Panorama of Open Science and Open Access: A bibliometric analysis of publications in SCOPUS (2000-2026)

Panorama de la Ciencia Abierta y el acceso abierto: Un análisis bibliométrico de publicaciones en SCOPUS (2000-2026)

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wejournalreview.com
2026 • V.2 • N.1

ISSN: 3066-4217

Recibido: 03/06/2025 | **Revisado:** 17/07/2025 | **Aceptado:** 27/12/2025 | **Publicado:** 31/12/2025

Cite: Murillo-González, A., Calderón-Chacón, R. (2026). Panorama of Open Science and Open Access: A bibliometric analysis of publications in SCOPUS (2000-2026). *We Journal Review*, 2(1), 9-18. https://doi.org/10.38202/journal21.2

Abstract

The primary objective of this article is to present a bibliometric analysis of the literature concerning open science and open access published in the Scopus database between 2000 and 2026. Adopting a quantitative approach with a descriptive scope, this study employs bibliometric techniques to evaluate the evolution and behavior of the field. The research corpus was delimited through specialized search equations, identifying a total of 7,933 sources. The findings reveal a significant upward trend in scientific production in recent years, highlighting dominant research themes and a strong pattern of international collaboration. Consequently, this analysis offers critical insights into the trends and patterns of scientific output, providing a comprehensive overview of the current research landscape while identifying key directions for future inquiry.

Keywords: open science, bibliometric analysis, scientific publications.

Resumen

El artículo tiene como objetivo principal proporcionar un análisis bibliométrico de los documentos publicados del 2000 al 2026 en SCOPUS relacionados con el tema de ciencia abierta y acceso abierto. Se trata de un enfoque cuantitativo, con alcance descriptivo, que utiliza técnicas bibliométricas para dar una visión cuantitativa del comportamiento de la temática. La población de estudio se delimitó a través de ecuaciones de búsqueda en las bases de datos indicadas teniendo como resultado un total de 7933fuentes. Los resultados muestran un aumento en la producción de artículos sobre ciencia abierta en los últimos años, así como los principales temas de investigación en este campo y la colaboración internacional común en la investigación sobre ciencia abierta. Este análisis bibliométrico permite conocer las tendencias y patrones en la producción científica relacionada con la ciencia abierta y brinda una visión general de la investigación en este campo, así como identificar cuáles son las líneas de investigación a futuro.

Palabras claves: ciencia abierta, análisis bibliométrico, publicaciones científicas

Introduction

Science is a human activity characterized by its dynamism and capacity to adapt to new contexts and challenges. In recent years, a transformation in scientific practice has been observed, driven by factors such as technological development, globalization, social demand, and a crisis of confidence within the scientific system. Regarding this, research into the evolution of the concept of open science addresses it as a paradigm shift within the scientific community concerning how science should be conducted. Open science is by no means a new scientific method, but it becomes an alternative in "how it is done" and increases the possibility of verifying the efficacy and rigor of various methodologies. This paradigm seeks to foster transparency, collaboration, and open access to scientific results and research data. Thus, open science presents an opportunity to improve both the scientific process and its products to strengthen the link between science and society.

The European Union is recognized as a driver of this movement, with the primary objective of incentivizing cooperation between researchers and facilitating the socialization of research data. As a precedent, the emergence of open access policies at the beginning of the 21st century can be mentioned, primarily with the Bethesda Statement on Open Access Publishing in 2003, which sought to make published information freely accessible to everyone, thus laying the foundation upon which the philosophy of open science would be built. Later, the Berlin Declaration (2003) recognized the internet as a tool that allows for a more efficient dissemination of knowledge, relating to some degree the potential of electronic publications to manage the dissemination of scientific knowledge.

In this sense, the advancement of scientific publications has benefited from technological progress in editorial management platforms, which allow for the management of not only published documents but also the implementation of best practices related to open access and open science. These best practices include the use of open licenses, depositing in institutional or thematic repositories, publishing in open access journals, and dissemination through academic social networks, among others. Regarding this, Seroubian (2022) indicates that, despite these advances and the advantages of electronic publishing systems, "editorial policies and legislation continue to impose restrictions, as well as economic and legal barriers to accessing publications" (p. 288). These restrictions can affect the visibility, impact, and quality of scientific publications, as well as limit society's right to information and knowledge.

International organizations such as UNESCO (2021) define the term open science as "an inclusive construct that combines various movements and practices with the aim of making multilingual scientific knowledge openly available and accessible to all, as well as reusable by all" (p. 7). Therefore, it is a social construct that encompasses the practices of open access, open source, open infrastructure, open data, and citizen science.

The objective of this work is to identify trends surrounding the topic of open science based on scientific production in Scopus during the period between 2000 and 2026. Through metrics and bibliometric techniques, it seeks to provide a quantitative view of the behavior of this subject matter.

