ORIGINAL RESEARCH

A 10-year Scientometric Analysis of the Characteristics of the Worldwide Publication on the Toxic Effects of Fluoride

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Abstract

Aim: To perform a 10-year scientometric analysis of the characteristics of the worldwide publication on the toxic effects of fluoride.

Materials and methods: A bibliometric study of the worldwide scientific production on the toxic effects of fluoride during the years 2011–2020 was performed. All metadata from the Scopus database were evaluated. These were then exported to SciVal (Elsevier) for analysis of quantity, collaboration, and impact indicators.

Results: We found that the "Biological Trace Element Research" was the most productive journal with 22 published manuscripts and that the most productive universities on the systemic toxic effects of fluoride on the body were Shanxi Agricultural University, Guizhou Medical University, and Huazhong University of Science and Technology with 31, 11, and 10 manuscripts, respectively. In addition, it was found that most of the world scientific production on the toxic effects of fluoride was published in Q1 level journals (top 25%).

Conclusion: Finally, it was concluded that most of the total production on this topic was published in high-impact Q1 journals, with China being the leading country in terms of number and impact of publications. Finally, there was evidence of collaboration between the United States, China, and India, being the countries that led in co-authorship by country.

Clinical significance: This research is of clinical importance as it allows the identification of the most productive institutions, authors, and countries in this field. In this way, strategic alliances can be established to enhance the development of research.

Keywords: Fluoride, Scientometrics, Toxicity.

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Introduction

Since the last decades, several efforts have been made at the preclinical and clinical levels to understand the role of fluoride in the biological system.[1] Several studies have focused on the molecular mechanisms related with fluoride toxicity.[2,3] It is important to recognize that community water fluoridation has become a widespread intervention and recognized in some cases as a pillar of modern public health, as a preventive agent for dental caries.[4]

This review shows that the toxic effects of fluoride increase the prevalence of skeletal fluorosis and intellectual disability.[5–7] These findings are supported by experimental neurotoxicity and toxicokinetic studies that fluoride passes into the brain,[4] causing oxidative stress[3,8–11] organelle damage and apoptosis in single cells,[5] regulation of intracellular redox homeostasis, mitochondrial damage, endoplasmic reticulum stress, altered gene expression,[3] and possible physiological and toxicological consequences of fluoride in the pulmonary system.[1,10]

The toxicology and epidemiology of fluoride documents frequent nonspecific chronic gastrointestinal symptoms and gut inflammation,[12,13] multiple changes in the developing enamel known as enamel fluorosis,[2] and the possibility of future disease because of early fluoride exposure.[9]

Scientometrics consists of a quantitative analysis of scientific publications in each field of knowledge. With this analysis, it is possible to identify through different bibliometric indicators that allow visualizing the status of scientific publications. In addition, the most novel aspect of bibliometric studies is that they allow to identify the characteristics of scientific production to identify the most productive authors, institutions, countries, etc. in a given field of knowledge.[14–16]

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For dentistry worldwide, it is relevant to know the status of worldwide research on the toxic effects of fluoride in the body. In this way, we can be prepared to make clinical decisions in the application of fluoride according to the needs of the patient.

Therefore, the objective of this study was to perform a 10-year scientometric analysis of the characteristics of the worldwide publication on the toxic effects of fluoride.

Materials and Methods

Study Design

A scientometric study of the worldwide scientific production on the toxic effects of fluoride during the years 2011–2020 was carried out. All metadata were extracted from the Scopus database. Because

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this study analyzed all manuscripts published on the subject it was not necessary to perform a sample size calculation. Subsequently, all metadata were exported to SciVal (Elsevier) for analysis of scientometric indicators (collaboration, impact, and production).

