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Fluoride on the Internet: Content analysis of web-pages from the Google search engine.

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Acknowledgement

Abstract

Objectives/background:

This study aimed at providing more knowledge about what kind of information is available to people when looking for information about fluoride on the Internet.

Methods:

The search engine Google was used to search for web-pages written in the period 1997-2016, with the keyword "fluoride teeth". Top 10 web-pages that were written in each of the specified years were analyzed according to a set of pre-selected parameters, including whether the content was positive or negative with regards to dental fluoride. The language of selected web-pages was also analyzed with regards to emotional content.

Results:

We found more positive web-pages (67.2%) than negative (22.2%) in the search period. There were significantly more positive web-pages ($\chi^2(1) = 10,790$, p < .001) the last four years (2013-2016) than the first four years (1997-2000). There is a difference in the types of fluoride supplements in pages that are positive versus negative with a higher frequency of "other fluoride supplements" in positive web-pages, and "water fluoridation" in negative web-pages. More negative emotional words were found in web-pages categorized as negative compared to the positive web-pages.

Conclusion:

This study has shown that the majority of top-rated web-pages found on Google are positive towards oral fluoride supplements, and more positive pages are found in recent years. Also, emotional language appears to be different between pages that are positive versus negative to dental fluoride. More research is needed in order to find out the potential real-life impact of these findings.

Keywords: fluoride, oral health, caries, skepticism, detrimental effects, positive

Introduction

Dental caries is considered to be the one of the most prevalent chronic diseases in the world (Fejerskov, Nyvad, & Kidd, 2015), and it has led to numerous tooth extractions and early loss of teeth (Ahamed et al., 2012; Hull et al., 1997). After the introduction of fluoride to oral health, the prevalence of dental caries has declined significantly (CDC, 2001). Thus, the use of fluoride in oral health is considered to be one of the most important aspects of caries prevention (Fejerskov et al., 2015). There are however ongoing debates in the media on the Internet about the detrimental effects of fluoride, and whether fluoride used in oral health poses more risk to overall health than the benefit it represents for oral health (Fejerskov et al., 2015). The most often used arguments against fluoride for oral health purposes is that it has detrimental effects on skeleton, teeth, endocrine and nervous systems, kidneys, cardiovascular system and gastrointestinal tracts (Osvik, Årdal, Wigen, & Wang, 2017).

The discovery of the effect of fluoride on the dentition
The effect of fluoride on the dentition was first discovered by the dentist Fredrick McKay in 1901, when he noticed that many of his patients had mottled and brown stained enamel. Further investigation revealed that the stained enamel was hypomineralized, which would theoretically imply the teeth being more susceptible to carious lesions, but instead, they were more resistant to caries (Fejerskov et al., 2015). McKay started to suspect that these findings could be related to local water supply, since the tooth condition were localized to children in specific geographical regions. The findings revealed high levels of fluoride in the drinking water of these patients (14.7 ppm) (Fejerskov et al., 2015). However the etiology of mottled enamel was not established until 1930 by some systematic animal experiments, and human epidemiological studies done by Dean and his team (Fejerskov et al., 2015). This enamel condition was later diagnosed as dental fluorosis.

The detrimental effect of fluoride on tooth (dental fluorosis) was what initiated the further investigation and discovery of its anticariogenic properties (Fejerskov et al., 2015). A study conducted in 21 cities in the US, reported 50% prevalence of dental fluorosis of any severity at the level of 1 ppm in drinking water, where the most cases had the less severe forms (questionable and very mild) (Fejerskov et al., 2015). This study showed simultaneously a dose-response relationship between fluoride in water and a decline in caries with the optimal level of fluoride in water determined to be 1-1.2 ppm, which gave maximal caries reduction

with minimal dental fluorosis (Fejerskov et al., 2015). The strong association between fluoride concentration and reduction in caries was not established until 1944, where one of the studies were done in Grand Rapids which showed a reduction in prevalence of caries lesions by 60-65% in the permanent dentition of children born subsequent to the change in water supply (Arnold, 1957). Community water fluoridation programs were developed following these findings in The US (Beltrán-Aguilar, Barker, & Dye, 2010), and by the middle of 20th century, other countries started to introduce fluoride into water supplies (Fejerskov et al., 2015). The optimal concentration in water were used to determine the concentration of fluoride in other systemic products such as tablets, vitamin drops and salt (Fejerskov et al., 2015).

The conviction of necessity to ingest fluoride in order to exert its anticariogenic effect was based on the belief that it was mainly due to fluoride becoming incorporated into crystals in the enamel during tooth formation. This process was believed to make the enamel more resistant to acid attack (Fejerskov et al., 2015). Based on this conviction fluoride was regarded as a micronutrient in caries prevention. Some are even still considering it as important in diet, even though the understanding of the cariostatic mechanism of fluoride has changed (Fejerskov et al., 2015).

The cariostatic mechanism of fluoride
In order to understand the cariostatic mechanism of fluoride, it is important to understand that the caries process is a progressive loss of tooth minerals caused by biofilm metabolism, leading to the development of cavity over the time (Fejerskov et al., 2015). The mode of action of fluoride in influencing the caries process, is based on the availability in the oral fluids such as saliva and biofilms and is disregarding the agent used. Overall, the concept of fluoride related to oral health is to delay caries progression by reducing demineralization and enhancing remineralization.