Literature Review

Open science represents an innovative approach that promotes collaboration among academics and ensures complete openness and transparency throughout all stages of research (Mendoza & Paravic, 2006). However, the philosophy of access or openness to scientific knowledge is not a recent debate. In this regard, David (2008) indicates that attempts to open knowledge can be traced back to the late

16th and early 17th centuries, an era that marked a rupture with the previously predominant norm of maintaining secrecy in the search for nature's mysteries. Instead, it introduced a renewed set of regulations, incentives, and organizational structures that reinforced scientific researchers' commitment to the prompt disclosure of knowledge. This context presented the ideal ecosystem for the creation of scientific journals, which emerged within the framework of scientific societies (David, 2008).

The modern evolution of the open science concept is heavily influenced by the rise of information and communication technologies in recent decades. In this sense, key historical milestones include the Budapest Open Access Initiative (2002) and the Bethesda Statement on Open Access Publishing (2003). The former focuses on promoting open access to scientific and academic literature, advocating for the online publication of freely accessible research. On the other hand, the Bethesda Statement focuses on open access policies for research results funded by federal funds in the United States, establishing guidelines for the public availability of scientific findings backed by government financing. Both initiatives share the objective of fostering transparency and access to scientific research but focus on different aspects and applications of open science.

Currently, open science is conceived as an essential social commitment established among research stakeholders. This results in a more effective alignment between academia and societal needs. Furthermore, it supports the effectiveness of open access practices and FAIR data; the latter has been recently promoted by the European Commission, which requires research data to be published in a FAIR (Findable, Accessible, Interoperable, Reusable) manner (Alcalá & Anglada, 2019). A recent study conducted by Boon et al. (2022) highlights that to achieve success in implementing this collaborative philosophy, universities must invest in institutional support, generate awareness, and foster active dialogue among their staff, addressing how to carry out effective public engagement.

To identify trends in scientific production, it is necessary to apply bibliometric analysis techniques, as they allow for the evaluation and monitoring of published literature in terms of bibliometric data, such as citation information regarding authors, publications, institutions, journals, and countries. Bibliometrics is based on the calculation of bibliometric indicators obtained through statistical analysis of quantitative data from scientific production. Studies of this type have focused on the analysis of a country's production, a discipline, journals, and/or research groups (Franco-Paredes et al., 2016).

Bibliometric analysis can help identify areas of interest, gaps in the literature, and conceptual, social, or cognitive structures within a given research field, thereby inspiring new ideas for investigation.

Methodology

Research Approach

The research is framed within a quantitative approach with a descriptive scope. A bibliometric analysis was conducted to examine the structural behavior of research related to the topic of open science published in the Scopus database from 2000 to 2026. This database represents a critical source of scientific literature covering all branches of knowledge, indexing over 15,000 journals and 50 million articles structured into approximately 251 categories and 151 research areas (De La Vega Meneses, 2024).

Study Population

To define the units of analysis for this study, a delimitation of documents published in the aforementioned database was performed. The specialized search equations used for this purpose are detailed below in Table 1.

Table 1.
Query parameters

Database	Equation	Result
Scopus	(TITLE-ABS-KEY ("open science")) AND PUBYEAR > 1999 AND PUBYEAR < 2027 AND (LIMIT-TO (SRCTYPE , "j")) AND (LIMIT-TO (PUBSTAGE , "final")) AND (LIMIT-TO (DOCTYPE , "ar") OR LIMIT-TO (DOCTYPE , "re"))	7933

As a selection criterion, all published documents were required to include "open science" and "open access" or "scientific data" within their title, keywords, or abstract. Furthermore, documents had to be indexed as scientific articles published in journals, possess a "final" publication status, and have been released between 2000 and 2026. This timeframe was selected to visualize production over the last quarter-century, as output prior to the turn of the millennium was not significant.

Data Collection Techniques

Once the query was generated, the results were verified to ensure the articles aligned with the research objectives by reviewing the search sequence outcomes. The resulting articles were exported in BibTeX format, which facilitates the storage and management of bibliographic references. The final database consists of a .bib file, where each entry corresponds to a scientific article containing its respective bibliographic metadata.

Data Analysis

For this research, a scientific mapping of the published information was conducted to provide a general overview of the conceptual evolution of open science. To achieve this, the

following elements were analyzed: Temporal production of documents, information sources, most cited documents, literature dispersion, network approach from a semantic perspective and network approach from a social perspective.

Information processing was performed using RStudio, specifically utilizing the Bibliometrix statistical processing package, which enables statistical analysis of the database and generates data reflecting the bibliometric behavior of the subject. Additionally, VOSviewer software was employed to visualize co-occurrence graphs.

Results

Description of Obtained Data

After loading and processing the database using the Bibliometrix library, a total of 7,933 processable articles were obtained, published across 2,704 different journals. The average number of articles published per year was 305.11, with the dataset exhibiting a standard deviation of 475.75. The recorded annual growth rate is 21.79%, indicating that the volume of publications on open science is increasing at an accelerating pace.