Search Strategy

The search strategy, analyses, and interpretation were elaborated by two researchers specialized in bibliometrics. Metadata extraction was carried out using the keywords "Fluorosis" and all its variants that appear in the Emtree terms (https://www.embase.com/#emtreeSearch/default) y MeSH x(https://www.ncbi.nlm.nih.gov/mesh/) de Embase y Pubmed respectivamente. Se utilizo los operadores booleanos "AND" y OR" y se estableció la siguiente estrategia de búsqueda: TITLE-ABS-KEY ("Drug-related Side Effects and Adverse Reactions" OR "Drug-related Side Effects and Adverse Reaction" OR "Drug Related Side Effects and Adverse Reaction" OR "Drug Side Effect*" OR "Effects Drug Side" OR "Side Effect* Drug*" OR "Adverse Drug Reaction*" OR "Drug Reaction* Adverse" OR "Reactions Adverse Drug" OR "Adverse Drug Event*" OR "Drug EventS Adverse" OR "Side Effects of Drugs" OR "Drug Toxicity" OR "Toxicity Drug" OR "Drug Toxicities" OR "Toxicities Drug" OR "Toxemia" OR "Fluoride Toxicity" OR "Toxicity of fluoride" OR "Fluoride exposure" OR "Toxicity effect*" OR "Fluoride effect*") AND TITLE-ABS-KEY ("Fluoride binding" OR "Fluoride content" OR "Fluoride derivative" OR "Fluoride uptake" OR "Fluorides hydrofluoride" OR "Karitane fluoride tablets" OR "Calcium Fluoride" OR "Fluorides Topical" OR "Sodium Fluoride" OR "Acidulated Phosphate Fluoride" OR "Sulfur Hexafluoride" OR "Tin Fluorides")

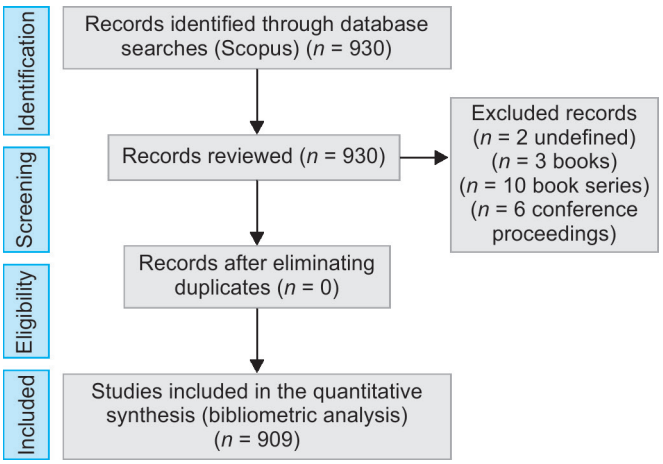
Data Collection

The extraction was performed on 16 January 2022. A total of 930 documents were collected from Scopus corresponding to the years, which were exported in .csv format to SciVal software (Elsevier). We identified 909 original articles, 2 undefined, 6 conference proceeding, 3 book, and 5 book series (Flowchart 1). The database included some variables such as: year, author, journal, h-index, CiteScore, and Field-weighted Citation Impact (FWCI).

Scientometric Analysis

The scientometric analysis was performed with Scival software. The impact indicators were evaluated using the SciteScore of each of the journals evaluated and the number of citations per publication and SCImago Journal Rank (SJR) and FWCI. The production indicators were evaluated according to the number of publications per journal, per author, and per country. Finally, the collaboration indicators were evaluated by co-citation and co-occurrence using VOSviewer software 1.6.18 (Leiden University).

Flowchart 1: Flow diagram



Results

Top-10 Most Productive Scientific Journals on Systemic Toxic Effects of Fluoride

Biological Trace Element Research was found to be the most productive journal with 22 published manuscripts, followed by *Chemosphere and Fluoride – Quarterly Reports* with 18 and 15 manuscripts, respectively. However, *Ecotoxicology and Environmental Safety* had the highest average number of citations per publication (46.8 citations). On the other hand, *Environmental Pollution* had the highest source-normalized impact per paper (SNIP) value with an average of 1.8, which evidences its high impact in this field of knowledge. Finally, in relation to SJR, it was found that *Environmental Pollution* also had the highest value (2.1), indicating that it was the journal that had the highest number of citations received in weighting with the prestige of the journal (Table 1).