What is harmful?
Correct concentration of fluoride is established through many studies and are dependent on several factors such as the amount of naturally occurring fluoride in water and other dietary products, age, individual risk factors etc., and will therefore differentiate between countries (Fejerskov et al., 2015). The Norwegian health authorities recommend to brush teeth twice a

day with toothpaste containing a concentration between 1000 to 1500 ppm fluoride (Helsedirektoratet, 1999).

The effects of fluoride ingested are cumulative (if constant dose), and there has been shown a linear relationship between daily intake of fluoride and the prevalence of fluorosis, even in small concentrations (.1 mg per kilogram body weight) (Fejerskov et al., 2015). That means that in order for a child that weigh 12 kilograms to ingest .1 mg F per kilogram bodyweight, it needs to cover the head of a child's toothbrush with paste (approximately 1.2 mg of 1000 ppm toothpaste). Therefore, this child might be at risk of developing dental fluorosis if brushed twice a day. However, this should not be a problem if the guidelines are followed - kept in mind that it is only a risk when the dentition is developing and if the ingestion is over a period of time (Fejerskov et al., 2015). In addition, absorption in the gut after ingestion is dependent on a lot of factors, such as type of toothpaste ingested, the time of ingestion (e.g. after meals the bioavailability will reduce significantly), what fluoride-salt there is (e.g. ca-f formulations, 20-30% of fluoride is usually bound to calcium being insoluble and thereby not absorbable), and so on. Therefore, calculations regarding recommended intake of fluoride need to be treated with caution (Fejerskov et al., 2015). However, more than 90% of dental fluorosis in the United States is considered to be very mild or mild form, which appears as barely visible white markings or spots on the enamel (Department Of Health And Human Services Federal Panel On Community Water Fluoridation (US), 2015).

Recently, a study assessed publications on PubMed with the purpose to analyze if there are any correlation between fluoride intake and the claimed detrimental health effects. These effects include problems related to the cardiovascular system, kidneys, skeleton diseases, cancer, etc (Osvik et al., 2017). Studies conducted in areas where the concentration of fluoride is below the upper limit permitted in Norway (1.5 ppm) did not show any correlation between the claimed harmful effects and fluoride (Osvik et al., 2017). Studies that did claim there are a correlation between fluoride in water and the harmful effects on health, were conducted in other countries where the fluoride concentration in water is higher than the recommended dose for caries prevention. Several of these latter studies also had methodological weaknesses and other biases (Osvik et al., 2017). This study concluded that at recommended doses, there is solid evidence of antiocariogenic effect of fluoride (Osvik et al., 2017).

Who drinks fluorinated water?

In 2012, it was estimated that a total of 377,7 million people distributed among 25 countries drank fluoridated drinking water. In addition to this, 57.4 million people distributed among 28 countries had access to natural fluoridated drinking water (The British fluoridation Society, 2012). In the United States, over 66% of the population (204 million people) have optimal fluoride levels in the drinking water either through public fluoridation or via private wells (The British fluoridation Society, 2012). Those who do not have publicly fluoridated drinking water come from smaller cities that have a water system that is not optimized for fluoridation (Freeze & Lehr, 2009).

In Europe, there are only 4 countries that have public fluoridated drinking water covering 13.7 million people. The reason why fluoridated drinking water is not more common is due to technical challenges, policies and complex water systems with several water sources (American Dental Association, 2005). Earlier, the city of Basel in Switzerland had fluoridated drinking water. They stopped adding fluoride to the public water system because they introduced fluoride in salt which made water fluoride redundant (American Dental Association, 2005).

The discovery of the cariostatic effect of fluoride made many health workers optimistic as it was a socio-economically cheap method of adding fluoride to the drinking water (Fejerskov et al., 2015). Although research has shown that fluoride in therapeutic doses is good (Osvik et al., 2017), there are many who oppose this.

The sides of the debate

Those who want to add fluoride in water in America are led by the American Dental Association (ADA) (Freeze & Lehr, 2009). On ADA web-page, they have a list of national and international organizations that support water fluoridation (American Dental Association, 2018). ADA emphasizes that their policies focus on "*generally accepted scientific knowledge*". All major national organizations of dentists, doctors, nurses, pharmacists, nutritionists and health organizations in the United States support ADA and water fluoridation (Freeze & Lehr, 2009).

Those who are against water fluoridation do not have the same impressive organizations with certified health workers and scientists.

"*Most of the antifluoridation organizations represent limited constituencies, and in some cases, their position could be seen as selfinterested. Several of the organizations exist solely as agents of an antifluoridation message (Citizens for Safe Drinking Water, Preventive Dental Health Association). Many of the others represent devotees of alternative medicine and nutritional health*" (Freeze & Lehr, 2009, p. 22). There are individual doctors and dentists that have publicly informed that they are against fluoride. Fluoridation action network sponsors a campaign that urges healthcare professionals and researchers to sign against fluoridation and has as far as 4700 signatures (Fluoride Action Network, 2018). After a quick search on this website, it seems that anyone can sign this campaign, even without having any education. Even if all the signatures come from healthcare professionals, 4700 is still a small number compared to the amount of health professionals who support fluoridation. Only ADA alone has over 144,000 members who support fluoridation (Freeze & Lehr, 2009).

