

Web search engines reveal conflicting information about 'Water Fluoridation.'

Priyanka V Vasantavada ^a, Roy Sanderson ^b, Louisa Ells ^c, Fatemeh V Zohoori ^{a*}

^a School of Health and Life Sciences, Teesside University, Middlesbrough, UK

^b School of Natural and Environmental Sciences, Newcastle University, Newcastle-upon-Tyne, UK

^c School of Clinical and Applied Sciences, Leeds Beckett University, Leeds, UK

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* Corresponding author

Professor FV Zohoori

School of Health and Life Sciences, Teesside University

Middlesbrough, TS1 3BA, UK

Tel: +44 (0) 1642 342973

Fax: +44 (0) 1642 342770

Email: v.zohoori@tees.ac.uk

Key Points:

- Web searching provides conflicting information on Community Water Fluoridation.
- No association found between publisher type and language sentiment of search results.
- Google trend peaks correspond with news/events regarding water fluoridation in media.

Abstract

Aim: To evaluate web search engines' informational content regarding Community Water Fluoridation (CWF) when accessed from the UK.

Methods: The search engine result pages (SERPs) regarding CWF from Google were identified, the content was analysed for themes and sentiments, and Google Trends information on CWF was examined.

Results: The SERPs were predominantly in favour of CWF. Anti-fluoridation themes were observed in SERPs that presented the arguments supporting and opposing CWF with equanimity, irrespective of the quality of scientific evidence. Hence, a web search for CWF yields conflicting information. Correlation is observed between current affairs and public interest in CWF.

Conclusion: UK residents seeking online CWF advice may experience confusion due to the prevalent conflicting information, which may influence their decision-making. Dental health professionals, Public health practitioners and policymakers should strive to improve the information provision on CWF online.

Introduction

Community water fluoridation (CWF) is the controlled addition of fluoride to a public water supply to reduce dental decay. Almost 24 countries worldwide, including the US, Canada, Australia and Brazil, fluoridate their water at the levels of 0.7-1.0ppm and serve about 372 million people (about 5% of the world population)¹. Globally, CWF has long been a contentious, sensitive and intensely debated issue. Despite scientific evidence backing fluoridation and various government endorsements of CWF as a significant factor in reducing dental health inequalities², opinions about it have been divided among the public³.

The discourse on CWF has migrated to the Internet over the years, necessitating research on the phenomenon. Internet users who do not prefer a specific website gather health and medical information using search engines⁴. A software system designed to search for information on the world wide web is called a web search engine. Search engines provide access to websites via user-generated keyword searches that vary depending on a user's knowledge or vocabulary. Choice of the search term can affect the types of websites produced in a search engine's results. The search results generated are referred to as search engine results pages (SERPs). The information generally is presented as a mix of web pages, images, and other types of files⁵.

Search engines maintain real-time information by running an algorithm on a 'web crawler'; hence search results may vary based on the location and time. Search results can vary across platforms due to different search engine algorithms. Search results are not listed in order of relevance or by scientific accuracy of content but in order of popularity, frequency of prior access or commercial sponsorship⁶.

CWF information on websites can range from being factual to unsubstantiated claims⁷. A study published in the US in 2004 found that 51% of relevant Google SERPs supported CWF, while 31% were opposed to it⁸. Recent studies on the online CWF information have observed that around half of the webpages favoured CWF and presented comprehensive albeit poorly referenced information⁹. However, anti-fluoridation page content tends to be more readable¹⁰ and, therefore, influential¹¹. The anti-fluoridation websites received twice as many page visits compared to government and public health organisations, and their social media engagement was 16 times higher¹².

Since the advent of Web 2.0, users have created and circulated information without content curation resulting in a misinformation minefield. According to the Reuters Institute Digital News Report 2020, Facebook, Twitter, and YouTube were the most used social media sites in the UK¹³. Hence, it is of interest that studies published in the US in 2014 and 2017 reported that CWF discussion on social

media was predominantly against CWF¹⁴. Anti-fluoridation content also ranged from 60-99% across these platforms.

