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WRIT 159A
Scientific Literacy
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The Case for Fluoride in Water

According to the Centers for Disease Control and Prevention (CDC), community water fluoridation (CWF) has been cited as “one of the 10 great public health achievements in the 20th century” (Allukian, 2018) for its role in preventing dental caries. Particularly in the United States and other countries around the world, the act of adding fluoride in public water systems has been done for decades now, and has continuously been statistically shown to lower the rate of dental caries, described as the weakening of teeth and/or bone. In 2022 alone, roughly 72.3% of Americans received fluoridated water through community water systems (CDC), totaling 209 million people nationwide. In many cases, Americans are able to find out if their water is fluoridated from the CDC itself depending on if their state shares that data publically—in clicking around the different water systems within Santa Barbara County, many community water sources were fluoridated, with an average concentration of 0.40 mg/L.

And yet, despite so many American households having access to fluoridated water through these public water systems, many are still cautious, wary of its toxicity in something that we all commonly drink and use everyday. In particular, previous water crises, like the one in Flint, Michigan, brought rise to public scare about lead poisoning, leading to some Americans becoming hyperattentive and advocating for the removal of *all* minerals in our drinking water. More recently, Robert F. Kennedy Jr., the Trump administration’s current secretary nominee for the Department of Health and Human Services, has been under fire for advocating for the removal of fluoride to public water supplies upon entering the new presidential era (Reuters). In an NPR interview from November 2024, Robert F. Kennedy Jr. follows up on a question asking about the administration’s stance on water fluoridation from Steve Inskeep, a journalist from NPR, quoting that “fluoride is almost certainly causing neurological development and loss of IQ in our children, as well as arthritis, bone breakage, thyroid problems, bone cancer, and a number of other diseases…”, saying that fluoride should be removed in American water systems as “it’s a very bad way to deliver [fluoride] because it’s delivered through the blood system”.

Likewise to the American opinion on this topic, RFK Jr.’s stance on water fluoridation was also heavily mixed. In an op-ed following the NPR interview by Leana S. Wen, a columnist for Washington Post, she quotes that “although the data are clear that community fluoridation dramatically reduced cavities before fluoride toothpaste became available, the current benefit is much smaller” (Wen, 2024), releasing a following op-ed after criticism arguing that “there are other, more targeted ways to protect teeth [...] people living in areas without fluoridated water should use fluoridated toothpaste [as seen] in most countries in western Europe, many of which have long decided to stop public water fluoridation”. However, in a separate op-ed from The Hill, Mary Beth Giacona, an opinion contributor, continues to note that "fluoridation helps to prevent the most common chronic disease in children: tooth decay” (Giacona, 2024), noting that the World Health Organization continues to update fluoridation guidelines along with the fact that fluoride is not the only mineral that is in water: they note that “other chemicals [such as aluminum sulfate, carbon dioxide, chlorine and ammonia [...] make our drinking water safe and germ-free”. They note that without this fluoridation of water, major consequences such as increased cases of cavities, as seen in Juneau, Alaska (Associated Press, 2018) led to more

expensive dental costs long-term to treat dental problems, in comparison to fluoridating water for significantly less, which the CDC has noted to be the most cost-effective method for preventing tooth decay in children and adults (Murchio, 2022).

While there has been a lack of quantitative studies done in the United States regarding public opinion of water fluoridation in the 21st century, studies done in other well-developed countries provide insight into how the general public perceives CWF. In 2009, a study released by the *Canadian Journal of Public Health* showed that 63.0% of Canadian adults saw CWF as safe, with 59.7% of them believing that it was effective (Quiñonez, 2009), while 16.3% of respondents reported avoiding fluoridated products all together. In 2010, a study released in Australia found that 70.5% of Australian respondents supported water fluoridation, with 15.1% being opposed and 14.3% remaining neutral (Armfield and Akers, 2010). Within many of these survey-based studies, researchers note that while water fluoridation improves dental health, Armfield and Akers state that "opponents of water fluoridation often have relevant or legitimate concerns [...] such as mandatory fluoridation [...] relating to personal choice". The arguments for and against water fluoridation continue to remain heavily debated in today's society, even as this topic spans as far back as the mid-20th century.

Fluorine, the 9th element on the periodic table, and its anionic form, fluoride, are naturally occurring minerals that are found in nature, including water, in varying concentrations. Going back into the 20th century, fluoride has been effectively delivered and actively involved in one's everyday lifestyle, whether it be through community based methods (such as public water systems), professionally through a dentist (fluoride gels), or self-administered in daily routine (such as the usage of fluoride toothpaste twice a day, as recommended by dentists) (O'Mullane, 2016). Fluoride is also naturally occurring and can be found in certain foods and beverages, such as fish and tea. According to a study conducted by Çakır (2023), tea has some of the highest natural fluoride concentrations, although low enough to where it does not cause toxicity.

