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Original Article

A bibliometric analysis of epidemiological studies investigating the relationship between community fluoridated water consumption and human cancers

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ABSTRACT

Objectives: The objective of the study was to do a bibliometric analysis of epidemiological studies investigating the relationship between community fluoridated water consumption and human cancer occurrence.

Material and Methods: A systematic PubMed and SCOPUS database search was done to collect articles of epidemiological studies investigating the relationship between community fluoridated water intake and human cancer occurrence. All relevant articles published in English, published from the year 2000 till November 23, 2021, and with accessible full text were obtained. Bibliometric data were obtained from each of these articles and analyzed using the Microsoft Office Excel 2021 (Microsoft Corporation, Washington DC, USA) software.

Results: A total of 12 articles were obtained for this study. These articles investigated different cancer sites. The least investigated cancer sites were the eye (n = 1 article), lip (n = 1 article), and skin (n = 1 article), while the most investigated site was the bone (n = 8 articles). A total of 38 institutions sourced these epidemiological articles. The three institutions with the highest number of authors of these study articles were Harvard University (n = 6 authors), Moi University (n = 5 authors), and Newcastle University (n = 5 authors). Less than half (5/12) of these articles were funded. The UK was the country with the highest number of funding organizations on the research topic area.

Conclusion: The volume of research investigating the relationship between community fluoridated water intake and cancer occurrence is very low, with zero output from several countries. Globally, the USA is the hottest spot for research on this topic area.

Keywords: Fluoride, Water, Consumption, Cancer, Bibliometric analysis

INTRODUCTION

Dental caries can be defined as a multifactorial, biofilm-mediated, sugar-driven, and dynamic disease that is characterized by the localized destruction of the mineralized structures of the tooth.[1] According to the World Health Organization, dental caries is the most common non-communicable diseases globally, affecting over 2 billion people.[2] If dental caries is not treated early, it can progress into serious complications – such as pulpitis, pulpal necrosis, odontogenic abscess, sinusitis, and others –which can significantly reduce the quality of life of the person affected.[2-4] The economic implication of dental caries is so enormous;[2] for example, the cost of treatment of dental caries consumes about 5–10% of the health-care budgets of industrialized countries.[2]

As part of dental public health protection strategy, community water fluoridation has been used to significantly reduce the burden of dental caries across populations.[5,6] The history of water fluoridation can be traced to Colorado Springs, Colorado, in 1901, when Dr. Frederick McKay – a fresh dental graduate – discovered "mysterious" brown stains in the teeth and decided to investigate the cause.[7] In his research journey, Dr. McKay met Dr. G.V. Black – a renowned American dentist – in 1909 who agreed to collaborate with him in tracing the root cause of the brown teeth stains among Colorado people.[8] Together, they discovered that those teeth with "mysterious" brown stains were highly resistant to dental caries.[8] Thereafter, there arose a growing interest, in the scientific communities, concerning the phenomenon discovered by McKay and Black.[8] Eventually, in 1931, McKay discovered that those brown dental stains – dental fluorosis – occurred due to high fluoride levels in drinking water.[8] In the late 1930s, Dr. H. Trendley Dean – a researcher at the National Institute of Health (USA) – and his staffers discovered that a fluoride concentration of 1.0 part per million rarely cause dental fluorosis.[8] By 1945 – the year when the World War II ended – the first trial of the effectiveness of community water fluoridation programs in dental caries prevention began in Grand Rapids, Michigan.[8] The Grand Rapids water fluoridation project took 15 years, and from the project, it was proven that the fluoridated water consumption reduced the caries rate in children living in Grand Rapids by 60%.[8]

Since the Grand Rapids discovery, may cities in the US, as well as several other places in the world, have incorporated community water fluoridation into their dental public health programs.[8]

In 1999, the Center of Disease Control and Prevention regarded community water fluoridation as one of the 10 greatest achievements in public health in the 20th century due to the huge successes, it has recorded in the reduction of the global disease burden of dental caries.[6]

However, there have been a lot of controversies and debates regarding the safety profile of fluoridated water.[9] For example, there is an ongoing debate in the scientific community about the role of fluoridated water in cancer development in humans; and different epidemiological studies had been conducted to establish or refute this relationship.[10-22] While some studies reported no relationship between fluoridated water consumption and cancer occurrence, others reported a direct or an inverse relationship between them.[10-22]

Despite the significant quantity of epidemiological studies that had investigated the relationships between community water fluoridation and human cancers, no known study has the quantity of the existing epidemiological evidence. Therefore, there is a need for a bibliometric analysis of these studies. A bibliometric analysis is a kind of research which seeks to statistically measure the impact of research publications and the researchers or organizations investigating a topic area of interest.[23-29] Through bibliometric analysis, research hotspots and the trend of productivity on a research topic area can be evaluated.[30]

Aim

This study aims to do a bibliometric analysis of epidemiological studies investigating the relationship between fluoridated water consumption and cancer occurrence in humans.