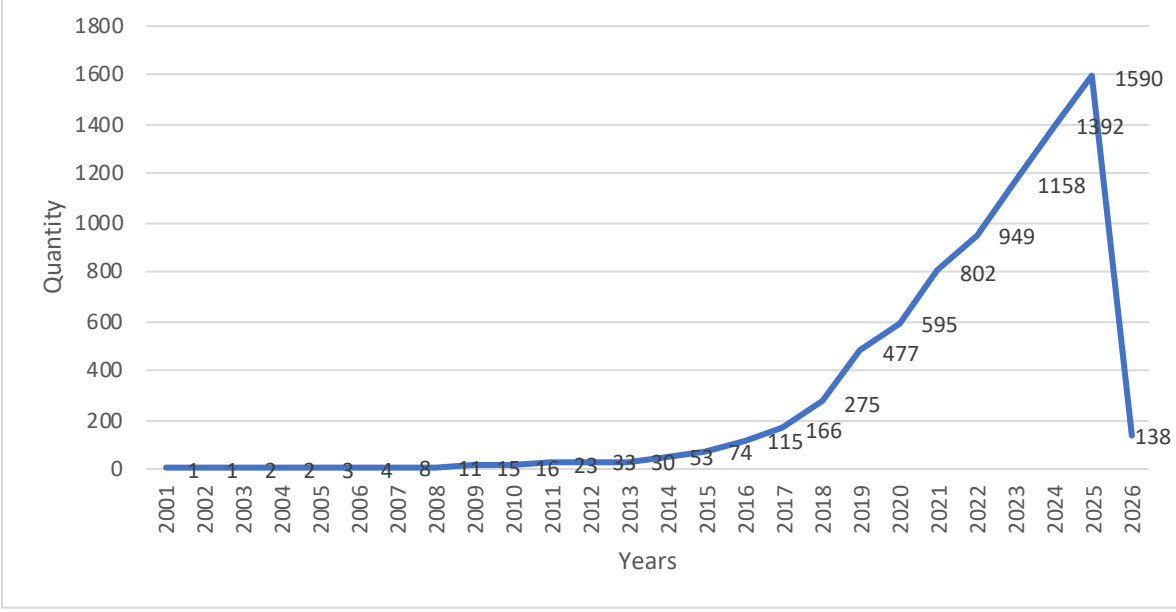
Furthermore, the analysis identified a total of 17,940 keywords and an average citation rate of 17.66 per document. Figure 1 illustrates the annual publication trend, highlighting an exponential growth in output, particularly during the last five-year period, which shows the most pronounced growth curve. (Figure 1.)

The observed publication trends can be explained by the strong global shift toward electronic publishing, as this format facilitates the ability of scientific journals to guarantee access to research data through open science and open access practices. Consequently, these topics have become prominent subjects of study in recent years. In this regard, Beigel (2022) notes that, given the technological facilities available to publishers, open science could potentially amplify the gap between technologically advanced nations and poorer countries with precarious digital infrastructure. This issue remains a priority for research concerning the implementation of these policies in current publishing systems.

According to Unzurrunzaga et al. (2024), the open access movement is currently experiencing tension between commercial and collaborative models. Over the last decades, it has become increasingly common for science funding bodies to mandate that research results be made available under open access modalities. Countries and institutions worldwide, following the roadmap established by UNESCO in 2021 with the publication of the "UNESCO Recommendation on Open Science," have been adopting open access policies, which explains the strong trend toward exponential growth in this field. Furthermore, Osorio-Sanabria et al. (2020) emphasize that scientific knowledge is now considered a public good; therefore, new scientific dissemination technologies must facilitate its access, transfer, exchange, and reuse.

Other authors, such as Debat and Babini (2020), as cited by Unzurrunzaga et al. (2024), suggest that the marked growth in these publications may stem partly from reflections on

Figure 1.
Trends in Open Science Publications in Scopus by Year



inequities in scientific communication generated by Article Processing Charge (APC) models. In this sense, Latin America stands out as a leading region in promoting the Diamond Open Access model. In this model, journals are primarily funded by institutions or science and technology associations, ensuring that neither the author nor the reader incurs costs, thereby reducing access gaps.

Primary Sources of Scientific Publication

Table 2 presents the ten journals with the highest production of articles regarding the consulted topic. The table displays the journal name, the number of articles published, and the year of indexing. Additionally, the 2024 Scimago Journal Rank (SJR) index is provided for each journal, serving as a measure of its influence and prestige within its respective field. This information is intended for researchers seeking to publish on the topic of open science in journals that already hold significant relevance in the field.

