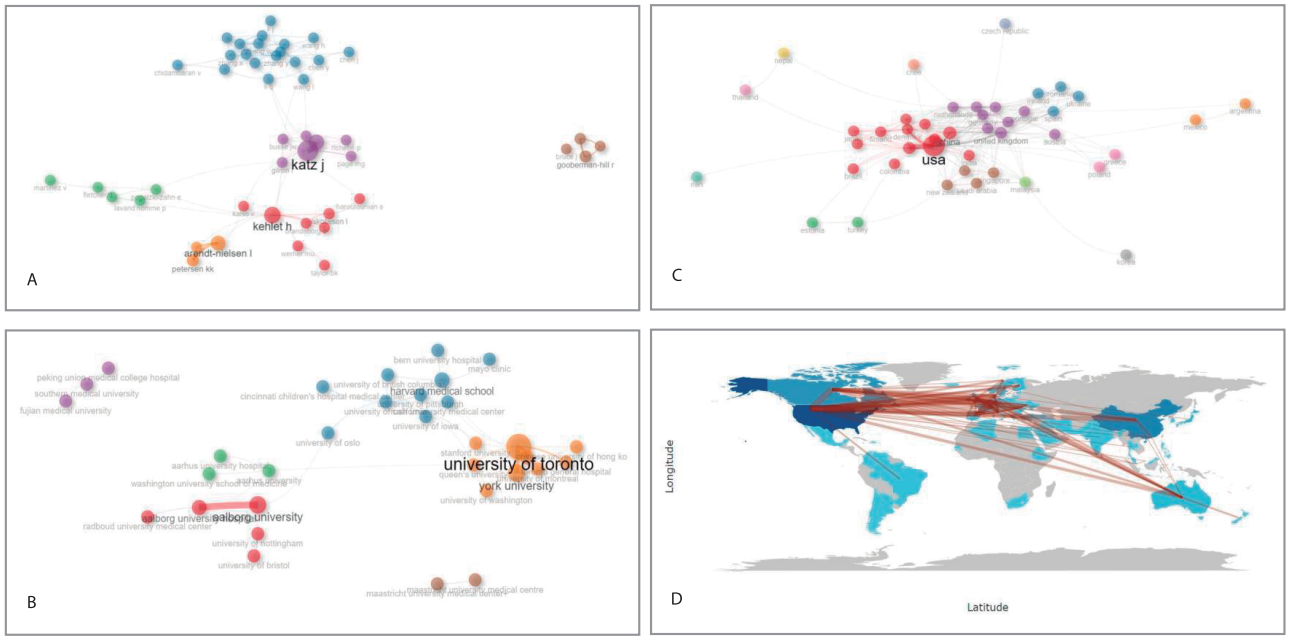

Figure 3. Collaborative networks and strength of regional and international collaboration in global research into chronic postoperative pain A. Collaboration between authors. B. Collaboration between affiliations. C. Collaboration between countries. D. Frequency of regional and international collaboration.

When determining the evolution and impact of the research by authors, affiliations and countries, it was shown that the five most prolific authors come from three countries: Canada, Denmark and Belgium. Joel Katz is the most prolific author with the highest impact (44 papers and *h*-index of 25), having as his affiliation Toronto General Hospital, located in Canada (Table 2). Regarding the most prolific affiliations, of the five most prominent, three are Canadian and two are Danish. The University of Toronto and York University are the institutions with the highest number of published papers on chronic postoperative pain (59 and 42 articles, respectively). However, the United States ranks first as the most prolific country, with a total of 371 articles, followed by China with 179. The United States and Canada are the countries with the highest impact from their research on this topic (*h*-indices of 57 and 41, respectively) (Table 2).

Table 2. Output characteristics and impact of the most prolific authors, affiliations and countries in global research into chronic postoperative pain

Authors	Papers on chronic postoperative pain	*h*-index	*g*-index	*m*-index	Total citations	Current affiliation	Country
Joel Katz	44	25	44	1.25	2,486	Toronto General Hospital	Canada
Henrik Kehlet	33	18	33	0.9	5,260	Rigshospitalet	Denmark
Lars Arendt-Nielsen	28	12	28	1.22	895	Aalborg University	Denmark
Hance Clarke	28	17	28	1.13	1,321	Toronto General Hospital	Canada
Patricia Lavand'homme	21	13	21	0.7	2,117	University Catholic of Louvain	Belgium

Affiliation	Papers over time				Total papers on chronic postoperative pain	*h*-index	Country
	1983-1993	1994-2003	2004-2013	2014-2023			
University of Toronto	0	0	12	47	59	29	Canada
York University	0	0	10	32	42	24	Canada
Rigshospitalet	0	0	12	24	36	19	Denmark
Aalborg University	0	0	2	31	33	15	Denmark
Toronto General Hospital	0	0	8	25	33	22	Canada

Country	Papers over time				Total papers on chronic postoperative pain*	h-index
	1983-1993	1994-2003	2004-2013	2014-2023		
United States	1	5	75	290	371	57
China	0	0	6	172	178	19
Canada	0	1	27	114	142	41
United Kingdom	0	1	29	99	129	37
Denmark	0	1	20	82	103	33

* The output was counted individually. Therefore, a single paper may have been counted several times depending on international collaboration.