MATERIAL AND METHODS

Study type

This study was a bibliometric analysis of epidemiological research articles investigating the associations between community fluoridated water intake and cancer occurrence.

Search strategy

Between November 23, 2021, and November 30, 2021, an online filtered electronic search of English literature published from the year 2000 to October 2021, on community fluoridated water intake and cancer was conducted. The search was done on the PubMed and SCOPUS databases using these search terms: "Fluoride" and "cancer" [Table 1].

Article selection

The database search yielded 1299 publications (PubMed = 308 and SCOPUS = 991). All the titles and abstracts for articles of the 1299 publications were screened for relevance based on the selection criteria [Table 2], of which 1277 (PubMed = 293 and SCOPUS = 986) were excluded from the study, leaving 20 articles (PubMed = 15 and SCOPUS = 5) for full-text screening. After full-text screening, only 15 (PubMed = 12 and SCOPUS = 3) epidemiological studies were obtained. All the included articles obtained from SCOPUS database (n = 3) were duplicates of 12 included articles obtained from

Table 1: Online databases with search strategies.

Database	Search strategy	Hits
PubMed	(Fluoride[Title/Abstract]) AND (Cancer[Title/Abstract]) *Filters – from 2000 to October 2021; journal article; English*	308
SCOPUS	(TITLE-ABS-KEY (fluoride) AND TITLE-ABS-KEY (cancer)) AND PUBYEAR>1999 AND PUBYEAR<2022 AND (LIMIT-TO (OA, "all")) AND (LIMIT-TO (DOCTYPE, "ar")) AND (LIMIT-TO (LANGUAGE, "English")) AND (LIMIT-TO (SRCTYPE, "j"))	991

PubMed. After deduplication, only 12 articles were included in this study for analysis.

Data extraction

Bibliometric data were obtained manually by two reviewers (KKK and TOO) from the included articles using a data extraction sheet developed by the authors using the information obtained from existing bibliometric analysis.[23-30] This sheet obtained information concerning the following:

- Authors names
- Country and institutional affiliation of the authors
- Total publications of the authors, institutions, and countries
- Studied cancer types
- Funding sources.

Table 2: Criteria for the selection of included articles.

Inclusion criteria	Exclusion criteria
Peer-reviewed original articles	Thesis, conference papers, editorials, letters, commentaries, review articles, books, book chapters, etc.
Articles published within the past 20.83 years (2000–2021 [October])	Articles published from 1999 downward
Articles written in English	Articles written in German, French, Spanish, Chinese, and other non-English languages
Epidemiological studies that were primarily written on cancer occurrence and community fluoridated water	Articles that focused on other fluoride sources such as dentifrice (toothpaste), mouth wash, dental varnishes, and other fluoride-containing solutions used in patient care.
Articles with accessible full texts	Articles whose full texts are not accessible

Data analysis

Extracted data were analyzed using the Microsoft Office Excel 2021 (Microsoft Corporation, Washington DC, USA) software. Descriptive statistics were used to describe the findings obtained. Results were presented in texts, tables, and charts.

RESULTS

In the SCOPUS and PubMed databases, only 12 epidemiological articles on the topic area of interest (i.e., epidemiological studies investigating the relationship between community fluoridated water intake and cancer occurrence) were written in English, with accessible full text, and published between 2000 and November 23, 2021. These articles were authored by a total of 70 authors [Appendix 1].

Trend analysis

Figure 1 shows the trend analysis of the included epidemiological articles by year. Not all years had an article published on the research topic area. The years with the highest outputs were 2014 ($n = 2$) and 2019 ($n = 2$).

Authorship by country

A total of 11 countries sourced these articles. The USA ($n = 27$ authors), the UK ($n = 12$ authors), and Kenya ($n = 9$ authors) were the top three countries with the highest number of researchers investigating the relationship between community fluoridated water intake and cancer occurrence. However, only the USA has more than 1 article on such [Table 3].