Table 2.
Journals with the Highest Volume of Published Articles

Journal Name	Number of Articles	Indexing Year	SJR 2024
BMJ OPEN	332	2011	1,016
SYSTEMATIC REVIEWS	175	2002	2,137
PLOS ONE	167	2006	0,803
JOURNAL OF NEUROCHEMISTRY	97	1995	1,499
JBI EVIDENCE SYNTHESIS	73	2020	1,061
JOURNAL OF SYSTEMS AND SOFTWARE	73	1995	0,975
ROYAL SOCIETY OPEN SCIENCE	68	2014	0,795
F1000RESEARCH	67	2012	0,537
BEHAVIOR RESEARCH METHODS	61	2004	2,462
MEDICINE (UNITED STATES)	59	2000	0,982

The three sources identified with the highest number of retrieved articles directly linked to the topic of open science are BMJ Open, Systematic Reviews, and PLOS ONE, whose characteristics were obtained from their official portals. BMJ Open is distinguished as an online, open-access journal focused on publishing medical research across all disciplines; it features a fully open peer-review model, continuous publication, and a strong emphasis on editorial transparency by disseminating reviewer reports and previous manuscript versions. For its part, Systematic Reviews specializes in publishing high-quality systematic review products, including protocols, rapid reviews, updates, and methodological research, with a commitment to disseminating results regardless of their outcome, thereby promoting scientific integrity and exhaustiveness. Finally, PLOS ONE presents itself as a community of journals aiming to accelerate scientific progress, ensure the wide dissemination of knowledge, and facilitate its availability to all of society.

Highlighted Articles in Open Science

The most cited article among the retrieved records is the one published by Price-Whelan et al. (2018) in The Astronomical Journal; it is an open-access document licensed under CC BY 3.0. The importance of this record lies in proposing how the transition toward this common-good model is materialized through open-source infrastructure and collaborative development projects such as Astropy and PsychoPy. The Astropy Project exemplifies how the creation of an open software and "open development" ecosystem—where anyone can propose changes and participate in governance—fosters tool reuse and interoperability, democratizing access to technical capabilities that previously depended on large institutions. Meanwhile, the philosophy behind PsychoPy reinforces that open science requires not only the availability of documents but also the accessibility of research tools, allowing even those without advanced programming training to conduct precise and replicable studies.

The second most cited document, with a total of 3,703 citations, was published in the journal Behavior Research Methods. The article emphasizes that open-source tools are fundamental to ensuring that scientific communication acts as a common good accessible to all. It exemplifies this through the PsychoPy2 platform, which is open-source and democratizes the creation of complex experiments, allowing even researchers without advanced technical training and undergraduate students to participate fully in the production of high-precision knowledge. A critical contribution toward reproducibility and open science is the functionality that allows researchers to specify and "freeze" the exact version of the software used in their studies, ensuring the experiment can be replicated with total fidelity in the future, regardless of subsequent system updates (Peirce et al., 2019). Table 4 presents a list of the most cited articles.

One of the most notable articles in the list provided in Table 4 is the document with the highest citation count for the year 2018, published in the journal PeerJ. This is an open-access article licensed under Creative Commons Attribution 4.0 International (CC BY 4.0). The study analyzes the trends of over 100,000 documents published in an Open Access (OA) state through 2015. It concludes that approximately 28% of the literature reviewed up to that date was published under some category of open access. Furthermore, the authors project a growing trend toward this dissemination modality, evidenced by the reported annual percentages. A particularly striking finding reported by the authors is the high citation rate of OA articles, which receive 18% more citations than the average (Piwowar et al., 2018).

Table 4.
Most Cited Articles Related to Open Science Studies, by Total Citations and Citations per Year

Author	Average citations per year	Total number of citations	DOI
Price-Whelan et al., 2018	694,44	6250	10.3847/1538-3881/aabc4f
Peirce et al., 2019	462,88	3703	10.3758/s13428-018-01193-y
Nosek, 2018	138,67	1248	10.1073/pnas.1708274114
Mix, 2001	33,15	862	10.1016/S0277-3791(00)00145-1
Piwowar, 2018	92,33	831	10.7717/peerj.4375
Mueller, 2014	62,69	815	10.1016/j.jneumeth.2013.10.024
Brynn Hibbert, 2016	73,55	809	10.1039/c6cc03888c
Simons, 2017	80,70	807	10.1177/1745691617708630
Himanen, 2019	82,88	663	10.1002/advs.201900808
Nooner, 2012	41,87	628	10.3389/fnins.2012.00152

Bradford's Law Indicator

Bradford's Law is a bibliometric indicator used to identify the most productive sources on a specific subject (Parra-González & Segura-Robles, 2019). Consequently, it is possible to assume that these sources are the most likely to be cited in new scientific articles addressing the same topic.

Figure 2 illustrates the distribution of journals according to Bradford zones. These zones identify the sources containing the highest volume of information, with Zone 1 (Core Zone) concentrating the highest density of relevant literature. The results reveal that only 3% of the retrieved journals are located within the Core Zone. This suggests that research on open science is disseminated across a wide variety of publications and is not concentrated within a limited number of high-impact journals.