Arguments

The main argument for the proponents is that, according to the studies, fluoride in the drinking water reduces the caries incidence and will help especially those with low socioeconomic status who cannot afford or prioritize toothpaste and other fluoride products (Fejerskov et al., 2015). The arguments that the pro-fluorists had during the fluoride debate in Norway in the 1950s is listed in Table 1.

*Table 1 (K*vamme, 2010*).* Translated from Norwegian to English.

Reduces caries activity up to 60%
No influence on the general health
Most effective caries prophylaxis
Cheapest caries prophylaxis
Fluoride is an essential element
There is overwhelming research material
WHO and experts recommends water fluoridation

In a study that analyzed the arguments against fluoride, they came up to 255 separate arguments against fluoride (Freeze & Lehr, 2009). These arguments can be merged into

categories and are presented in Table 2. The table is organized with the most credible at top and those that are most conspiracy theoretical at the bottom.

Table 2. Common arguments against the use of fluoride (Freeze & Lehr, 2009). Table is edited by cutting out a part of the list that discusses counter arguments against these claims.

Anti-fluoridationist Claims
Fluoridation is not effective. It is not responsible for the historical reduction in the occurrence of dental caries.
Fluoridation is not cost-efficient. Cheaper and more effective fluoride delivery systems are available.
Fluoridation systems are prone to engineering failures that could release toxic concentrations of fluoride into public water supply systems.
Fluoridation is a health hazard. It causes increased incidence of dental fluorosis, skeletal fluorosis, hip fractures, bone diseases, heart problems, allergic reactions, and certain types of cancer. It is implicated in Downs syndrome, Alzheimer's disease, diminishment of IQ, and premature aging. Fluoridation constitutes a form of socialized medicine, involuntary mass medication, and/or human medical experimentation.
Fluoridation is an infringement on personal freedoms and liberties. It is an unacceptable governmental intrusion into private life.
Fluoridation is a planned conspiracy against the populace: (a) by certain industries as a cheap method of disposing of their toxic fluoride wastes, or (b) by government, as a method of pacifying the public chemically.

Psychological theories

There are many countries in the world that do not have fluoridated drinking water. Even after it was concluded that the water would not be fluoridated in some countries, the debate

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continued. The same arguments that were used against water fluoridation was now used against fluoride dentifrices, tablets and varnishes (Kvamme, 2010). If the research shows that fluoride is safe and very effective (American Dental Association, 2005), why are there still many who are completely opposed to fluoride?

Kahneman describes a theory that our mind thinks and makes decisions using two different systems. System 1 is an automatic and often unconscious system that does not require much energy, and it is this system that is used most of the time. System 2 in contrast requires more energy and activates when we try to solve a problem, think carefully or think critically (Kahneman, 2014).

Our brain absorbs vast amounts of sensory impressions at all times (Lewis, 2015). This information requires time and energy to process. Because we do not have the energy or time to analyze this information, our mind uses mental shortcuts, heuristics, which let us make quick decisions and let us function satisfactory everyday life (Dietrich, 2010). Since our brain uses shortcuts, it is disposed to make systematic errors (Plous, 1993). Occasionally, these shortcuts can lead to convictions that are not necessarily true, and these beliefs can be further enhanced by these shortcuts.

Once a person has become convinced of something, it is incredibly difficult to make the person change his mind unless this person has been trained for critical thinking. According to psychologist Torstein Låg one of the reasons why it is difficult to make a person change his conviction on a topic is due to the familiarity backfire effect (Låg, 2015). That is, if a person first becomes misinformed and someone tries to correct this error, the person will forget about this correction and remember only the incorrect information that he or she initially heard. Also, information included in the correction that might resemble or appear to support the original erroneous claim will be remembered (Låg, 2015). This false information feels more familiar since it has been repeated, although some have attempted to correct the error. This effect seems to be stronger among children and elderly who do not have the cognitive resources to challenge the false information (Låg, 2015). When misinformation is harmless, this can be seen as inconsequential or even funny, but when misinformation adversely affects people's health, it becomes a definite problem. Today's increased vaccine resistance is an example of this (Låg, 2015).

Purpose of this study

Various oral uses of fluoride have been shown to have positive effects on oral health and few side effects. There are however people that are critical to the usefulness of fluoride related to oral health, and those that fear that it might be harmful to health in general. As dental students, we have treated patients who are opponents and proponents, and this have made us curious about how and where lay people get their information from and what kind of information is available. Google is considered the world's largest search engine (Net Markedshare, 2018), and we have chosen to use it as a way to gather data for this master thesis, with the purpose to find what kind of information there is about fluoride and oral health on the Internet.

Hypothesis

1) We expect that the majority of web-pages in the last 20 years from 1997-2016 identified by using "fluoride teeth" as a search term on Google will be negative with regards to the health effects of orally administered fluoride.

    a) We expect that there are differences in the contents of web-pages that are negative compared to those that are positive; specifically, that they are addressing different types of fluoride products.

    b) We expect that more negative web-pages are to be found as we approach more recent years compared to the positive web-pages.

2) We believe that the contents of the negative web-pages on fluoride will rely more on emotions than the positive web-pages, and thus contain more emotional words than the positive web-pages.