Authorship by institution

A total of 38 institutions sourced these epidemiological articles. All the institutions produced just one article except for Harvard University which had two articles. The three

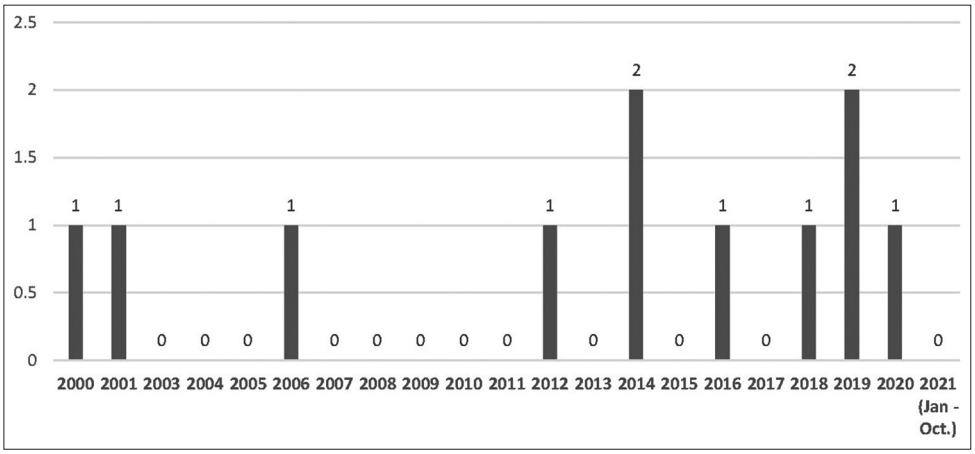

Figure 1: Trend analysis, by year, of the included articles.

Table 3: Affiliation countries of authors of the included studies.

Country	Total number of authors per country#	Total number of articles per country*
Taiwan	4	1
Japan	3	1
UK	12	1
Spain	1	1
USA	27	6
India	3	1
Canada	2	1
Turkey	5	1
Kenya	9	1
France	4	1
South Korea	1	1

#Some authors have more than 1 country affiliation; *some articles have multiple country affiliation

institutions with the highest number of authors of these study articles were Harvard University (n = 6 authors), Moi University (n = 5 authors), and Newcastle University (n = 5 authors) [Table 4].

Cancer types

These articles investigated different cancer sites. The least investigated cancer sites were the eye (n = 1 article), lip (n = 1 article), and skin (n = 1 article), while the most investigated site was the bone (n = 8 articles) [Table 5]. Only three articles investigated all cancer sites.

Journals

Table 6 shows the list of journals where these articles were published. All these articles were published in 11 journals, of which only five have cancer in their journal titles. *Cancer Causes and Control* journal was the only journal with more than one of these articles.

Funding

Less than half (5/12) of these articles were funded [Figure 2]. [Table 7] shows the information regarding the external funding sources (grants) of these articles. The UK was the country with the highest number of funding organizations on the research topic area. None of these funding organizations are situated in the African, Australian, or South American continent.

DISCUSSION

The findings obtained in this study are noteworthy. The volume of epidemiological studies investigating the relationship between community fluoridated water intake and cancer occurrence, published within the past two decades, is very minute compared to that recorded concerning

Table 4: List of institutions involved in the included studies.

Affiliations	Authors*	Articles
Taiwan		
Kaohsiung Medical College	4	1
Japan		
University of Tokyo	1	1
Okinawa Dental Clinic	1	1
Smon Medical Center	1	1
UK		
Newcastle University	5	1
University of Leeds	4	1
University of Oxford	3	1
Spain		
Andalusian Health Service	1	1
India		
Pandit Bhagwat Dayal Sharma Post Graduate Institute of Medical Sciences	3	1
Canada		
Institut national de santé publique du Québec	2	1
Université de Montréal	1	1
CSSS de Bordeaux - Cartierville - Saint Laurent	1	1
Turkey		
Marmara University	4	1
Trakya University	1	1
Kenya		
Moi University	5	1
Academic Model Providing Access to Healthcare	2	1
University of Eldoret	2	1
France		
International Agency for Research on Cancer	4	1
South Korea		
Seoul National University	1	1
USA		
University of Pittsburg	1	1
Stony Brook University	3	1
Harvard University	6	2
Children's Hospital	1	1
Beth Israel Deaconess Medical Center	2	1
Texas Department of State Health Services	3	1
Wake Forest University	1	1
Boston University	1	1
University of North Carolina at Chapel Hill	2	1
National Cancer Institute	1	1
University of Chicago	1	1
Massachusetts General Hospital	1	1
University of Florida	1	1
Rush Presbyterian and St. Luke's Medical Center	1	1
University of California	1	1
Nebraska Health System	1	1
The Cleveland Clinic Foundation	1	1
Creighton University	1	1
University of Kansas Medical Center	1	1

*Some authors have more than 1 institutional affiliation

Table 5: The cancer types investigated by the articles.