CWF schemes serve around 6 million people in the UK, i.e., less than 10% of the UK population, and CWF schemes are subject to public consultation¹⁵. Individuals use online health information to make health decisions¹⁶, and it is, therefore, vital to examine the online information on CWF. This study aimed to examine the web search engine's informational content regarding CWF when accessed from within the UK. The objectives were to identify and analyse the content of Google SERPs regarding CWF and examine Google Trends information on CWF.

Methods

Identification and selection of websites

This study's focus was the fluoridation of water, not the other forms of fluoridation (salt, milk) or the chemistry of fluorides. Therefore, the search phrase "water fluoridation" was used to reflect the scope of this study. Region restrictions were not implemented as this study attempted to simulate a universal search by a layperson from within the UK. Before starting the searches, browser cookies were cleared, and search engines were not logged into to try minimising the 'filter bubble' – the effect of algorithms based on individual user search history. Paid advertisements were not included as people performing focussed searches tend to avoid advertised material¹⁷.

Since previous studies have found that individuals identified Google as their first resource for finding health-related information online¹⁸; a 'universal' search was performed using the Google search engine in the UK, on 1 December 2017 on a computer using the web browser Google Chrome.

Content analysis of the search engine result pages

The SERPs were categorised as pro-fluoridation, neutral, anti-fluoridation and unrelated. Anti-fluoridation SERPs were webpages that argue against CWF. In contrast, pro-fluoridation SERPs were those that argue in favour of CWF. Webpages that presented all views with equanimity or without an open position were considered to be neutral SERPs. Pages that did not discuss CWF were deemed unrelated.

The content of the Google SERPs relevant to 'water fluoridation' were evaluated for occurrences of 12 themes related to CWF. Web sites were excluded if the site: was not in English; was a broken web link or contained no information pertinent to the themes; contained no information pertinent to the themes other than links to other CWF sites; referred to information from a previous website or article;

was an online forum/ discussion thread where opinions and/or feelings were displayed and did not contain any information originating from the sites hosts or authors⁸.

Sentiment analysis

The Google SERPs were classified based on website sponsorship to explore the relationship between the tone of language and publisher type. According to the American Medical Library Association criteria, SERPs were classified into those published by organisations (government agency, educational institution, a professional organisation such as a scientific or research society, non-profit); commercial companies; and individuals¹⁹. The SERPs tabulated in MS Excel file were then analysed in R using the 'Tidyverse' package for text manipulation and 'RSentiment' package for sentiment analysis²⁰. The SERPs were analysed for the presence of sentiments: very positive, positive, neutral, negative and very negative.

Examination of Google trends

Google trends results are generated by taking a dataset representative of all Google searches, which provides a method of analysing what people are searching for²¹. Firstly, Google search trends for the term "water fluoridation" between 2004 and 2018 were analysed. Secondly, the correlation between the search volumes in Google Search (spikes in trends) and Google News results during the 'spike' was investigated. The study chose monthly counts of searches in the considered timeframe to gain a more accurate match with national news. As the UK version of Google Trends was used, it only assesses searches performed within the UK.

Results

Classification and Content Analysis of Google SERPs

The Google 'universal' search conducted on 1 December 2017 generated 249 SERPs over 25 pages. Both the quantity and the quality of CWF information available online was examined to assess the informational content. On examination of the content of the 249 SERPs, 99 were in support of CWF, 26 were in opposition, 48 were neutral, 45 were unrelated to CWF, and 31 SERPs contained no information pertinent to the pre-determined themes. Therefore, 76 SERPs were excluded from the thematic content analysis, most of which were commercial water filter companies advertising fluoride filters. Thus, 173 SERPs were included in the thematic content analysis, i.e., 69.5% of the total search results generated (Figure 1).