Dental caries, known to weaken and crumble the teeth, occurs when acid from bacterial breakdown from carbohydrates breaks down dental plaque, leaving teeth more susceptible to exposure for degradation. In specific, when fluoride is absorbed into the carbonated apatite (enamel mineral) crystals in the teeth, it aids in creating a protective barrier against acid corrosion of the enamel (Featherstone, 1999). By adding fluoride orally into the mouth, such as through fluoridated water, it helps protect teeth by remineralization, which essentially assists in the healing process before cavities form (Allukian, 2018). As the consumption of sugars (carbohydrates) and fats are common, this can lead to an increase in acidity in the mouth, prone for deteriorating teeth. Saliva, which has "buffering components" (Featherstone, 1999) consisting of basic components (eg. bicarbonate, phosphate, peptides) along with calcium and phosphate, which help maintain the acidity in the mouth by neutralizing it. Fluoride assists in remineralization as calcium ions are attracted to fluoride, allowing it to absorb and form a protective barrier around the teeth. In a study conducted by Sanders and Slade in observing the level of dental caries in American children that do not drink tap water (with fluoride in it), they observe that "children and adolescents who did not drink tap water had significantly higher prevalence of dental caries experience than those who drank tap water [...] even adjusted for sugar-sweetened beverage consumption" (2021), presenting the fact that fluoride does aid in avoiding tooth decay even for those who consumed sugar, which is a carbohydrate. Fluoride overall helps in making acidic environments more neutral in the mouth and saliva, making it less prone to dental caries and dental degradation.

The fluoridation of water has been highly endorsed by the world's leading science and health organizations, such as the World Health Organization (WHO), the International Association for Dental Research (IADR), the FDI World Dental Federation, and dental professionals. A scientific range of 0.7-1.2 mg/L of fluoride in water has been established to be the optimal amount of fluoride before it reaches more elevated levels, although this fluoride concentration varies per climate and is dependent on the temperature of a location (O'Mullane, 2016). While fluoride is naturally found on the surface, the WHO states that it can be added in a controlled manner (Çakır, 2023). In the United States, an "optimal fluoride concentration of 0.7 mg/L" under the U.S. Public Health Service provides a quantitative number that achieves the balance between protecting one's teeth and avoiding a condition called dental fluorosis. To ensure that fluoride levels are not dangerously high, the Safe Drinking Water Act and the United States Environmental Protection Agency provide fluoride standards for drinking water, including the maximum concentration that the EPA allows before they step in and send alerts to the general public.

Dental fluorosis, or the distortion of teeth due to high amounts of fluoride, is a consequential side effect of fluoride-rich water. If concentrations of fluoride are not monitored or maintained within the concentrations provided by the WHO, it can develop for those (such as children or adolescents) who are in the process of getting permanent teeth. More specifically, having excessive fluoride at a young age, as teeth start developing, can inhibit or weaken the enamel mineralization process by altering the replenishing of calcium ions. The overall result of dental fluorosis leads to enamel that are porous and vulnerable, causing early erosion of teeth (Aulestia, 2020). It is important to note that adults cannot get dental fluorosis, as the enamel is fully formed (Allukian, 2018). Unfortunately, dental fluorosis is common in countries where fluoride-rich drinking water is not heavily regulated, particularly in third-world countries. While low concentrations of fluoride have been shown through evidence to help with dental health, reaching past those limits only increases the chances of fluorosis (Vithanage, 2015). While there are a number of different techniques to remove excess fluoride from public water systems (such as bone charcoal, activated alumina, clay, distillation), there are no specific techniques that are inexpensive and employable in countries that suffer from poverty. However, preventative measures have been taken in regards to setting a maximum concentration of fluoride—for example, in the United States, a fluoride concentration standard of 4.0 mg/L is set by the EPA to prevent severe skeletal fluorosis, similar to dental fluorosis in the fact that it can also lead to bone deformation, although this condition is considered rare (Allukian, 2018). As a result, it is crucial to set concentration ranges that are universal and acceptable, as fluoride, in unregulated concentrations, can create the opposite effect.

In correlation to the argument made by RFK Jr. linking fluoride to loss of IQ in children, a systematic review conducted in 2025 revealed that higher levels of fluoride exposure (classified as higher than 1.5 mg/L) has been correlated to lower IQs in children (Taylor, 2025), highlighted by the National Toxicology Program under the U.S. Department of Health and Human Services. This systematic review, dating back to 2016, notes that this concentration was intended with fluoride taken from a number of sources, not just fluoridated water, and also provides inconclusive results for connecting children's IQ levels to the American water fluoridation standard of 0.7 mg/L. While these studies were focused on countries outside of the United States, other meta-analyses done when it comes to water fluoridation and IQ have been shown to have no association (Kumar, 2023), but does confirm that "fluoride exposures to levels below 1.5 mg/L in water provide consistent evidence for the lack of an adverse effect on IQ". In

a similar systematic review released in 2023 focusing on studies mainly in China, India, and Pakistan (but none in the United States), the authors also note a similar correlation between higher fluoride concentrations and lowered IQs, but emphasize in their conclusion that further, longitudinal studies must be done for full understanding (Veneri, 2023). With this difference seen in research related to water fluoridation, it only shows that more work must be done in the United States to understand how Americans experience water fluoridation, such as having the fluoride levels in each American county publicly available while also working on longitudinal studies in relation to the quantitative data to determine the neurotoxicity of fluoride. In comparison to other countries, the fluoride concentrations in the United States are fairly low—with limited evidence leading to direct conclusions on the stance (Rabin, 2025).

Despite the research done behind the scenes, it has been reported that the general public is typically divided and mixed when it comes to adding fluoride into water. Allukian (2018) reports that this is primarily due to the lack of public knowledge when it comes to community water fluorination, as health professions fail to educate the public about the benefits of fluoride in water. In addition, Allukian notes that there is a general distrust when it comes to using the government as a source of scientific information for decision making. As this debate continues to heat up, it is important that we must provide scientific evidence and information about community water fluoridation in effective ways for the general public to take a stance, rather than following social media or implicit statements from those who may not be as knowledgeable.

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