Material and Methods

Method

We used Google search engine and searched for web-pages published within the period 1997-2016, using the keyword "fluoride teeth". We chose these keywords since they are two emotionally neutral words and relevant for finding information about the effects of fluoride on teeth and oral health. We selected the top 10 for each year in this twenty year period, and selected-pages were then analyzed by the two authors according to a set of preselected parameters.

Table 3. Preselected parameters and description

Preselected parameters	Description
If the web-pages have a positive / negative point of view of dental fluoride	If we felt subjectively that the article was positive, negative or neutral towards fluoride.
If the web-pages have quality certification such as HON code	A certificate that ensures the reliability and credibility of the information that is written on the web. "*The Health On the Net Foundation has elaborated the Code of Conduct to help standardize the reliability of medical and health information available on the World-Wide Web*" (Health On the Net foundation, 2017).
Type of fluoride supplement	- Toothpaste - Fluoride varnish - Fluoride in water - Fluoridated mouth rinse - Other fluoride supplements – other fluoride supplements or a combination of the supplements above.

	- Fluoride in general – if the web-sites were writing about fluoride in general.
If it is possible to comment on the web-page	Some web-pages like blogs have the possibility to comment on the page.
Are there any advertisement on the page?	For example, pop-ups, clear product placements etc.
Commercial/non-commercial	If the web-site (the specific site we were visiting, and not the domain) were making or intended to make a profit (Oxford, 2018). We noted a yes on this parameter if there was possible to buy products from this specific website and did not search the whole domain for this opportunity. If we saw a "add to cart" or "shop" link on the page that we analyzed, we rated that this site was commercial.

Google's search engine settings were set to select web-pages published at specific time intervals (years). Before we started the search, we made some adjustments to the search settings to prevent the impact of the search result. First, we deleted the cookies on the browser between each search to prevent previously stored information from affecting the search result. Web-pages that were specifically promoted by Google as advertising was excluded from the study. Links that further referred to other search engines, such as Google Scholar, were also excluded.

Then we searched and analyzed the web-pages individually according to the parameters in order to increase interrater-reliability. Inter-rater reliability is the measurement of the extent to which data collectors assign the same score to the same variable. In order to investigate hypotheses 1, 1a and 1b the authors of this thesis made individual, subjective decisions on whether the contents of the web-pages were positive or negative with regards to the use of fluoride for oral health purposes. Cohen's kappa was calculated to demonstrate interrater-

reliability of the authors' with regards to the classification of web-pages as either positive or negative to orally administered fluoride. The calculation gives a kappa score of .72, which is a "substantial agreement" (McHugh, 2012). In the instances where the authors disagreed about classification, disagreements were solved by discussions.

In order to investigate Hypothesis 2, we used a computer program called Linguistic Inquiry and Word Count (LIWC). LIWC is a computerized text analysis program that analyzes text files according to predetermined built-in dictionaries and calculates the percentage of words that matches with these dictionaries (Pennebaker, Chung, Ireland, Gonzales, & Booth, 2007) (Pennebaker et al., 2007). There are dictionaries for different word-categories such as emotions, thinking styles, social concerns and parts of speech (Pennebaker et al., 2007). We looked at the word-categories related to emotions, more specifically positive and negative emotions, in order to investigate hypothesis 2. A positive and a negative article was randomly selected from our list for each year. The web-pages were downloaded and saved in TEXT format and was further analyzed for emotionally charged words by running each of the downloaded web-pages through LIWC. Scientific web-pages were excluded for this analysis due to a lot of non-relevant information on the web-pages that would affect the result of the analysis. The results were further analyzed and calculated statistically with Mann-Whitney U test, which is a non-parametric test that compare two independent groups or conditions when the dependent variable is not normally distributed.

SPSS v24 was used for all statistical analyses. Hypotheses 1, 1a, and 1b was investigated using descriptive analyses and Chi-square tests.

Results

General results

A total of 200 web-pages were selected for analyses – of these, 133 pages were classified as positive, 43 negative, 23 neutral and 2 non-relevant (these two were excluded from the study). When categorizing these web-pages according to their content, the pre-selected parameters, there were 65 pages of commercial content, 133 non-commercial, 35 web-pages with able to comment, 50 pages with advertisement and 5 pages with Hon-code. When looking into the commercial content, 34% of all the commercial positive web-pages were linked to Colgate.

*Table 4*. Summary of findings from the study

Web pages that have/are:	Number of web-pages
Positive	133
Negative	43
Neutral	23
Commercial	65
Non-commercial	133
Comment section	35
Advertisement	50
HON-code	5

Ratings of web-page content: Positive versus negative contents

With regards to Hypothesis 1, we expected the majority of web-pages in the 20-year study period to be negative. Of all the 200 web-pages selected for analysis, 67,2% had a positive point of view for fluoride, while 22.2% had a negative point of view, and 11.6% had a neutral point of view. The fluoride category that have the biggest number of positive web-pages are "other fluoride supplements" (N=70, 52.6%). The fluoride category that have the biggest number of negative web-pages are "water fluoridation" (N=18, 42.9%).