Approximately 60% of the 173 SERPs acknowledged the improvement in dental cavity resistance, 51% agreed on the cost-effectiveness of CWF, and 58% stated that it improves a person's quality of

oral health. In contrast, about 45% acknowledged that fluoride, when ingested in excess quantities, causes dental fluorosis; approximately 17% reported an increased risk of skeletal diseases, and about 13% discussed the possible risks of cancer, thyroid disorders, and the effects on a person's intelligence quotient. There were few SERPs that strictly opposed CWF.

Of the 173 SERPs, 6 SERPs were excluded from sentiment analysis as those pages were non-existent at the time of sentiment analysis (December 2018- May 2019). The sentiment analysis indicated that most SERPs (across all sponsor categories) were 'very positive', and only 21 SERPs were adjudged to be of 'very negative' sentiment (Figure 2). This result is per the content analysis finding of most SERPs being in favour of CWF. This study did not find any association between publisher type and language sentiment.

Google Trends data analysis

Trends data can provide insights into what Google users are curious about and how people worldwide react to critical events. A "spike" is a relative search interest in the topic compared to itself. Media deeply influence information prevalence. Examining related Google news searches can help to understand conditions that might be driving spikes in Google Trends²¹. The peaks in Google trends correspond to the news that involved government policy-making regarding CWF (Table 1 and Figure 3). These results highlight the influence of media on online health information-seeking behaviour.

Discussion

This study brings new learning to the impact of web media in the fluoridation debate; however, the findings are time-sensitive given the web's dynamic nature. For UK residents seeking online CWF advice, current information provision is conflicting. Conflicting health information refers to the presence of contradicting statements regarding the health-related issue, which might arise in cases of variation in the interpretation of scientific evidence by experts. Such a scenario may be confusing for the public, healthcare professionals and policymakers when faced with decision-making due to the difficulty in discerning the accuracy of the information²². Although it is acknowledged that online information seekers require help to assess and judge health information rationally, little research has been done to estimate the significance of the problem and its potential effect on public health.

The Google search in this study generated the following search titles based on user activity ("Searches related to water fluoridation") for the keyword: 'water fluoridation', 'fluoride in water uk map', 'fluoride in water dangers', 'fluoride in water conspiracy', 'fluoride in water good or bad', 'fluoridation definition', 'effects of fluoride in water', 'fluoride in water pros and cons' and 'water fluoridation

controversy'. These results highlight the prevalence of conflicting information on CWF across the web.

A study published in the US in 2004 found 100 search results on 'water fluoridation'. Of the 59 websites that were included in thematic analysis, 51% provided information supporting CWF, 31% were opposed to it, and 44% agreed that CWF is cost-effective and improves a person's quality of oral health. While the 2004 study found themes on the risk of hip fractures/osteoporosis, osteosarcoma/cancer, arthritis and congenital abnormalities; our study found themes concerned with skeletal diseases, cancers, pineal gland and thyroid diseases⁸. Hence, there is a shift in public concerns regarding the health effects of CWF. The effect of CWF on the pineal gland was found to be one of the most discussed aspects in anti-fluoridation vlogs on YouTube¹², but only eight SERPs in this study mentioned it. The informational content generated by Google search in this study was mostly in favour of CWF.

The difference in the volume of the SERPs generated by the 2004 study and this study is notable. The majority of the SERPs in this study were pro-fluoridation web pages that mostly were government websites from countries with active CWF schemes like the US, Australia, New Zealand and the UK. The anti-fluoridation web pages were few when compared to the prevalence of neutral web pages. Similar results were observed in a 2018 research study from Australia that assessed the quality of CWF information online⁹. The 'neutral' pages discuss research supporting and opposing CWF with equanimity, irrespective of the quality of scientific evidence¹¹. Critical consumers of health information are known to seek information they perceive as unbiased to arrive at their own conclusions²³. Consequently, the appearance of anti-fluoridation themes in the 'neutral' SERPs may be fuelling the CWF debate.