Cancer site	Number of articles*	References
All sites	3	[10,11,19]
Digestive organs	4	[10,11,20,21]
Respiratory organs	4	[10,11,19,20]
Urinary organs	4	[10,11,19,20]
Hormonal and/or reproductive organs	4	[10,11,19,20]
Bone	8	[10,11,13-17,22]
Brain and nerves	3	[10,11,15]
Blood and lymph	3	[11,15,19]
Lip and skin	1	[11]
Eye cancer	1	[18]

*Some articles investigated more than 1 cancer site

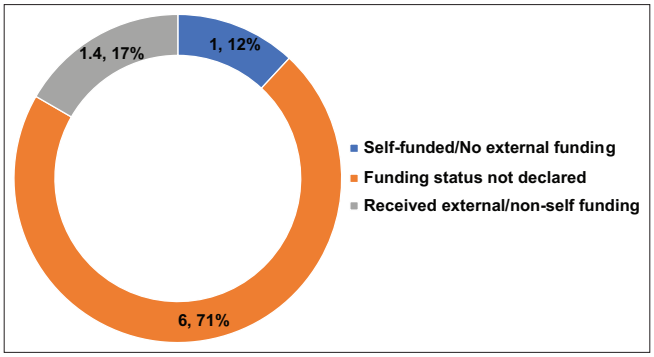

Figure 2: Funding status of the analyzed articles.

Table 6: List of journals where the articles were published.

Journal	Total number of articles
Cancer Epidemiology, Biomarkers, and Prevention	1
South Asian Journal of Cancer	1
Journal of Epidemiology	1
Environmental Research	1
International Journal of Epidemiology	1
Cancer Epidemiology	1
Journal of Trace Elements in Medicine and Biology	1
International Journal of Cancer	1
Journal of Dental Research	1
Environmental Geochemistry and Health	1
Cancer Causes and Control	2

Table 7: Sources of funding for the funded articles.

Funding organization	Country	Articles funded*
National Institutes of Health	USA	3
CDI Research Inc.	USA	1
International Agency for Research on Cancer	France	1
European Commission	Belgium	1
Union for International Cancer Control	Switzerland	1
Bone Cancer Research Trust	UK	1
National Institute of Health Research	UK	1
Children with Cancer UK	UK	1
National Science Council	Taiwan	1

*Some articles had more than 1 source of funding

research on other cancer topics;[31-33] for example, the annual publication rate in cancer rehabilitation research is currently 136 articles per year.[33] Overall, this suggests that the level of global research interest on fluoridated water and cancer is low.

However, the country with the highest number of articles, authors, and institutions on the topic area is the USA. Furthermore, based on the number of articles per funding institutions, the USA is the home to the biggest funder of epidemiological studies on this topic area. This finding is consistent with that recorded concerning research in many other research topic areas.[25,31,33-37] The reason why the USA has dominated the research world may be due to the huge pot of funding its government apportion to research and development.[38]

It is also noteworthy that these studies investigated different cancer sites. However, the most investigated cancer site was the bone. The reason why majority of these studies focused on bone cancer may be because bone cancer is the most debated risk factor associated with fluoridated water consumption.[10,11,13-17,22]

This study has its limitations. First, only those articles written in English with accessible full text were included in this study; this means that those articles written in other languages and those without accessible full texts were excluded from the study. However, all articles written in English were retrieved through our institutional library, except the article by Steiner[12] which was inaccessible. Second, only those articles published from 2000 upward were analyzed in this study; studies older than 2000 were excluded from the study, and this may be considered as a limitation. Therefore, not all articles published on the topic since the inception of research on the topic area was included in this study.

Notwithstanding this limitation, this study has its strengths. First, to the best of the authors' knowledge, this study is the first to do a comprehensive bibliometric analysis of articles on this topic area. Second, this study has identified the research hotspots concerning the topic area, which no other known study had identified these spots. Third, unlike most bibliometric analysis which used only one database, this study used the two largest databases of health literatures in the world.[23-31,33-37]

CONCLUSION

The volume of research investigating the relationship between community fluoridated water intake and cancer occurrence is very low, with zero output from several countries. Globally, the USA is the hottest spot for research on this topic area.

Declaration of patient consent

Patient's consent not required as there are no patients in this study.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

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APPENDIX

Appendix 1: List of authors of the included epidemiological studies, affiliations, and total publications.