Top-10 Most Productive Universities on the Systemic Toxic Effects of Fluoride

The most productive universities on the systemic toxic effects of fluoride on the body were Shanxi Agricultural University,

Table 1: Top-10 most productive scientific journals on systemic toxic effects of fluoride

Scopus source	*Publications*	*Citations*	*Citations per Publication*	*SNIP*	*CiteScore 2020*	*SJR*
Biological Trace Element Research	22	221	10	1.1	5	0.6
Chemosphere	18	254	14.1	1.7	10.1	1.6
Fluoride – Quarterly Reports	15	131	8.7	0.4	1.8	0.2
Chinese Journal of Endemiology	7	2	0.3	0.3	1.2	0.2
Environmental Pollution	6	98	16.3	1.8	10.8	2.1
Environmental Science and Pollution Research	6	82	13.7	1.1	5.5	0.8
Archives of Toxicology	6	181	30.2	1.4	9.6	1.2
Ecotoxicology and Environmental Safety	6	281	46.8	1.5	8.2	1.3
Environmental Toxicology	6	112	18.7	0.9	6.6	0.8
Food and Chemical Toxicology	6	143	23.8	1.5	8.6	0.9

Guizhou Medical University and Huazhong University of Science and Technology with 31, 11, and 10 manuscripts, respectively. However, in relation to citations per publication, Zhengzhou University accumulated the highest average with 18.5 citations. Finally, this university also presented the highest normalized indicator considering the area of knowledge and year of publication FWCI = 1.97 (Table 2).

Top-10 Most Productive Authors on the Systemic Toxic Effects of Fluoride

Jundong Wang was the author whose scientific publications had the highest impact with an h-index of 30, followed by Aiguo Wang with h-index of 23 and Jundong Wang with h-index of 21. However, the most productive author was Jundong Wang with 16 published manuscripts. However, author Tao Xia, although he had only 21 published manuscripts had the highest average number of citations per publication with a mean 28.9 citations (Table 3).

Impact of Global Scientific Publications on the Systemic Toxic Effects of Fluoride

It was found that most of the world's scientific production on the toxic effects of fluoride was published in Q1 level journals (top 25%), while only 41 papers were published in lower impact Q4 journals (top 76–100%). On the other hand, it was identified, that the most productive year was 2014 with 40 manuscripts, followed by 2020 with 39 manuscripts (Table 4).

Co-authorship by Country

With a minimum of two co-authors per country, it was identified that there were three countries of major clusters (United States, India, and China), which condensed the highest co-authorship strength per country. There was a strong interaction between these three clusters; however, the other surrounding countries had no evident interaction (Fig. 1).

Citation by Journal

With a minimum of two citations per paper, the journals *Fluoride*, *Environmental Science and Pollution Research*; and *Journal of Dental Research* were found to have the highest citation strength. There was a strong interaction between these three clusters and the rest of the journals. However, there was only one journal that did not show interaction (*Journal of Indian Society of Periodontology*) (Fig. 2).

Co-occurrence by Index Keywords

With a minimum of 15 occurrences per index keyword, 3,762 words were represented in four major clusters. In the red cluster, the keyword that condensed the highest co-occurrence strength

Table 2: Top-10 most productive universities on the systemic toxic effects of fluoride

Institution	*Country/ Region*	*Scholarly output*	*Citations*	*Citations per Publication*	*Field-weighted citation Impact*
Shanxi Agricultural University	China	31	445	14.4	0.9
Guizhou Medical University	China	11	157	14.3	0.8
Huazhong University of Science and Technology	China	10	280	28	1.8
Jilin University	China	7	91	13	1.0
Bharathiar University	India	6	65	10.8	0.6
Harbin Medical University	China	5	22	4.4	0.6
Universidade de São Paulo	Brazil	5	66	13.2	0.7
Zhejiang University	China	4	35	8.8	1.1
Zhengzhou University	China	4	74	18.5	1.9
King Saud University	Saudi Arabia	4	38	9.5	0.5

Table 3: Top-10 most productive authors on the systemic toxic effects of fluoride

Name	*h-index*	*Scholarly output*	*Most recent publication*	*Citations*	*Citations per publication*	*Field-weighted citation impact*
Jundong Wang	30	10	2020	174	17.4	0.8
Aiguo Wang	23	9	2020	242	26.9	1.9
Jundong Wang	21	16	2020	237	14.8	1.0
Tao Xia	21	8	2020	231	28.9	1.9
Ruiyan Niu	20	15	2020	259	17.3	0.9
Zilong Sun	20	15	2020	275	18.3	0.9
Shun Zhang	18	8	2020	213	26.6	2.0
Qiang Niu	18	6	2020	152	25.3	2.1
Jianhai Zhang	16	8	2020	121	15.1	0.6
Yuliang Zhang	7	6	2018	90	15	1.0