This study is limited to the UK as search engines influence the information provided via location and previous search terms. Variability was observed in SERPs and page ranks depending on browsers (usage, settings, history), device, personalisation, time, and place of access; both in this study and previous research⁹. However, this is concerning since most individuals believe that the order in which search engine results appear is indicative of its quality or relevance²⁴. Seeing as Google Trends results show a spike in public interest around the time of government legislations, public health officials could renew communication efforts around that time to improve visibility of accurate and reliable CWF information on the web.

The informal emotional tone of language can be influential in swaying public opinion. Since CWF is considered a contentious issue, previous studies have evaluated the online sentiments based on the type of publisher²⁵. While these studies restricted the analysis to the broad characterisation of the information being pro-, anti- or neutral towards fluoridation, our study attempted to analyse the text

based on the emotion conveyed through language usage. In this study, the RSentiment software found most of the Google SERPs to be 'very positive' in sentiment while describing CWF irrespective of the website sponsorship. However, these results should be interpreted cautiously as a human's perception of sentiment differs from that of software.

Conclusion

When encountered with conflicting health information, a non-specialist may experience confusion, and the less reliable they perceive the information to be, the less likely they are to engage in health behaviours. Personalisation of web content without the user's conscious choice leads to the phenomenon of online 'echo chambers', wherein a person is exposed only to content resounding one's beliefs²⁶. Consequently, evidence-based health communication strategies should be developed for online information seekers in general and regarding CWF in particular.

The Royal Society of Public Health, in its 2019 report, *Moving the Needle*, called for increased efforts to limit health misinformation online with self-regulation by social media platforms²⁷. Search engines should be encouraged to at the very least flag SERPs with health misinformation as misleading and urge caution to their consumers. There is a need to legislate on instituting mechanisms to monitor if not moderate health information on the world wide web to quell the spread of health misinformation. Health communication's focus should be to empower the public to source accurate and reliable information amongst the myriad of conflicting information currently available. This is essential if the web is to assist the public in making informed opinions and choices.

Declaration of Interest

The authors have no conflicts of interest to disclose.

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Author contributions

PVV, FVZ and RS conceived and designed the study; FVZ supervised the project with help from RS and LE; PVV analysed the data and FVS and RS contributed to the interpretation of the findings; PVV and FVZ took the lead in writing the manuscript. All authors read, provided critical feedback and approved the submitted paper.

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Table 1 News/ Event possibly associated with Google search spikes

Figure legends:

