PHARMACY REVIEW

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Maintaining Good Oral Health With Fluoridated Water

Abstract: *Community water fluoridation (CWF) has been a public health measure against tooth decay since 1945. Strong evidence supports the use of CWF in reduction in caries risk in the pediatric population, and numerous studies also show benefit in adults. CWF remains an important contributor to oral health despite the availability and widespread use of other fluoride-containing dental products. The efficacy, safety, and optimal use of CWF will be discussed.*

Keywords: fluoride; fluoridated water; oral health; dental caries

Introduction

Dental caries is a pathologic process that occurs when lactic acid is produced by bacterial digestion of the fermentable carbohydrates in one's diet.[1] Lactic acid is the primary end-product made by *Streptococcus mutans*, a bacterial species commonly found in the human oral cavity. Lactic acid diffuses into the tooth where mineral ions such as calcium are removed from the hard tissues of teeth in a process known as demineralization.[2] Fluoride is an ion known to help prevent and reverse demineralization.[3] The primary mechanism of action of fluoride in reducing dental caries is topical. Fluoride promotes remineralization and inhibits demineralization of dental enamel during the caries process by contacting tooth surfaces. Fluoride can be found in various dental care products such as toothpastes, gels, mouth rinses, and varnishes. Before these products were available, fluoride was added to public drinking water, known as community water fluoridation (CWF). CWF has been named one of the greatest public health measures of the 20th century by the CDC.[4] The following will describe efficacy, safety, and optimal use of fluoridated water.

> Even though tooth decay can be reduced with fluoridated mouth rinses and toothpaste, fluoridated water is cost effective and provides complementary benefits to such products

Efficacy of Fluoridated Water

The effectiveness of fluoridated water in reducing dental carries is well documented.[4-14] Grand Rapids, Michigan, was the first community to add fluoride to public drinking water in 1945.[14] Eleven years after adding fluoride to drinking water, a 60-65% reduction in the prevalence of dental caries in the permanent teeth of children born after 1945 in Grand Rapids was demonstrated.[14] These beneficial effects led the cities of Newburgh, New York, and Evanston, Illinois, to fluoridate their public drinking water.[15,16] Children who consumed fluoridated water throughout their lives in Newburgh had a 58% lower rate of decayed, missing, and/or filled teeth compared to children of the same

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age in neighboring Kingston, New York—a community without fluoridated water.[15] Even older children of Newburgh who were not exposed to fluoridated water all of their lives had a 41-52% lower risk of dental caries compared with Kingston children of matched ages. A similar risk reduction (57%) in dental caries was demonstrated in children from Evanston, Illinois, after just 71 to 82 months of consuming fluoridated water.[16] A 2015 Cochrane Review evaluated the effects of consuming fluoridated water in children and found a 35% decreased risk of tooth decay, fillings, and premature loss of primary teeth in children who consumed fluoridated water compared to those who did not.[17] The same review also found a 26% risk reduction in the loss of permanent teeth and 15% increase in the percentage of caries-free children in the group consuming fluoridated water.[17]

These benefits of CWF are not just limited to children. Numerous studies in adults have also shown significant reduction in dental caries.[11-13] Results demonstrate that fluoridated water may reduce the risk of dental caries by up to 27% in adults of all ages.[11]

Safety of Fluoridated Water

The safety of fluoridated water has been reviewed and endorsed by several scientific and public health organizations.[18-20] A number of high-quality studies did not find any significant association between the consumption of CWF and increased risk for cancer, heart disease, osteoporosis, bone fractures, Down syndrome, immune disorders, low intelligence, kidney disorders, allergic reactions, or Alzheimer's disease.[6,19] Regarding children, the documented risk of consuming fluoridated water is limited to dental fluorosis, which presents as white streaks visible on dental enamel and in rare cases, presents as pitting of the teeth.[21] Dental fluorosis is caused by consuming excessive amounts of fluoride while the teeth are still forming prior to eruption. In 2015, in an effort to reduce the risk of fluorosis while maintaining the beneficial reduction in dental caries, The U.S. Public Health Service narrowed their recommended fluoride concentration from .7 mg/L-1.2 mg/L to .7 mg/L (.7 parts per million, ppm) as the optimal fluoride concentration to maintain in public drinking water.[20,22]

Cost Effectiveness of Fluoridated Water

When compared to the cost of other prevention programs, water fluoridation is the most cost-effective means of preventing tooth decay for both children and adults in the United States.[23] In fact, the CDC has identified CWF as the most cost-effective method of delivering fluoride to all members of the community regardless of age, educational attainment, or income level.[23] Studies have shown that for water systems that serve over 1000 people, the economic benefit of water fluoridations exceeds cost and the benefit-cost ratio increases with the size of the population.[24] In a study conducted in 2016, researchers found that the annual savings associated with individuals avoiding tooth decay as a result of water fluoridation were estimated at US$6.8 billion, or US$32.19 per person, for the more than 211 million people who had access to fluoridated water through community water systems serving more than 1000 people.[24]

Benefiting From Fluoride at Home

As of 2018, 73% of the US population had access to optimum levels of fluoridated water.[25] However, not all with access choose to drink CFW. Jadav et al conducted a study to determine the source of water consumed by pediatric patients.[26] The survey indicated that most (58%) patients use non-filtered tap water for cooking, but only 10% reported using non-filtered tap water as their primary source of drinking water. Most respondents consumed bottled or vending water as their primary source of drinking water. A second study found the number of US children and adults who do not consume tap water increased from 40% in 2013-2014 to 63% in 2017-2018.[27] Approximately 13% of Americans consume bottled water as their primary source of drinking water and another 45.4% report often consuming bottled water.[28] Distilled, purified, and spring/artesian bottled waters have an average fluoride content between .01-.08ppm, suggesting those who rely on bottled water as their primary source of drinking water are missing out on the caries-protective effects of water fluoridation.[29]

If filtered water is preferred, consuming the recommended fluoride level can be achieved by drinking tap water using a home water filter with an activated charcoal/carbon or hollow-fiber membrane filter.[30,31] Although a small reduction in fluoride content may be seen in the first few liters filtered, the change in fluoride concentration beyond this amount is insignificant.[30,31]

The CDC has declared that consuming fluoridated drinking water in addition to using fluoridated products such as toothpaste provide important and complementary benefits.[33] Fluoridated water keeps a low level of fluoride in saliva and dental plaque all day. The much higher concentration of fluoride in toothpaste offers additional benefit. Fluoride also slows the activity of the bacteria that causes decay and combines with enamel on the tooth surface to make it stronger and better able to resist decay. Together, the 2 sources offer more protection than using either one alone. A 2016 systematic review of the effects of

terminating CWF, which includes data as recent as 2003, concluded there is an increase in dental caries when CWF is ceased.[34] This study suggests that CWF remains beneficial despite the availability and widespread use of fluoride-containing dental care products such as toothpastes, gels, mouth rinses, and varnishes.

Conclusion

Available evidence establishes the relationship between consumptions of fluoridated water and reduction in dental caries. Even though tooth decay can be reduced with fluoridated mouth rinses and toothpaste, fluoridated water is cost effective and provides complementary benefits to such products. Consuming fluoridated water on a consistent basis is a safe and effective way for both preventing and remineralize carious lesions. It must be emphasized, however, that tooth decay is not caused by a lack of consuming fluoridated water. Other methods of good oral hygiene such as tooth brushing and flossing should be used along with the consumption of fluoridated water to help decrease the occurrence of dental carries.

Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The author(s) received no financial support for the research, authorship, and/or publication of this article.
AJLM

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