Table 4: Impact of global scientific publications on the systemic toxic effects of fluoride

CiteScore quartile	*2011*	*2012*	*2013*	*2014*	*2015*	*2016*	*2017*	*2018*	*2019*	*2020*	*Overall*
Q1 (top 25%)	9	5	13	17	9	13	15	13	18	23	135
Q2 (top 26–50%)	6	9	6	15	9	14	7	14	9	9	98
Q3 (top 51–75%)	2	2	9	2	6	2	5	5	3	4	40
Q4 (top 76–100%)	2	7	3	6	7	4	4	3	2	3	41
Total	19	23	31	40	31	33	31	35	32	39	314

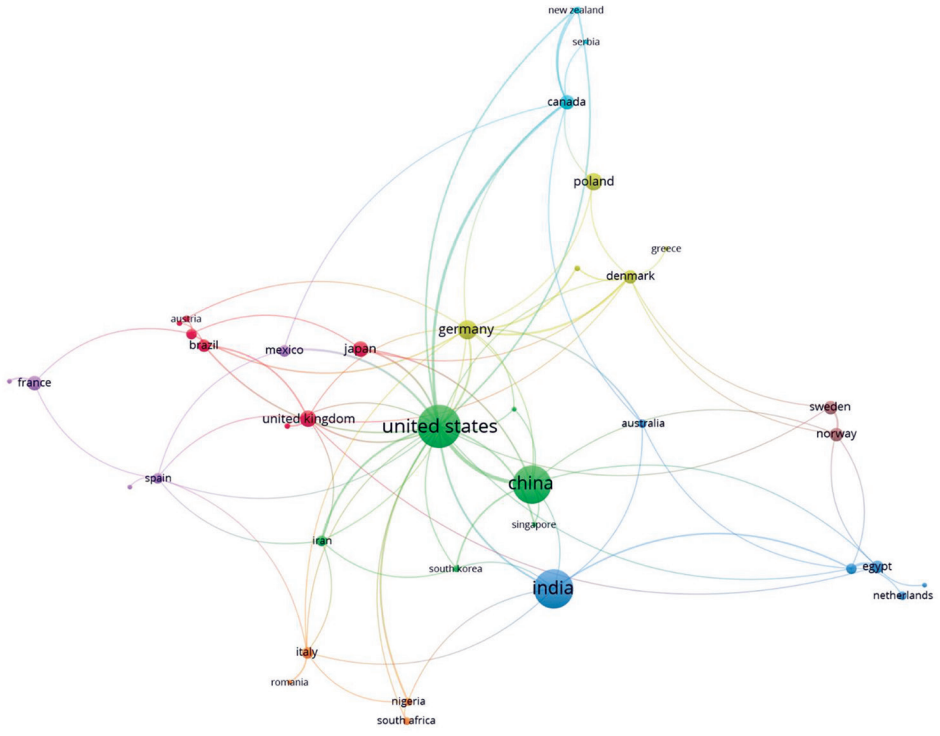


Fig. 1: Co-authorship by country

was sodium fluoride, in the green cluster the most representative was the word fluoride, in the blue cluster it was the word fluoride sodium, while in the yellow cluster it was animal experiment (Fig. 3).

Discussion

Exposure to high concentrations of fluoride, often exceeding 100 ppm, could give rise to a wide range of toxicity phenotypes, so there has recently been renewed concern in the public sector to determine whether fluoride is a safe source at high exposure levels.[5] Neurotoxicity and other adverse effects appeared to be dose dependent, and tentative reference dose calculations however suggest the possibility that accepted safe concentrations in drinking water may be below fluoride concentrations.[4]

The various opinions regarding the health effects of fluoride at appropriate doses appear to be in controversial positions.[4,5,9] The publications on this subject are approached for its various effects, both adverse and beneficial, which makes it necessary to understand the global interest in relation to fluoride and future research trends, with productivity indicators, so the scientometric analysis was a relevant strategy that allowed us to identify the main contributing countries and institutions authors and citations that lead in addressing this issue. We identified 909 original articles, 2 undefined, 6 conference proceeding, 3 book, and 5 book series.