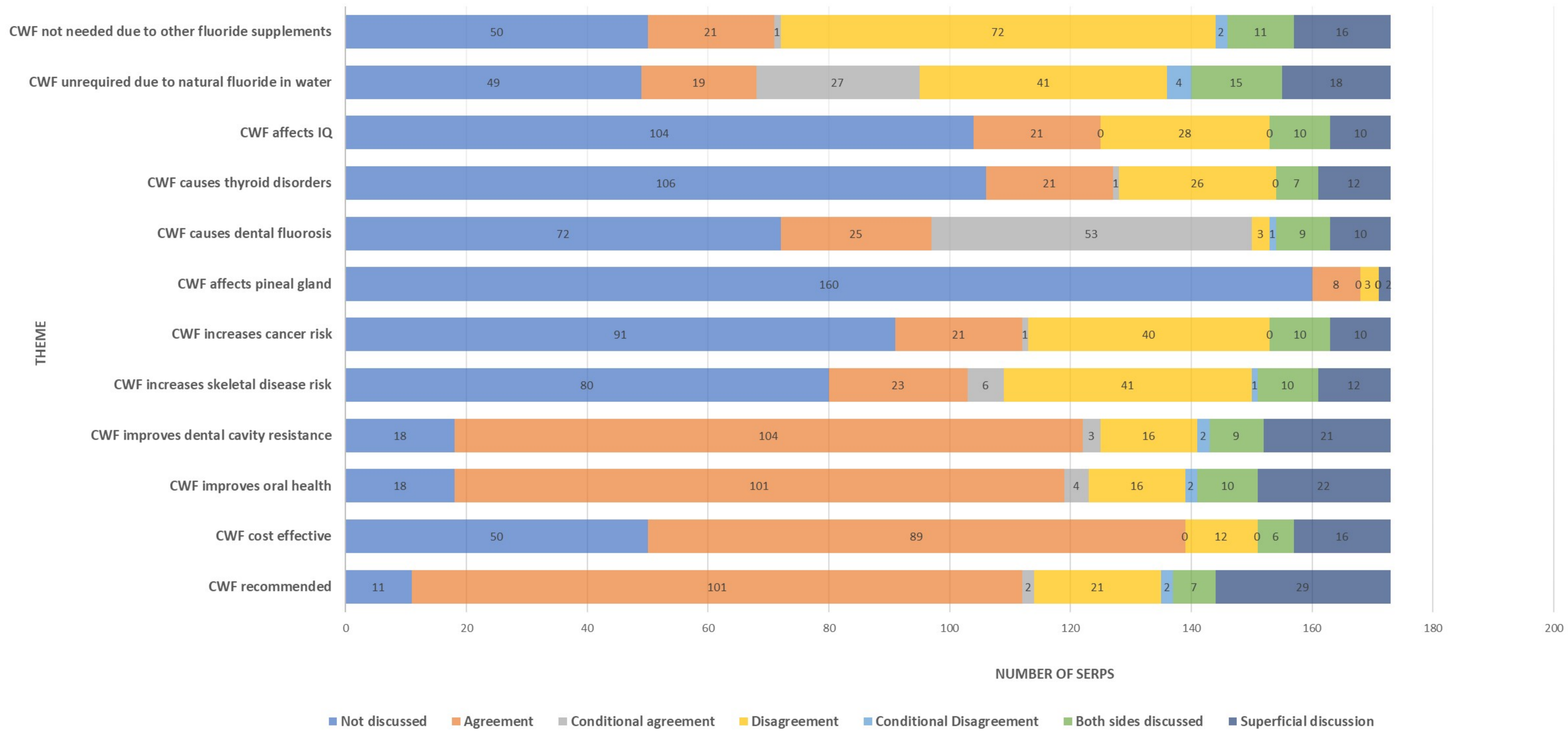
Figure 1: Thematic Analysis of Google SERPs (n=173)