Zone 3 is traditionally known as the dispersed zone; it includes sources that, while having published on the central theme, are less closely related, or whose importance has decreased over time. For the data analyzed, this zone represents 78% of the sources. Regarding open science, it can be noted that a large number of journals have published articles related to the topic; however, their impact or relevance is not as significant, suggesting that these are journals with a low volume of related production.

Network Approach from a Semantic Perspective

Regarding the relationships between the main descriptors, Figure 3 shows a mapping of the primary concepts through the use of network analysis, selecting author keywords as the grouping category. The most prominent terms are open science, open access, open data, scholarly communication, and research data. Each term is presented as a node, while the lines connecting them represent their mutual relationships.

The term co-occurrence analysis reveals a conceptual network where Open Science is positioned as the central epistemological core (blue cluster), establishing an intrinsic relationship with transparency, reproducibility, and data management (Open Data). This network configuration suggests a paradigm shift in the dissemination of scientific knowledge, where validity no longer resides solely in the final product (the published article) but in the openness and verifiability of intermediate processes. Furthermore, the willingness to open data is increasingly regarded as a societal common good, aligning with the perspectives of authors such as Peirce et al. (2019), Osorio-Sanabria et al. (2020), and Unzurrunzaga et al. (2024).

The link with the scholarly communication and scientific publishing cluster (highlighted in green in Figure 3) evidences the theoretical distance between the democratization of access and economic sustainability models, represented by Article Processing Charges (APCs). Ultimately, the infrastructure represented by academic libraries and new peer-review models (green) provides the necessary institutional support so that the openness of science is not merely an ethical ideal, but a technical requirement for innovation and large-scale knowledge synthesis.

The terms can be analyzed from four distinct perspectives: specialized, motor, emerging or declining, and basic themes. In Figure 4, it is observed that the basic themes of the research remain those traditionally associated with the subject: "open science," "open access," and "reproducibility." These constitute general categories that are fundamental or essential to the content of the document set.

The diagram categorizes the structure of the field by examining the relationship between centrality (relevance) and density (development), identifying four fundamental thematic typologies. In the motor themes quadrant, Open Science, Open Access, and reproducibility are positioned, consolidating themselves as the dynamic and most developed core articulating contemporary research. In contrast, basic and transversal themes, represented by systematic reviews, meta-analysis, and the COVID-19 context, show high relevance but lower internal development. Meanwhile, niche themes, led by public health, mental health, and scoping reviews, demonstrate high technical specialization and internal cohesion, although their influence remains distant from the network's central axis.