Also, we wanted the examine the differences in the types of fluoride products or administration methods mentioned between positive and negative web-pages (Hypothesis 1a). The Chi-square test shows a significant interaction between the rating categories and types of

fluoride $\chi^2(5) = 26.34$, p < .001. An inspection of the ratings shows an interesting difference in positive and negative ratings for the topic of water fluoridation, where almost half (42.9%) of the total number of negative web-pages is about this topic (waterfluoridation). In contrast, waterfluoridation makes up only (12.8%) of the web-pages classified as positive. Figure 1 shows the number of web-pages related as either positive or negative for each fluoride category, and this is also shown numerically in Table 4.
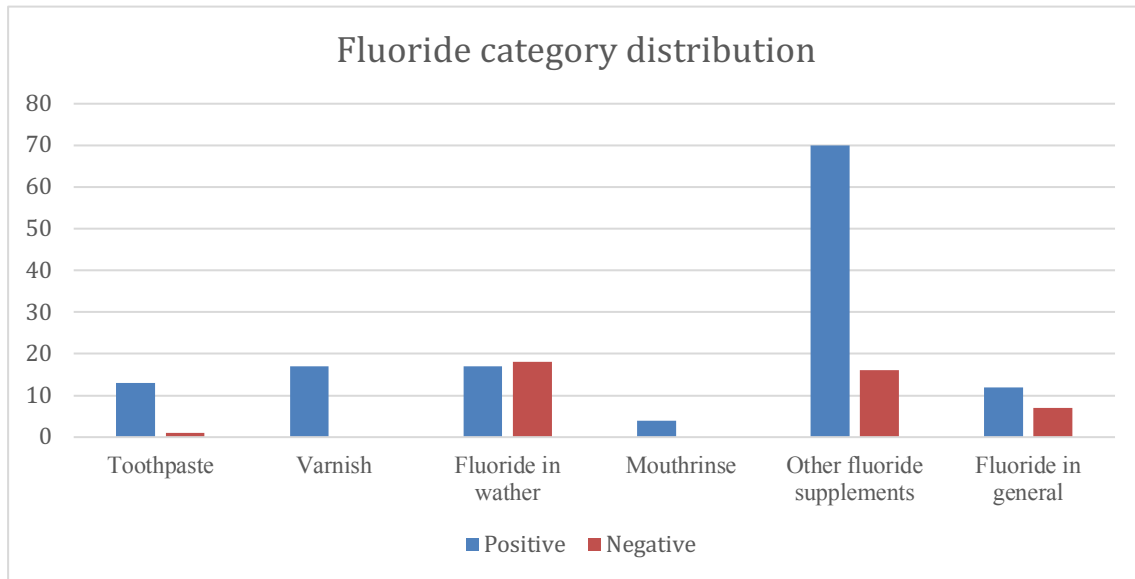
Figure 1. Fluoride category distribution. Y-axis represents the number of observations. X-axis represents the fluoride category.
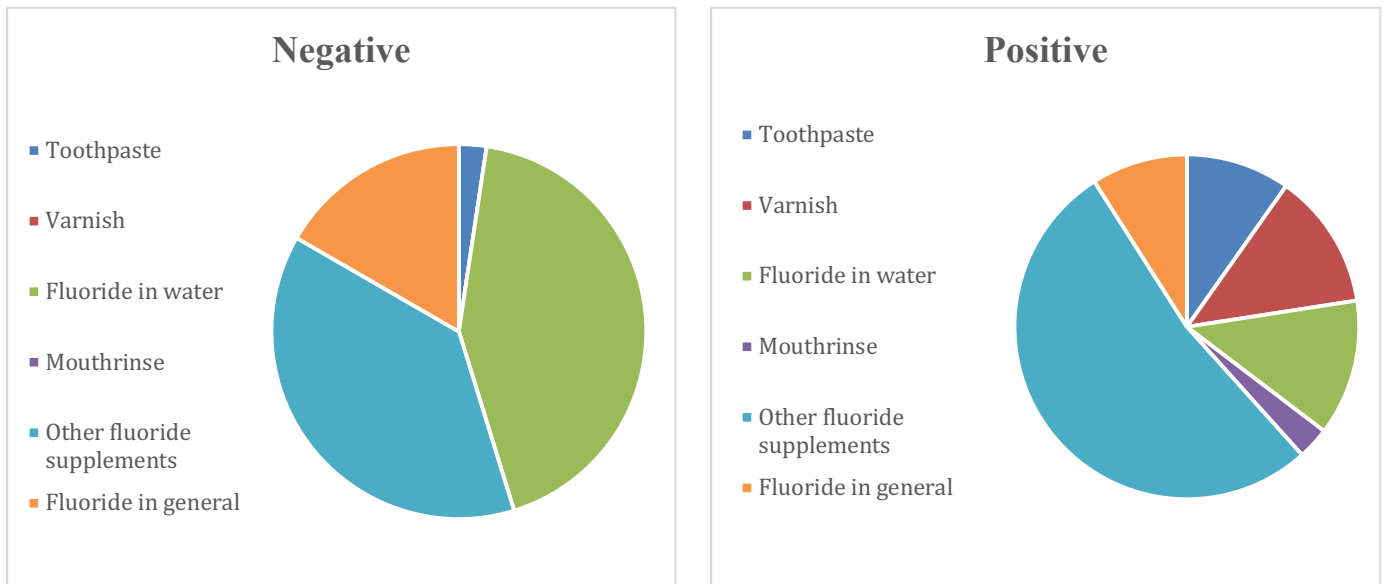
Figure 2. Fluoride category distribution in percentages for negative (left) and positive web-pages (right) separately.

