Fluoride Facts – NLWA Research
(updated 14 June 2023)

1. Fluoride is the name for several different chemical compounds containing the highly-reactive element fluorine. Fluoride can be found as a solid mineral or be dissolved in water or acidic solutions. Water leaches fluoride out of the ground and it concentrates naturally in well and surface water, meat, potatoes, fish, sugar, milk, and beans. Tea leaves are often very high in fluoride content, with concentrations as high as 100 parts per million (ppm) or more (Kanduti, 2016), resulting in brewed teas with fluoride concentrations of 1 to 6 ppm (ADA, 2018).
2. Fluoride will be found in any food processed with fluoridated water, including many supermarket items. (ADA, 2018)
3. The US Environmental Protection Agency (EPA) regulates public drinking water and treats fluoride as a contaminant, having established a legally enforceable Maximum Contaminant Level (MCL) of 4.0 ppm and an unenforceable Secondary Maximum Contaminant Level (SMCL) of 2.0 ppm. (ADA, 2018)
4. The US Food and Drug Administration (FDA) regulates bottled water and treats fluoride in water as a food additive. Bottled water that contains fluoride within its standards may be labeled, "Drinking fluoridated water may reduce the risk of tooth decay." This health claim is not intended for use on bottled water products specifically marketed for use by infants. (ADA, 2018)
5. In the United States, the standard concentration of fluoride in toothpaste is 1,000 - 1,100 ppm. (CDC, 2001)
6. The FDA treats the much higher concentration of fluoride in toothpaste as an over-the-counter drug and requires this warning, "**Keep out of reach of children under 6 years of age**. If more than used for brushing is accidentally swallowed, get medical help or contact a Poison Control Center right away." (ADA 2018)
7. Community Water Fluoridation (CWF) first began in the USA in 1945. (ADA, 2018)
8. Fluoride toothpaste first became available in the USA in 1955. (Mitchell, 2013)
9. A recommended fluoridation range of 0.7 - 1.2 ppm was set by the Public Health Service in 1962. In 2015, the PHS replaced the range with a single target value of 0.7 ppm to reduce risk of dental fluorosis (discolored teeth). These are non-punitive recommendations. The only legally enforceable standard for fluoride is the EPA's Maximum Contaminant Level of 4.0 ppm. (HHS 2015))
10. More than 125 national and international health, service, and professional organizations recognize the public health benefits of community water fluoridation for preventing dental decay, including WHO, CDC, AMA, ADA, American Academy of Pediatric Dentistry, and the Mississippi Dental Association. (ADA, 2018)
11. At the turn of the century, the Centers for Disease Control and Prevention (CDC) proclaimed community water fluoridation (along with family planning, vaccinations, water chlorination, and infectious disease control) as one of ten great public health achievements of the 20th century. (ADA, 2018)
12. 370 million people (5% of worldwide population) receive artificially fluoridated water. (CRS, 2013)
13. As of 2014, nearly 75% of the U.S. population that were on public water systems (211 million people) had artificially fluoridated tap water. (ADA, 2018)
14. As of 2015, more than 177 U.S. communities in 35 states have voted to adopt or retain successful fluoridation programs. (ADA, 2018)

15. Multiple studies of communities with good oral hygiene practices and use of topical fluoride (toothpaste, mouthwash, dental varnishes) show no decrease in dental health when CWF is ended, whereas communities with poor dental hygiene showed marked increases in cavities when CWF has been halted. (ADA, 2018)
16. The decision to fluoridate a public water supply in the USA is made by the state or local municipality and is not mandated by any federal agency. (CRS, 2013)
17. Mississippi Administrative Code 15-20-72-3 mandates CWF for all community water systems (CWS) serving at least 2,000 people.
18. Any Mississippi CWS that fluoridates and wishes to discontinue CWF must provide a written request to the Director of the Bureau of Public Water Supply; comply with the Bureau of Public Water Supply policy for *Discontinuation of Community Water Fluoridation for a Public Water Supply*, and receive written approval from the Director of the Bureau of Public Water Supply. (MSDH)
19. In absence of CWF, ADA recommends the following dosage schedule of sodium fluoride which requires a physician prescription. No fluoride supplement is recommended for newborns and reduced amounts for children < 6 years of age. (ADA, 2018)