Network Approach from a Social Perspective

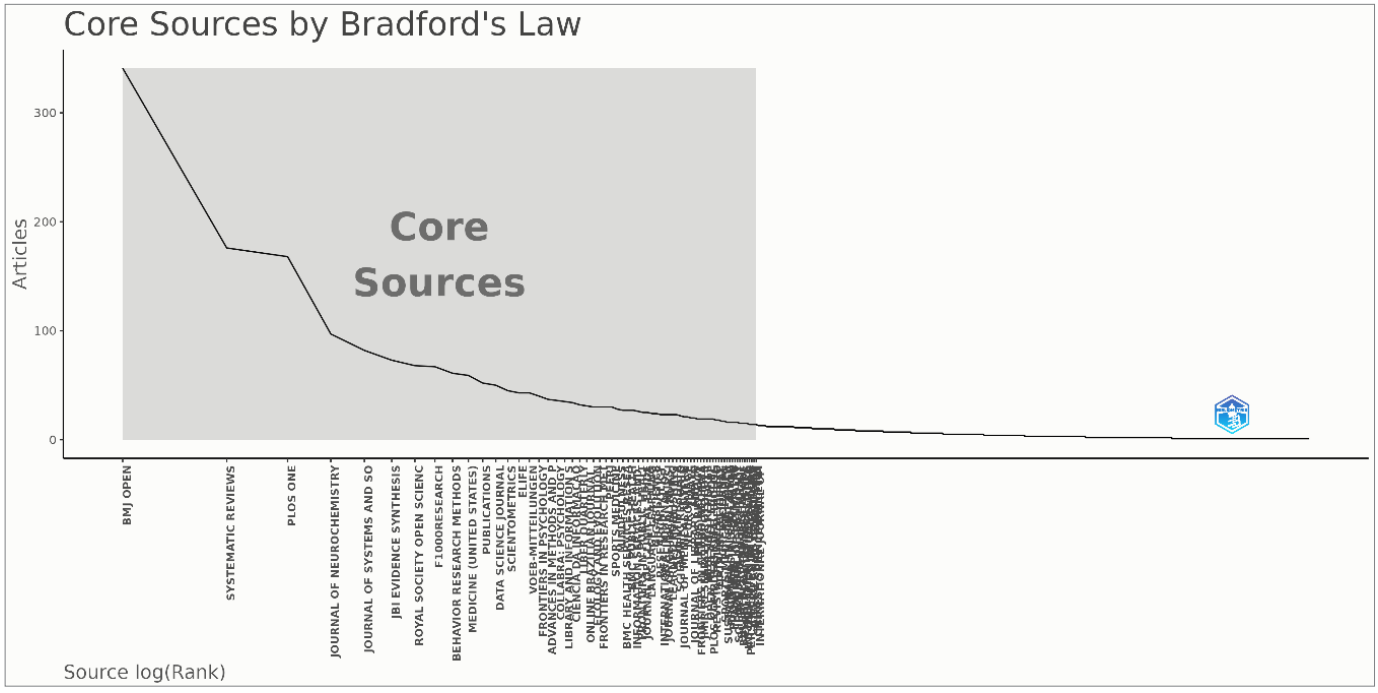


Figure 2.
Number of Journals according to Bradford Zones

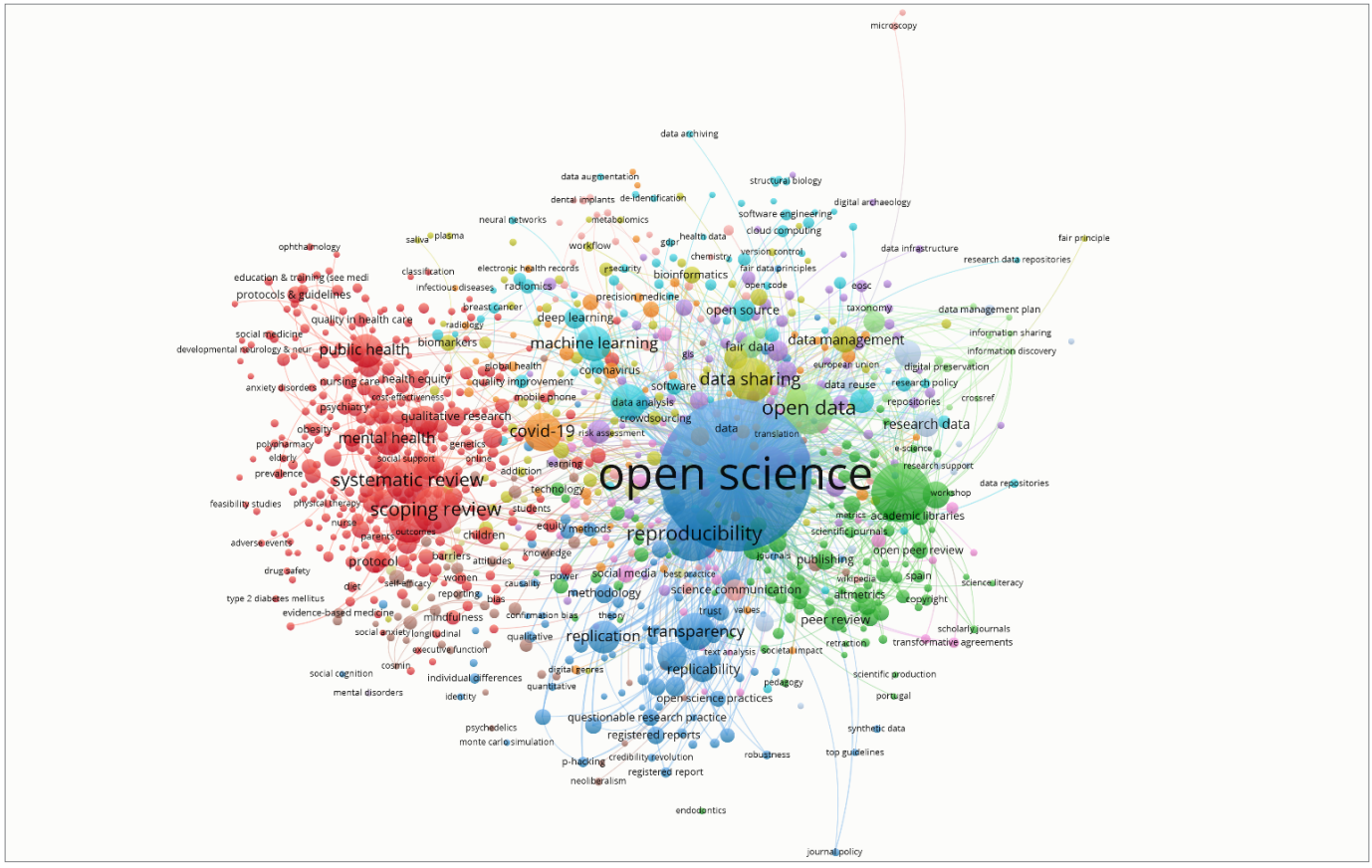


Figure 3.
Relationship map between terms based on author keywords

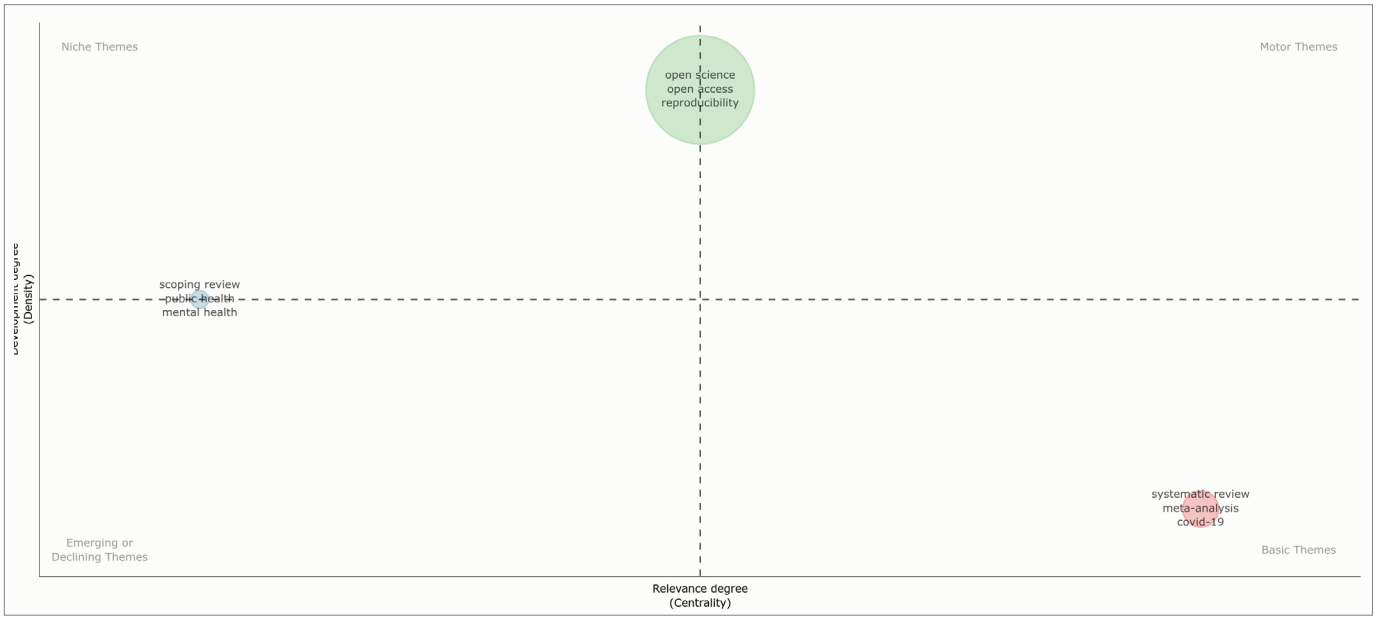


Figure 4.
Distribution of author keywords according to their degree of relevance and development

An analysis of international collaborations reveals a robust connection primarily among English-speaking countries. Interestingly, there is a strong relationship between Australia and both European and North American nations. The primary connection occurs between North America and Europe, which aligns with the concentration of sources and the predominance of English as the primary language of scientific communication.