Table 5. Distribution of types of fluoride-supplements for the positive/negative ratings of web-page contents

Fluoride category	Positive	Negative	Total
Toothpaste	13	1	14
Varnish	17	0	17
Fluoride in water	17	18	35
Mouthrinse	4	0	4
Other fluoride supplements	70	16	86
Fluoride in general	12	7	19
Total	133	42	175

According to Hypothesis 1b, there should be more negative web-pages in recent years compared to earlier years. Comparing the web-pages/articles from the first 4 years with the last 4 years (Figure 2), shows that there is a significant difference in the amount positive and negative web-pages $\chi^2(1) = 10,790$, $p < .001$. There are more positive web-pages in the last 4 years (2013-2016), than the first 4 years (1997-2000), and there are less negative web-pages from the last 4 years (2013-2016) than the first 4 years (1997-2000). Looking more into to the commercial content of these web-pages, 46.7 % of the positive commercial web-pages from the last 4 years are linked to Colgate while no web-pages from the first 4 years are.
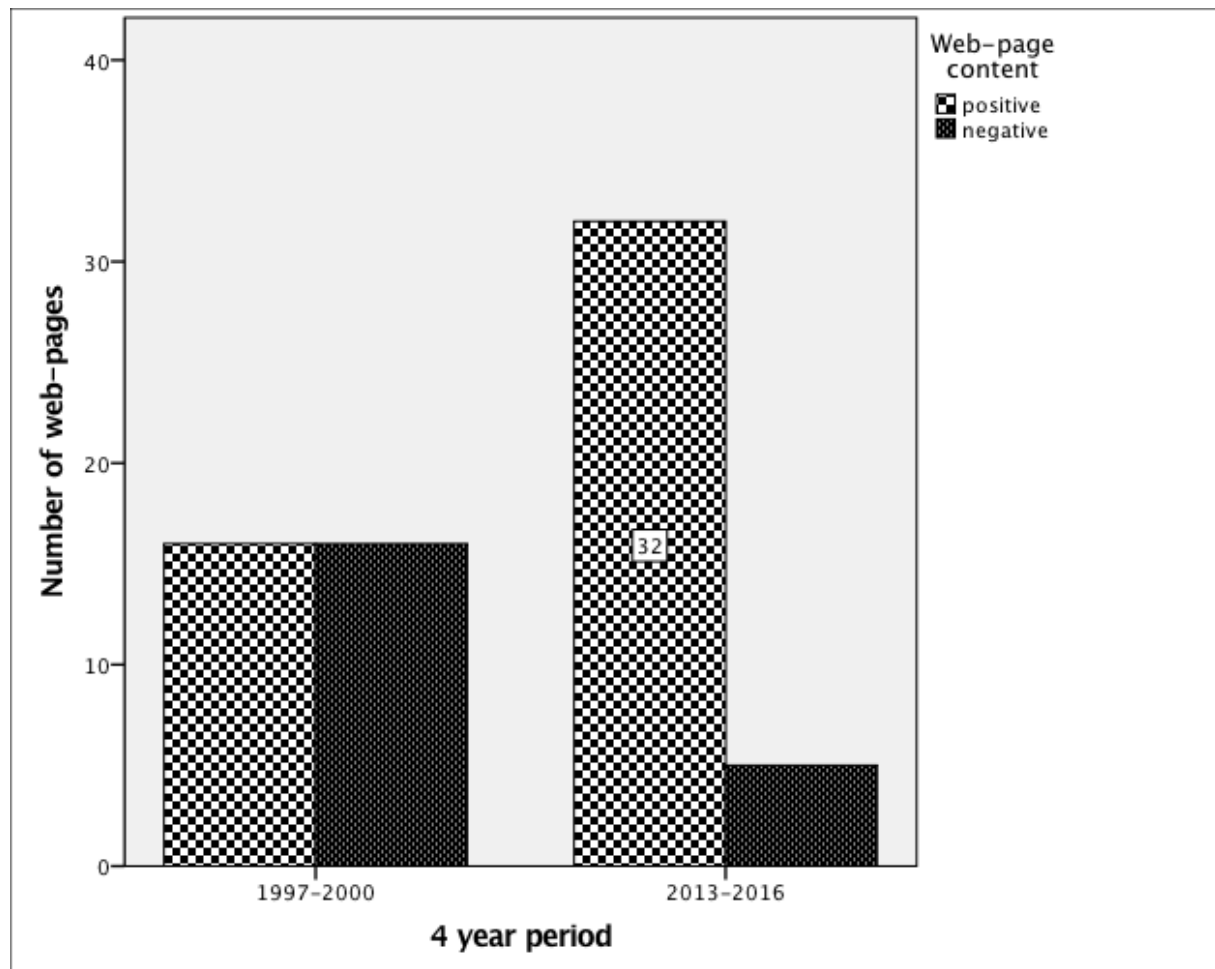
Figure 3. Comparing positive and negative web-pages from the first 4 years (1997-2000) with the last 4 years (2013-2016)