Table 1. Dietary Fluoride Supplement Schedule for Children at High Caries Risk[8]

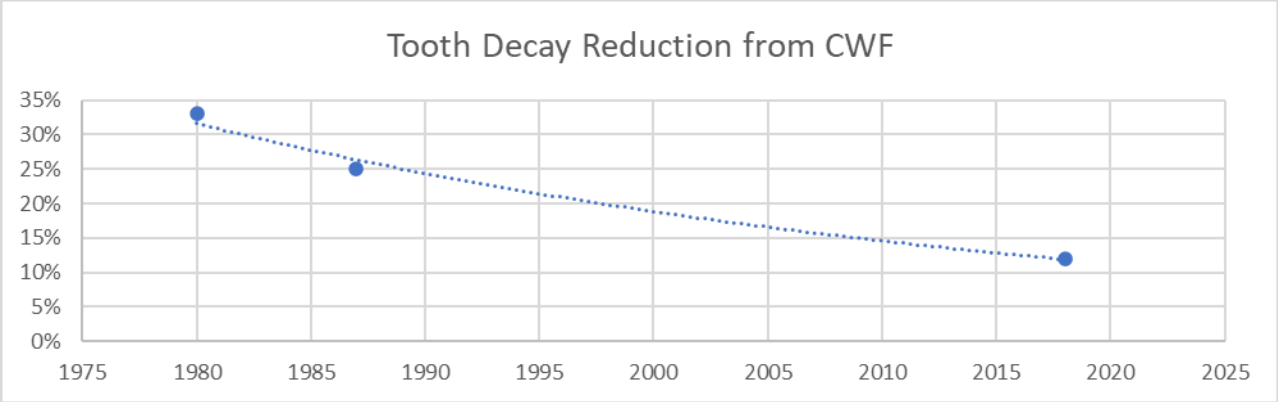
Age	Fluoride ion level in drinking water (ppm)*		
	<0.3 ppm	0.3–0.6 ppm	>0.6 ppm
Birth – 6 months	None	None	None
6 months – 3 years	0.25 mg/day**	None	None
3–6 years	0.50 mg/day	0.25 mg/day	None
6–16 years	1.0 mg/day	0.50 mg/day	None

* 1.0 part per million (ppm) = 1 milligram/liter (mgL) **2.2 mg sodium fluoride contains 1 mg fluoride ion.

20. The recommended beneficial amount of fluoride can be obtained from a variety of sources other than water (e.g., fluoride toothpastes, rinses, and supplements). (CRS, 2013)
21. Fluoride toothpaste accounts for more than 90% of sales in the USA. (CDC, 2001)
22. "[D]rinking fluoridated water, brushing with fluoride toothpaste, or using other fluoride dental products can raise the concentration of fluoride in saliva present in the mouth 100- to 1,000-fold. The concentration returns to previous levels within 1 - 2 hours." (CDC, 2001)
23. "In the earliest days of fluoride research, investigators hypothesized that fluoride affects enamel and inhibits dental caries [cavities] only when incorporated into developing dental enamel (i.e., pre-eruptively, before the tooth erupts into the mouth). Evidence supports this hypothesis, but distinguishing a true pre-eruptive effect after teeth erupt into a mouth where topical fluoride exposure occurs regularly is difficult. However, a high fluoride concentration in sound enamel cannot alone explain the marked reduction in dental caries that fluoride produces. The prevalence of dental caries in a population is not inversely related to the concentration of fluoride in enamel, and a higher concentration of enamel fluoride is not necessarily more efficacious in preventing dental caries." (CDC, 2001)
24. "[L]aboratory and epidemiologic research that has led to the better understanding of how fluoride prevents dental caries indicates that fluoride's predominant effect is post-eruptive and topical and that the effect depends on fluoride being in the right amount in the right place at the right time. Fluoride works primarily after teeth have erupted, especially when small amounts are maintained

constantly in the mouth, specifically in dental plaque and saliva. Thus, adults also benefit from fluoride, rather than only children, as was previously assumed." (CDC, 2001)

