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Original Research Article

Patterns and Distribution of Dental Caries and Dental Fluorosis in Areas with Varying Degrees of Fluoride Ion Concentration in Drinking Water: A Systemic Review and Meta analysis

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Abstract

Introduction: The current study was commenced to review the literature systematically to assess the patterns and distribution of dental caries and dental fluorosis in areas with varying degrees of fluoride ion concentration in drinking water.

Materials and Methods: The inclusion criteria were framed as per recommended by PRISMA guidelines.

Results: Overall, a total of 52 articles were identified from the search of major databases and manual scanning of reference lists of relevant articles. After initial screening based on titles and abstracts, full texts of 18 articles were retrieved for further evaluation. 13 articles were excluded. This left a total of 5 articles for inclusion in the review. Across 5 studies providing relevant data, indicated positive and statistically significant correlation between daily intake of fluoride and dental fluorosis and no relation was observed between water fluoride levels and the prevalence of dental caries.

Conclusion: The study concluded that there was a positive and statistically significant correlation between daily intake of fluoride and dental fluorosis and no relation was observed between water fluoride levels and the prevalence of dental caries.

Keywords: Meta-analysis, dental fluorosis, dental caries.

Introduction

Fluorine is a common element in the earth's crust. Fluorides are naturally present in the soil, rocks, and water throughout the world, with higher concentrations in areas where there have been recent/past pyroclastic activities or geologic uplift. Fluorides are also widely used in many industrial processes[1]. Surface water is normally low in fluoride, with values lower than (1.5 mg/L), while groundwater can contain higher concentrations of fluoride depending on geological conditions[2]. The major sources of systemic fluoride exposure are the diet (food and water) (USDA National Fluoride Database of Selected Beverages and Foods – 2004, and fluoride-containing dental products[1]. Starting from the first water fluoridation studies in the USA in the late 1940s, fluoride has had a tremendous impact on the oral health of millions of adults and children[3] The Bureau of Indian Standards (BIS) has set the maximum permissible level of fluoride in drinking water at 1 ppm[4]. Fluoride is a double-edged sword. Fluoride at optimal level, decreases the incidence of dental caries and is also necessary for maintaining the integrity of oral tissues but at the same time when taken in excess during developmental stages, can cause adverse effects like dental fluorosis and skeletal fluorosis[5]. The observation that the fluoride ion was associated with a decreased prevalence of dental caries led to the development of numerous other products containing fluoride which were intended to be ingested, applied topically to the teeth, or both. These products have had a direct impact on the current prevalence of both caries and enamel fluorosis[6-8]. However, during this same period, the prevalence of enamel fluorosis has also increased markedly in both optimally fluoridated and non-fluoridated areas[8,9]. There is always a need to assess the prevalence of dental fluorosis and dental caries in relation to water fluoride levels so as to revaluate the strategies in caries prevention and the use of fluoride products. This systemic review was thus undertaken with the objective of patterns and distribution of Dental Caries and Dental Fluorosis in Areas with Varying Degrees of Fluoride Ion Concentration in Drinking.

Material and Methods:

Data sources and search strategy

To achieve the objective of this study, we conducted both a systematic review and a meta-analysis. The review was based on a predefined protocol and it was conducted in accordance with PRISMA guidelines. We conducted a systematic search on Web of Science (www.webofknowledge. com), PubMed (www.ncbi.nlm.nih.gov/pubmed), Google Scholar (scholar.google.it) and Scopus (www.scopus.com) databases for publications. The following terms were searched 'dental fluorosis', 'fluorosis', 'Dean Index', 'Thylstrup and Fejerskov Index' and 'drinking' as keywords for literature search which was limited to only reports published in the English language. The fluoride concentration and variation can be related to climate, rainfall and temperature, and thus enlarging the timeperiod can introduce not only additional heterogeneity, but also information that does not necessarily reflect the current situation related to climatic changes.

Study selection and eligibility criteria

The protocol was pre-specified to include observational studies (prospective and retrospective, nested case-control and case-control designs), non-randomized clinical studies and randomized controlled trials (RCTs) which reported relation between dental caries and dental fluorosis One of the most important criteria for the initial selection of studies was the evaluation of the relationship between natural fluoride content

in drinking water and the prevalence of dental fluorosis.

Exclusion criteria

The exclusion criteria included studies that duplicate, studies on sample size smaller than 10, studies that do not provide useful information, case reports, reviews or editorials, only children cases and family-based studies.

Data extraction, Process of screening and selection of articles:

All the citations along with the title and abstract was added to a specified endnote library and final list of studies to be screened for inclusion in the study was prepared by removing the duplicates. Two researchers carefully screened the articles by assessment of the title and thorough reading the abstracts to shortlist the studies which are likely to satisfy the inclusion criteria of the review. Attempts were made to obtain full-text articles for all these shortlisted studies, and thorough assessment was done for the satisfaction of inclusion and exclusion criteria. Studies not satisfying inclusion criteria was excluded further.

Statistical analysis

The prevalence rate of dental fluorosis was investigated by pooling the sample of studies in subgroups given by the level of fluoride in drinking water and the age of people surveyed in the studies.