Emotional language and rating of web-pages contents

In order to investigate Hypothesis 2, that more emotional words are used in web-pages that are negative to fluoride, we analyzed if the proportions of emotional words used differed between web-pages rated as either positive or negative. We chose a random web-page from each rating category for each year. This resulted in a total of 20 positive pages and 16 negative (since there were years that had no negative pages). The texts of these pages were then analyzed using LIWC, and non-parametric Mann-Whitney U-tests were performed to check for differences in language use based on rating category. Looking at simple word counts there are no significant differences in the amount of words used in web-pages rated as positive versus negative. In order to investigate however, we found that there were significantly higher proportion negative emotional words in the web-pages that were negative/critical towards fluoride (Mdn = 1.76), than in the positive web-pages (Mdn = 1.00;

$U = 52.50$, $p < .001$. Also, there were differences in the proportions of other specific, negative word categories related to anxiety, anger and sadness. There were higher proportions of these word categories in the contents of web-pages rated as negative with regards to fluoride. No differences were found in the proportion of positive emotion words (see Table 6).

Table 6. The proportion of different emotional word categories in negative and positive web-pages, and tests of differences.

Rating categories	Word Count: Mdn (IQR)	Affect: Mdn (IQR)	Positive emotions: Mdn (IQR)	Negative emotions: Mdn (IQR)	Anxiety: Mdn (IQR)	Anger: Mdn (IQR)	Sadness: Mdn (IQR)
Positive	2402.00 (2009.00)	2.78 (1.69)	1.76 (1.36)	1.00 (.33)	.17 (.19)	.18 (.21)	.15 (.13)
Negative	3851.50 (5987.00)	3.87 (.91)	1.87 (1.42)	1.76 (1.14)**	.29 (.15)*	.36 (.41)**	.30 (.18)**

Note. Mann-Whitney U-tests; *p < .05; **p < .01

Discussion

To summarize the results, there are more positive web-pages than negative ones on Google top 10 web-pages with the search word "fluoride teeth" in the timespan from 1997-2016. The fluoride category that the positive web-pages had the highest frequency of are "other fluoride supplements" while the negative web-pages had the highest frequency of "water fluoridation". There are more positive web-pages in the last four years (2013-2016) than the first four years (1997-2000). Also, the negative web-pages have a higher proportion of negative emotional words compared to the positive web-pages, while there are no difference when it comes to the amount of positive emotional words.

Why positive web-pages?

As the results showed, the majority of the web-pages are positive towards oral fluoride products, which was not what we had hypothesized. One reason for these findings might be that internet-marketers associated with fluoride-selling companies know how to manipulate Google. As written in the limitation section, it is possible to manipulate Google search results so that your web-page arrives in the top 10 sections during a search. Since professional fluoride-selling companies want to earn money, they might have hired professionals to manage their web-pages so that their product reaches out to the masses. As we were analyzing the web-pages for commercial content, some of the commercial operators were seen repeatedly in the positive web-pages, especially Colgate - 34% of all the commercial positive web-page articles were linked to this domain. This is interesting, since 46.7 % of the positive commercial web-pages from the last 4 years are linked to Colgate while no web-pages from the first 4 years are. This might explain some of the reason behind the increasing positivity towards fluoride as we approach recent times. However, our analyses do not show that commercial web-pages generally are more positive than non-commercial web-pages.

Another reason for why there were more positive web-pages than negative as we approach recent years, can be because people may have become more enlightened and generally positive towards fluoride over time – therefore, more web-pages that is not directly connected to sales of fluoride products might write about them to get traffic to their pages.

Web-page ratings and fluoride types

One of the questions that we had was if there is any connection between types of fluoride supplement and how we had rated the web-pages with regards to fluoride (positive/negative). As the results show, there is a higher proportion of web-pages negative towards water fluoridation than positive.

One theory of why the negative web-pages focuses on water fluoridation might be that this is the only type of fluoride supplement that limits the freedom of choice (American Dental Association, 2005). As noted in table 2, it is looked as an infringement on personal freedom and liberties. Violating the value of freedom might upset a lot of people. Another reason might be that water fluoridation was the first fluoride product that was launched to the public and have been on the market for the longest time, it has therefore been exposed to a lot of research (American Dental Association, 2005). As written in the introduction, even though the research shows time and time again that the use of fluorides in the recommended doses is safe, it is difficult to change a non-believers point of view.

Those who are against fluoride also fear systemic disease from the intake of fluoride water. When the effect as already mentioned is mostly topical (Fejerskov et al., 2015), the need of ingestion gets pointless for people– so when there is fluoride in drinking water, it can raise a lot of questions. Although research, as mentioned in the introduction, has shown there is no correlation between the claimed harmful effects in digesting fluorides if the doses is within the recommended value (Osvik et al., 2017).

The reason for why the category "other fluoride supplements" were mostly associated with positive web-pages, might be due to the fact that the other fluoride supplements usually were about topical fluoride, and this has been promoted both by the dentists and dental health workers as an important measure in oral health, they also use these products actively when treating patients. Another reason might by that these are less associated with the claimed systemic diseases and dental fluorosis due to its topical effect, and it is also dependent on patient compliance – it supports patient autonomy.