In constructing thematic diagrams and maps to assess the frequency and transition of research topics on chronic postoperative pain, it was found that neuropathic pain, assessment of risk factors and pain management are among some of the most frequent topics (Figure 4A). For approximately the past 10 years, there has been a persistent interest in research on quality of life, prediction, prevention and assessment of risk factors, with recent interest in the study of pain in video-assisted thoracoscopic surgery and the construction of predictive models (Figure 4B). However, in the study of risk factors for neuropathic pain, the topics with the highest co-occurrence are breast cancer, thoracic surgery, hysterectomy and other topics related to orthopedic surgeries (Figure 4C). Based on the degree of relevance and development of topics, it is evident that the core themes are clinical studies, especially in the middle-aged population, but with the emerging inclusion of genetics and spinal ganglion studies, and even experimental studies with murine models (Figure 4D). Regarding topic transition, compared to the period from 1983 to 2018, in the past five years there has been increased interest in data systematization, conducting clinical trials and assessing pain services (Figure 4E).

Finally, when determining the most cited articles to date, it was found that 1) Persistent postsurgical pain: risk factors and prevention (*The Lancet*; 2,844 citations. DOI: 10.1016/S0140-6736(06)68700-X), 2) Chronic post surgical pain: 10 years on (*British Journal of Anaesthesia*; 698 citations. DOI: 10.1093/bja/aen099) and 3) Prediction of chronic postoperative pain: Preoperative DNIC testing identifies patients at risk (Pain; 610 citations. DOI: 10.1016/j.pain.2007.10.033) have been the most outstanding articles to date.

DISCUSSION

This study, for the first time in Spanish, provided an overview of the historical global research into chronic postoperative pain. It identified a predominance of original scientific output, which represents the execution of research projects seeking to generate evidence based on primary data [15]. Similarly, there is an international co-authorship rate of approximately 15 %, which, compared to other areas of knowledge, is relatively low [16]. This was correlated with the visual analysis and construction of collaborative networks by authors and affiliations, where a pronounced tendency towards institutional or national endogamy was identified. Even so, a pattern of collaboration was evident, led mainly by the United States and Canada, with some European and Latin countries. Hence, it can be inferred that the tendency to multicentric collaboration, which is increasingly active, would increase this percentage in the coming years. Although it is not possible to identity the exact causes of this phenomenon, it may be related to general limitations in science, such as lack of agreements, language barriers, lack of knowledge of the benefits of international collaboration and preference for conducting retrospective and cross-sectional studies [17,18].