Results: Overall, a total of 52 articles were identified from the search of major databases and manual scanning of reference lists of relevant articles. After initial screening based on titles and abstracts, full texts of 18 articles were retrieved for further evaluation. 13 articles were excluded. This left a total of 5 articles for inclusion in the review. Across 5 studies providing relevant data, indicated positive and statistically significant correlation between daily intake of fluoride and dental fluorosis and no relation was observed between water fluoride levels and the prevalence of dental caries.

Table 1: Study results

Sr.	Author	Year	Results
1	Mandinic, Z et al[10]	2009	The study conclude that there was an increase in prevalence of dental fluorosis with a corresponding increase in water fluoride content from 0.8 ppm to 4.1 ppm.
2	Sarvaiya BU at al[11]	2012	The study conclude that there was an increase in prevalence of dental fluorosis with a corresponding increase in water fluoride content.
3	Kiran Kumar D et al[12]	2013	No relation was observed between water fluoride levels and the prevalence of dental caries.
4	Sanders AE et al[13]	2019	Inverse income gradients in dental caries were most pronounced in the primary dentition.
5	Stangvaltaite-Mouhat L et al[14]	2021	Higher-level fluoride in the drinking water associated with lower dental caries experience in adults.

Discussion:

The current systemic review included 5 study on fluorides and dental caries. All studies enrolled both male and female patients. Across 5 studies providing relevant data, indicated positive and statistically significant correlation between daily intake of fluoride and dental fluorosis and no relation was observed between water fluoride levels and the prevalence of dental caries.

Mandinic, Z et al (2009)[10] examined fluoride content in water and in the most frequently used vegetables, potato and bean, grown in two different Serbian regions, i.e. control region (Valjevo) and high naturally occurring fluoride region (Vranjska Banja), and moreover, to correlate estimated daily intake with dental fluorosis occurrence as an adverse effect of fluoride exposure of schoolchildren in Serbia. Study confirmed significant difference in fluoride content in water, potato and bean, consumed by 12-year-old children in two investigated municipalities. Results of the study indicated positive and statistically significant correlation between daily intake of fluoride and dental fluorosis level in the fluorotic municipality of Vranjska Banja ($r = 0.61$; $p = 0.000017$).

Sarvaiya BU et al (2012)[11] estimate the prevalence of dental fluorosis in relation with different fluoride levels in drinking water among school going children of 6-12 years age group. The overall prevalence of dental fluorosis was found to be 69.84%. An increase in the community fluorosis index (CFI) with corresponding increase in water fluoride content was found. The study conclude that there was an increase in prevalence of dental fluorosis with a corresponding increase in water fluoride content from 0.8 ppm to 4.1 ppm. A significantly strong positive correlation was found between CFI and fluoride concentration in drinking water.

Kiran Kumar D (2013)[12] did a community based epidemiological study was thus designed to assess the patterns and distribution of dental caries and dental fluorosis in areas with varying levels of water fluoride ion concentration in drinking water supply. A total of 2401 school children were examined, dental caries prevalence was 38% with a mean DMF(S) of 1.2 ± 0.79. Occlusal caries was most common with a mean score of 2.53 ± 1.3. Fluorosis prevalence was 45%. TSIF scores in the category of 1-3 were the most common encountered. No relation was observed between water fluoride levels and the prevalence of dental caries. At water fluoride level ranging from 0.3 ppm to 5.2 ppm, the most common form of fluorosis to be observed was in the TSIF scores ranging from 1-3.

Sanders AE et al (2019)[13] investigated whether water fluoridation attenuated income-related inequality in dental caries among US children and adolescents. Children in families with low income—but not those living in poverty—were less likely than other income groups to live in a predominantly fluoridated country. Inverse income gradients in dental caries were most pronounced in the primary dentition.

Stangvaltaite-Mouhat (2021)[14] examined the association between fluoride levels in the drinking water and dental caries experience in adults in the context of varying tooth surface susceptibility. Data from the cross-sectional National Lithuanian Oral Health Survey conducted in 2017–2019 included a stratified random sample of 1398 35–74-year-olds (52% response rate). The proportions of median decayed, missing, filled surfaces decreased following the surface-based susceptibility hierarchy (group 1–33%, group 2–28%, group 3–24%, group 4–15%). When adjusted for potential determinants, higher-level fluoride (≥ 0.7 ppm vs < 0.7 ppm) in the drinking water associated with lower dental caries experience in all surface-based susceptibility hierarchy groups; Group 1: $\beta =$

− 0.23 (95 %CI − 0.44; − 0.001), Group 2: β = − 0.44 (95 %CI − 0.82; − 0.07), Group 3: β = − 1.14 (95 %CI − 1.88; − 0.41) and Group 4: β = − 6.28 (95 %CI − 9.29; − 3.30). The study concluded that higher-level fluoride in the drinking water associated with lower dental caries experience in adults and this was observed in all surface-based susceptibility groups. However, there is a need to validate the surface-based susceptibility hierarchy in longitudinal adult studies.

Conclusion: The study concluded that there was a positive and statistically significant correlation between daily intake of fluoride and dental fluorosis and no relation was observed between water fluoride levels and the prevalence of dental caries.

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