The interest of researchers on the subject began in 1803 and has intensified since 1965.[14–16] The various opinions regarding the effects of fluoride on health at accepted doses seem to be in controversial positions,[4,5,9] with scientific publications of adverse as well as beneficial effects in the field of oral health, an argument that makes it necessary to understand the worldwide interest in providing answers to the implications of fluoride on health and future research trends by means of the bibliometric analysis strategy.

Although the journal *Biological Trace Element Research* has the most publications, followed by *Chemosphere* and *Fluoride – Quarterly Reports* it is evident that research in recent years has been increasing, this may be because the topic continues to be of interest to researchers, who can turn to the highest impact journals, universities, authors, and co-authors most cited and thus conjugate teams or achieve timely linkages.

The clinical implications are that the scientometric analysis in this study revealed production indicators such as impact factor, number of publications per journal, per author, and per country.[17,18]

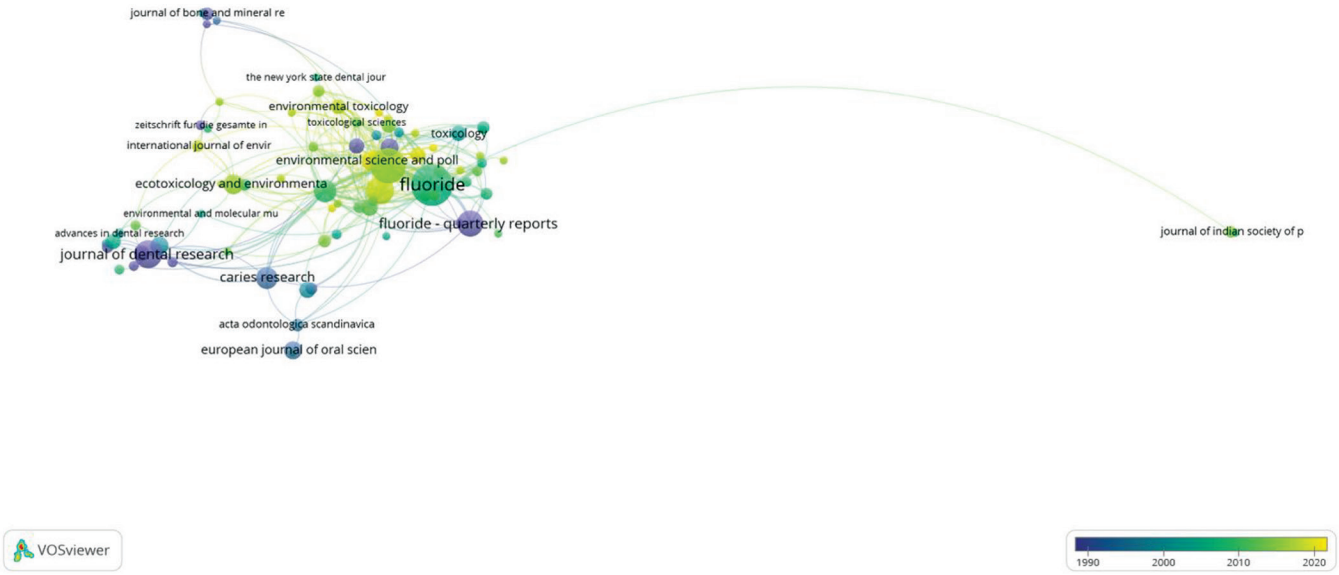


Fig. 2: Citation by journal

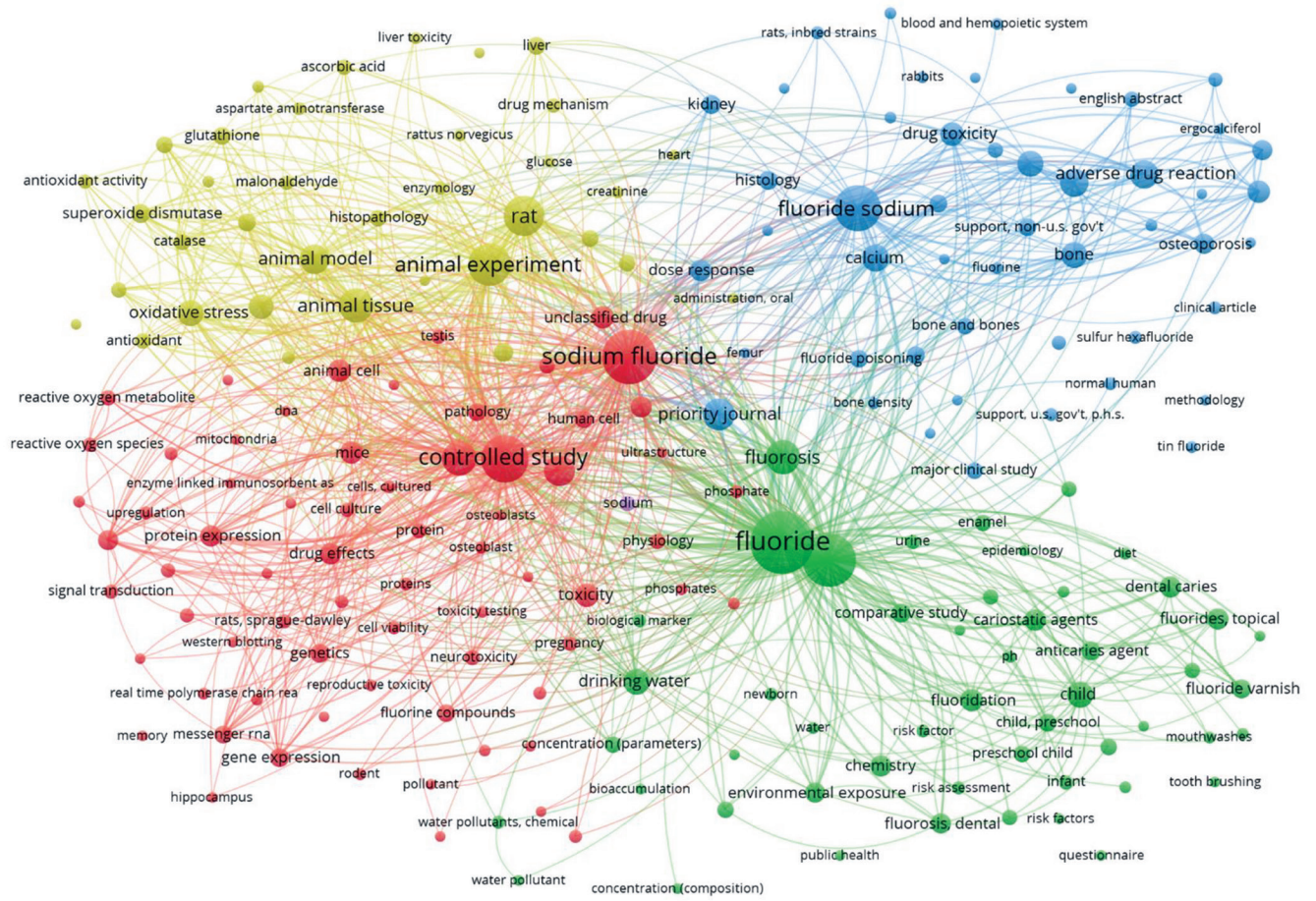


Fig. 3: Co-occurrence by index keywords

Finally, the indicators of collaboration through co-citation and co-occurrence; the subject is analyzed by the quantity of the indicators, which helps in the interpretation and analysis of quantitative published works.

The principal limitation is in relation to quality, this is limited because giving the same value to all the articles does not highlight their differential value in terms of quality indicator, also the equal influence of citations in the totality of the works in a sample and

the totality of the publications which do not reflect all the scientific activity of a given context must be considered. Nor is it limited to possible self-citations, which should not be for example, according to the study by Sweileh et al.,[19] there has been a steady increase in the number of publications on fluoride-related diseases in water. However, the increase in publications in Asian countries was not associated with a high percentage of international collaboration. On the other hand, Zampetti et al.[20] mentioned that bibliometrically fluoride has a long history in clinical dental practice, although further research is needed to understand the mechanism of action of this inorganic anion underestimated because of the possibility that they may have been motivated by authors seeking visibility, nor has it been possible to analyze the papers or conferences on the subject, the qualitative analysis needs to be strengthened.

Conclusion

Within the limitations of this bibliometric study, it was concluded that most of the total production on this topic was published in high impact Q1 journals, with China being the country that led the number and impact of publications. Finally, there was evidence of collaboration between the United States, China, and India, being the countries that led in co-authorship by country.

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