Words and emotions

The results show that the web-pages with a negative viewpoint on fluoride contain more emotional words indicating negative feelings than the web-pages with a positive viewpoint. One reason for these findings might be that the web-pages that focused on a negative perspective have an opportunity to use a different vocabulary than the positive web-pages, perhaps because negative web-pages cannot relate content to research findings or scientific evidence. Rather, these web-pages might be more focused on creating emotional engagement and focusing on personal stories and experiences, whereas positive web-pages have that benefit of relating to research findings and public health recommendations (which are most often deliberately "unemotional"). "Research suggests that narratives are easier to comprehend and audiences find them more engaging than traditional logical-scientific communication» (Dahlstrom, 2014, p. 13614). This might be the case for these negative web-pages too, the amount of emotional words might make it more like a narrative than a scientific paper, hence it is a mechanism to capture the audiences' attention.

Studies also have shown that negative events or negative content are remembered better than positive (Baumeister, Bratslavsky, Finkenauer, & Vohs, 2001) – and if these findings are applicable here, it means that negative emotional words in websites are better remembered by people exposed to it. As mentioned earlier, once a person has become convinced of something, it's incredibly difficult to make the person change his mind unless this person has been trained in critical thinking (Låg, 2015). This can also be a reason for the amount of emotional words in the negative web-pages.

Limitations

We expected that we would find more negative web-pages than positive ones on Google about fluoride. We believed this because we as dental students have treated patients and have had discussion with people that are against the use of oral fluorides. We thought that if we see people that are against fluoride in our everyday life, then there must be a big group that discusses this topic in a negative way with the anonymity of the internet. On the internet, their privacy is somewhat protected, and they might write whatever they want without public ridicule. But as our data showed, there is actually more positive web-pages that showed up than negative ones when using the search phrase "fluoride teeth". There are psychological theories that might explain why we thought that negative web-pages dominated the web.

One of the reasons might be that we remember better the web-pages we have seen and discussion that we have had that is negative towards fluoride. Humans have a tendency to better remember experiences and statements that have provoked strong emotions, especially negative ones (Baumeister et al., 2001; Kensinger, 2007; Psychologist World, 2018). As dentistry students, we have been taught that fluoride is safe to use and effective against decay. When we read articles that challenge that belief, we get provoked which make us remember the article better. When we then think back to talks that we have had about fluoride, we remember the provoking ones. We might then have gotten the conviction that there are more negative web-pages online and focused on those. In psychology this error of thought is called confirmation bias (Casad, 2016; Nickerson, 1998).

One of the criteria that we had when we designed this thesis was to search Google for web-pages that were unbiased by our own beliefs. Because of that, we chose search words that in our opinion were emotionally neutral. The result showed that by this search word, there were more web-pages that are positive towards fluoride than negative.

This result makes it tempting to say that there is in total more web-pages on the internet that is positive towards oral fluoride. But this might not be true. There are several factors that decides if a web-page get in the top 10 list on Google. Google have its own algorithms to select which web-pages that are allowed to be in top 10 posts. For example the amount of links that is connected to that specific web-page influence if it is allowed to the top 10 list (Google, 2018). And we do not know which search word people use when they are looking for information about fluoride online. As we saw in the text analysis of the positive and negative web-pages, the negative web-pages had more emotional words than the positive ones. This might indicate that the people who are negative towards fluoride use negative charged search words to find their information online. If that is true it means that the emotional content of the search sentence will change the google search results dramatically.

Cookies and top 10 web-pages

It is important to express that even though we changed the search settings on Google to find articles/web-pages that are written at certain years, the search itself is not a time capsule. For example, if we searched for web-pages that contained articles from the year of 2005, we do not get the results that the same search would have given us if did the same search in 2005.

As mentioned, Google have its own algorithms for which web-pages are allowed to be in the top 10. We decided that google only shows us articles that were written in those years that we chose. And for some web-pages that Google presented, we could not find out when that article/web-page was founded. Some web-pages might have been edited after the time they were published. This makes it impossible to predict if there is more positive/negative web-pages in the later years than the earlier ones.

We also experienced that the ranking of the top 10 web-pages might change between searches. If we did a search one day and did the same search with the same Google settings another time, the order of the web-pages on the top 10 list might have changed. This raises the question that if we had done this analysis another day, would the ratio between positive and negative web-pages have been much more different? We only did an analysis of the top 10, maybe we had found something else if we analyzed say top 40?

We also deleted the browser cookies for each search, this is not what people normally do in everyday life – this is also an important bias. A cookie is a packet of data that is sent to your browser from the web-page you visit with the purpose to remember information of your visit to simplify you next visit and adapt the search results according to this (Google, 2018). Thus, the search result might be affected by earlier search.

Conclusion

This study has shown that the majority of easily accessed web-pages found on the main internet search engine are positive towards oral fluoride supplements, and that the trend appears to be more positive pages in recent years. From a public health dentistry perspective, this might be considered an important finding since people are relying on Internet search engines such as Google to educate themselves on issues relating to health. However, it is beyond the scope of this study to generalize and say if these findings can be regarded as the norm for the topic of oral fluorides on the whole internet. We also find that language use in positive and negative web-pages appear different, where negative web-pages concerning fluoride uses significantly higher proportion negative emotional words compared to positive web-pages. One theory for this difference is that the negative web-pages lack the scientific evidence to back their claims about fluoride and need to use negative and provoking words to influence their readers. More research is needed concerning the spread of oral health information online and the factors that influence what information people attend to.

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