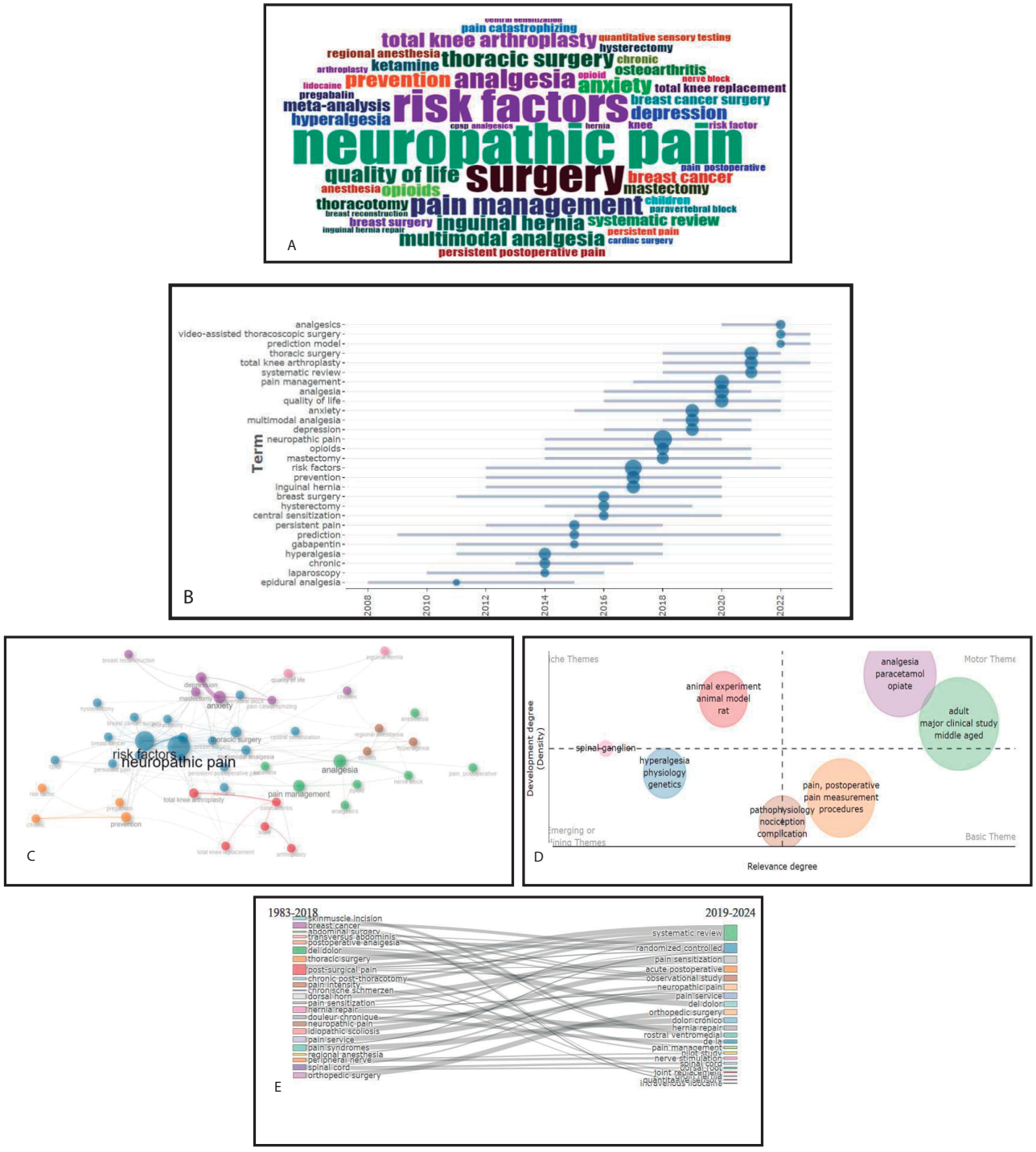

Figure 4. Hot topics and trends in global research into chronic postoperative pain
A. Cloud of keywords in the form of the most frequent bigrams. B. Frequency of topics over time. C. Co-occurrence network of terms that make up the research topics. D. Thematic map of research trends. E. Transition of trends over time.

Despite chronic postoperative pain is a heterogeneous scenario around the world and since its frequency depends on the specialty and volume of surgical patients treated [19], first-world countries have led such research, possibly due to their research strategy planning, hospital infrastructure and timely access to funding [18], but also because of their proactivity in establishing high-level collaborations that facilitate conducting high-impact studies. It could be said that the growth in the volume of publications has been evident over the past 10 years—compared to previous decades—possibly due to the consolidation of clinical services and research related to pain, but also due to the advancement of invasive intraoperative or postoperative strategies, which have shown an impact on postoperative pain as a health outcome, related to neuropsychiatric symptoms and quality of life [20].

The emergence of experimental and data systematization topics would correlate with the long-term timeline of the studies since the 1980s, which likely sparked the interest of researchers in the field to answer certain research questions using these approaches, based on previous primary data (in the case of data systematization) [21]. Furthermore, experimentation could be explained as the result of observational studies over time, which have demonstrated certain trends in chronic postoperative pain [22]. Nevertheless, clinical research has predominated with regard to the identification of risk factors, with recent interest in developing predictive models, possibly also clinical. This reveals a gap in the need for research in basic or translational sciences, the resolution of which would allow progress in precision medicine by advancing the search for solutions and individualization of the approach to chronic postoperative pain [23-25]. These could even be strategies and future research areas to be developed in countries or institutions seeking to promote research into chronic postoperative pain. Based on the co-occurrence networks, general surgery and subspecialties, gynecology and orthopedics are the surgical specialties that have investigated this topic to a greater extent [26,27]. Therefore, it was not possible to appreciate the production or approach in other surgical sciences.

The foregoing data can serve as a basis for designing future studies on chronic postoperative pain, since they reveal trends, hot topics, gaps and pluralism in research, which can be complemented with other arguments for the search for answers to current gaps in this field of biomedical knowledge [28-30]. Likewise, it provides useful information for identifying potential authors, affiliations and countries to establish national and international collaborations and massively promote ideas.

As limitations, it should be noted that only one database was used to search for published evidence, which inherently excludes gray literature or other types of literature. However, due to the methodology and statistical analysis carried out, Scopus is one of the few databases that allows these analyses to be performed because of the metadata contained in its repository, although it should be noted that there is an inherent bias in them, which does not depend on the researchers conducting these types of studies. In spite of this fact, it is possible to correct data during their standardization.

In conclusion, sustained growth in global research into chronic postoperative pain was revealed over the past 40 years, mainly led by Canadian and Danish institutions, despite that the United States has been the most prolific country. Likewise, it was determined that there is a predominant collaboration network between the United States and Canada, with European and some Latin American countries, although most of the scientific output has been achieved with national collaborations. There has been a significant transition in the topics studied in recent decades, moving from the use of drugs and determination of risk factors to the study of predictive models, data systematization and video-assisted surgery.

Author contributions: CJGE, MARP, DAMS, JSRR and PJBC contributed to conceptualization, data curation, formal analysis, research, methodology, writing of the original draft, review and editing. JANP, LAGV, LMMF, DPPM and MOS contributed to conceptualization, research, writing of the original draft and editing.

Funding sources: This article was funded by the authors.

Conflicts of interest: The authors declare no conflicts of interest.

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Reception date: November 28, 2023
Evaluation date: December 20, 2023
Approval date: December 22, 2023

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