S. No.	Authors	Affiliations	Total publications
1.	Yang C	Kaohsiung Medical College, Taiwan	1
2.	Cheng M	Kaohsiung Medical College, Taiwan	1
3.	Tsai S	Kaohsiung Medical College, Taiwan	1
4.	Hung C	Kaohsiung Medical College, Taiwan	1
5.	Takahashi K	University of Tokyo, Japan	1
6.	Akiniwa K	Okinawa Dental Clinic, Japan	1
7.	Narita K	Smon Medical Center, Japan	1
8.	Blakey K	Newcastle University, UK	1
9.	Feltbower RG	University of Leeds, UK	1
10.	Parslow RC	University of Leeds, UK	1
11.	James PW	Newcastle University, UK	1
12.	Pozo BG	Newcastle University, UK, and Andalusian Health Service, Spain	1
13.	Stiller C	University of Oxford, UK	1
14.	Vincent TJ	University of Oxford, UK	1
15.	Norman P	University of Leeds, UK	1
16.	McKinney PA	University of Leeds, UK	1
17.	Murphy MF	University of Oxford, UK	1
18.	Craft AW	Newcastle University, UK	1
19.	McNally RJQ	Newcastle University, UK	1
20.	Bassin EB	Harvard University, USA	1
21.	Wypij D	Harvard University, USA, and Children's Hospital, USA	1
22.	Davis RB	Harvard University, USA, and Beth Israel Deaconess Medical Center, USA	1
23.	Mittleman MA	Harvard University, USA, and Beth Israel Deaconess Medical Center, USA	1
24.	Archer NP	Texas Department of State Health Services, USA	1
25.	Napier TS	Texas Department of State Health Services, USA	1
26.	Villanacci JF	Texas Department of State Health Services, USA	1
27.	Kharb S	Pandit Bhagwat Dayal Sharma Post Graduate Institute of Medical Sciences, India	1
28.	Sandhu R	Pandit Bhagwat Dayal Sharma Post Graduate Institute of Medical Sciences, India	1
29.	Kundu ZS	Pandit Bhagwat Dayal Sharma Post Graduate Institute of Medical Sciences, India	1
30.	Levy M	Institut national de santé publique du Québec, Canada	1

(Contd...)

Appendix 1: *(Continued)*.

S. No.	Authors	Affiliations	Total publications
31.	Leclerc B	Institut national de santé publique du Québec, Canada; Université de Montréal, Canada; and CSSS de Bordeaux-Cartierville – Saint Laurent, Canada	1
32.	Schwartz GG	Wake Forest University, USA	1
33.	Sezgin BI	Marmara University, Turkey	1
34.	Onur ŞG	Trakya University, Turkey	1
35.	Menteş A	Marmara University, Turkey	1
36.	Okutan AE	Marmara University, Turkey	1
37.	Haznedaroğlu E	Marmara University, Turkey	1
38.	Vieira AR	University of Pittsburg, USA	1
39.	Crnosija N	Stony Brook University, USA	1
40.	Choi M	Stony Brook University, USA	1
41.	Meliker JR	Stony Brook University, USA	1
42.	Menya D	Moi University, Kenya	1
43.	Maina SK	Academic Model Providing Access to Healthcare, Kenya	1
44.	Kibosia C	Moi University, Kenya	1
45.	Kigen N	Academic Model Providing Access to Healthcare, Kenya	1
46.	Oduor M	University of Eldoret, Kenya	1
47.	Some F	Moi University, Kenya	1
48.	Chumba D	Moi University, Kenya	1
49.	Ayuo P	Moi University, Kenya	1
50.	Middleton DRS	International Agency for Research on Cancer, France	1
51.	Osano O	University of Eldoret, Kenya	1
52.	Abedi-Ardekani B	International Agency for Research on Cancer, France	1
53.	Schüz J	International Agency for Research on Cancer, France	1
54.	McCormack VA	International Agency for Research on Cancer, France	1
55.	Kim FM	No affiliation (Consultant in Dental Public Health, USA)	1
56.	Hayes C	Boston University, USA, and Harvard University, USA	1
57.	Burgard SL	University of North Carolina at Chapel Hill, USA	1
58.	Kim HD	Seoul National University, South Korea	1
59.	Hoover RN	National Cancer Institute, USA	1
60.	Douglass CW	Harvard University, USA	1
61.	Couper D	University of North Carolina at Chapel Hill, USA	1
62.	Simon MA	University of Chicago, USA	1
63.	Gebhardt MC	Massachusetts General Hospital, USA	1
64.	Scarborough MT	University of Florida, USA	1
65.	Gitelis S	Rush Presbyterian and St. Luke's Medical Center, USA	1
66.	Eckardt JJ	University of California, USA	1
67.	Neff JR	Nebraska Health System, USA	1
68.	Joyce MJ	The Cleveland Clinic Foundation, USA	1
69.	McGuire M	Creighton University, USA	1
70.	Anderson HC	University of Kansas Medical Center, USA	1