Figure 2: Sentiment analysis of 167 Google SERPs

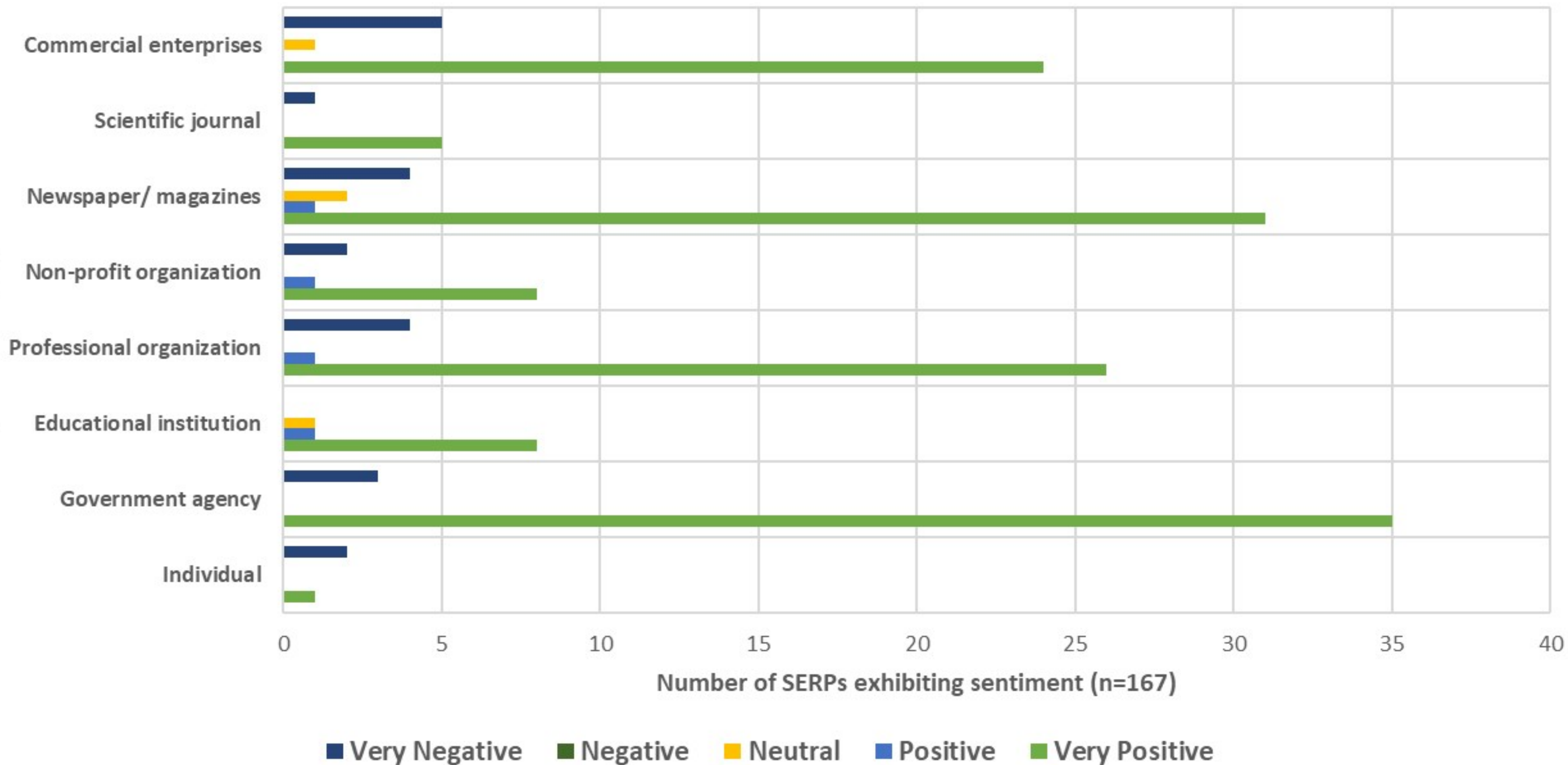
Figure 3: Graphical representation of web search interest over time for 'water fluoridation' in the UK
(On a scale of 0-100)

Table 1 News/ Event possibly associated with Google search spikes

Time of spikes	Search results
04/2004	Lancashire County Council task group report on Water fluoridation ²¹
07/2004	Adding fluoride to water in deprived areas of the north-east of England will reduce dental decay among children, the country's chief medical officer claims. ²²
12/2004	Controversial plans to introduce fluoride into the public water supply in Scotland are set to be abandoned, it emerged today. ²³
03/2005	Water Supply Regulations ²⁴
04/2005	Wales is not going to follow parts of England and introduce more fluoride into the water supply, it emerged yesterday. ²⁵
02/2008	Health Secretary Alan Johnson has called for fluoride to be added to England's water supplies as a key means of tackling tooth decay. ²⁶
02/2011	The High Court has ruled that a health authority was not acting unlawfully in seeking to add fluoride to Southampton's tap water. ²⁷
03/2014	Adding fluoride to water should be considered by councils in England to improve dental health, the government's public health advisory body says. ²⁸



Website sponsor category



Google search trends for the topic Water Fluoridation in the United Kingdom (01-2004 to 09-2018)