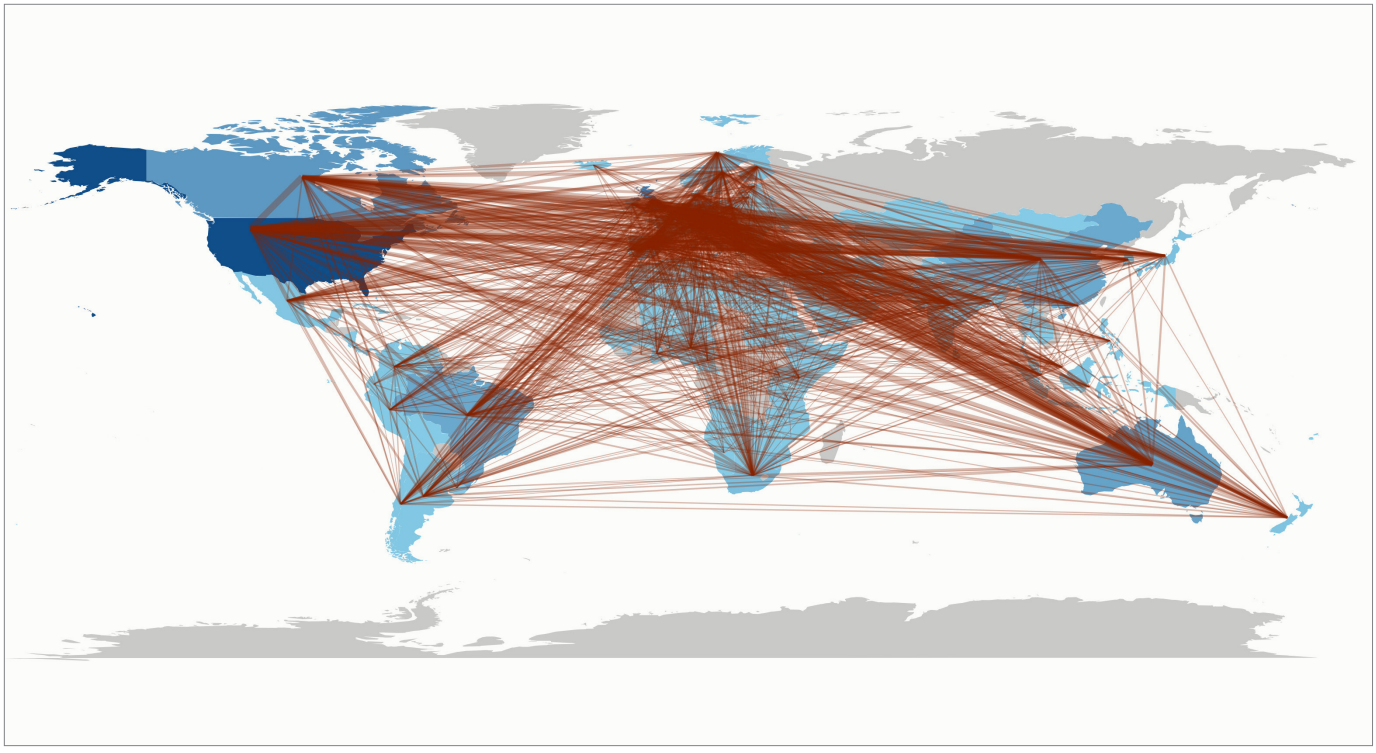


Figure 5.
Country Collaboration Network in Open Science Publications

Furthermore, the cartography highlights the growing prominence of East Asia, particularly China. The observed collaboration patterns suggest that international relations are mediated by both geopolitical and institutional factors, where nations with greater funding capacity and research tradition act as central hubs fostering knowledge exchange. As previously mentioned, a dense cooperation network is evident among Northern Hemisphere countries, likely driven by cultural proximity, the adoption of English as a lingua franca, and the existence of shared regulatory frameworks for Open Science. Nevertheless, the map also reveals the configuration of significant bridges toward the Southern Hemisphere, highlighting collaboration poles in Australia, Brazil, and South Africa. This points to a process of internationalization in science that, while still presenting asymmetries in connection density, seeks to integrate regional research agendas into the resolution of global challenges.

Conclusions

This study conducted a bibliometric evaluation of scientific production on Open Science, a concept encompassing principles and practices aimed at improving the quality, rigor, and reproducibility of scientific research. The results demonstrate a significant increase in the production of articles on open science in recent years, suggesting growing interest and heightened awareness within the scientific community. This phenomenon reflects a trend toward the valuation and adoption of more transparent and collaborative scientific practices.

Additionally, the primary research themes within the field of open science have been identified, with open access, open data, reproducibility, and transparency being the most frequent topics. This indicates that the scientific community is focusing its efforts on the fundamental aspects of open science that promote the accessibility and availability of scientific results and research data, as well as the dissemination and exchange of knowledge among the various stakeholders involved in the scientific system.

It was also observed that international collaboration is a hallmark of open science research, with robust cooperation between European and North American countries, underscoring the global nature and importance of cooperation in advancing open science worldwide. However, significant achievements in regionalizing these policies and integrating countries from across the globe into the open science philosophy are beginning to emerge.

This bibliometric analysis provides insight into the trends and patterns of scientific production related to open science. By evidencing the surge in publications, it reveals how the practice of science has evolved, highlighting the crucial role of open science in promoting transparency, collaboration, and open access to results and data. Moreover, it provides a comprehensive overview of research in the field, identifying the most relevant themes and the focus of current studies. This not only reflects the current state of the field but also points toward potential future directions for research and development.

Finally, the implementation of open science policies and the FAIR principles (Findable, Accessible, Interoperable, and Reusable) represent two of the primary future challenges in the research domain. Open science fosters transparency, collaboration, and free access to research findings, which not only accelerates the advancement of knowledge but also promotes greater trust in the scientific community. For their part, FAIR data ensures that datasets are easily locatable, accessible, interoperable, and reusable—essential factors for maximizing data value and leveraging their full potential in future investigations. The combination of open science policies and FAIR data will not only revolutionize the way research is conducted but also enable more efficient and effective responses to global challenges.

Authors contributions

Adrián Murillo-González: conceptualization, analysis, methodology, curation, initial writing, final writing.
Roberto Calderón-Chacón: analysis, methodology, curation, validation, final writing.

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