25. "[S]ome more recent studies have suggested that water fluoridation has become less important and effective in preventing caries when compared with the findings of earlier studies. Some of this research has attributed the smaller differences in caries prevalence between fluoridated and nonfluoridated communities to the widespread use of fluoride toothpaste and other preventive dental care, and to better nutrition, including higher intake of vitamin D." (CRS, 2013)
26. The results of a 1979-1980 survey found a 33% difference in the prevalence of dental caries among children in fluoridated and nonfluoridated regions in the United States, whereas a 1986-1987 national survey identified an 18% difference in caries prevalence. (Brunelle et al., 1990)
27. When the National Institutes of Health (NIH) analyzed the 1986-1987 results above and controlled for background and topical fluoride, they found the difference between fluoridated and nonfluoridated areas increased to 25%. (CRS, 2013)
28. A 2018 study of more recent data for 7,000 children aged 2 to 8 years and 12,604 children aged 6 to 17 years found a 12% prevention rate for decayed, missing, and filled tooth surfaces (DMFS) attributable to CWF. (Slade et al., 2018).
29. NLWA plot of the study data showing the declining benefit of community water fluoridation in the USA. Tooth decay reduction in children for many other nations follows a similar curve, whether they fluoridate their water or not, indicating other factors are dominant (increasing use of fluoride toothpaste, improving nutrition, increasing wealth, improving access to dental care, etc.)



NLWA interpretation: CWF is certainly beneficial in preventing tooth decay from plaque bacteria, but that benefit is decreasing over time because of improving dental hygiene practices and more fluoride intake from other sources such as toothpaste and processed foods. The trend line plotted across three authoritative studies shows the overall national effect of cavity prevention due to water fluoridation is now less than 12%. The benefit is going to be lower where people regularly brush with fluoride toothpaste, and higher where dental hygiene is poor.

30. Because the use of fluoridated dental products and the consumption of food and beverages made with fluoridated water have increased since 1945, many people now may be exposed to more fluoride than anticipated. (CRS, 2013)
31. Because of the increased use of fluoridated dental products and the tendency for young children to swallow these products, concern over *dental fluorosis* and other potential effects [skeletal, neurological] of fluoride ingestion has been increasing in recent decades. (CRS, 2013)
32. *Dental fluorosis* is caused by excessive fluoride intake while teeth are developing, and it is during this period before teeth erupt that dental tissues are very sensitive to fluoride (typically during a

child's first eight years). Mild dental fluorosis is characterized by opaque white or stained patches in the dental enamel. More severe fluorosis is characterized by pitting of tooth enamel. (CRS, 2013)

33. In 1986, EPA set its current Maximum Contaminant Level (MCL) of 4.0 ppm for fluoride, and also its Secondary Maximum Contaminant Level (SMCL) of 2.0 ppm to protect infants and young children against *systemic dental fluorosis* and "adverse effects on bone structure." (CRS, 2013)
34. In 2006, the National Research Council (NRC) released a study commissioned by the EPA that recommend the MCL be halved from 4.0 ppm to 2.0 ppm to "prevent children from developing severe *enamel fluorosis* and reduce the lifetime accumulation of fluoride into bone that the majority of the committee concludes is likely to put individuals at increased risk of bone fracture and possibly *skeletal fluorosis*, which are particular concerns for subpopulations that are prone to accumulating fluoride in their bones." EPA has not followed this recommendation. (ADA, 2018)
35. World Health Organization (WHO) guideline for maximum fluoride in drinking water is 1.5ppm. (WHO, 2017)
36. The most recent data from widespread medical examinations compiled by the CDC's National Center for Health Statistics in a 2010 study showed a marked increase in *dental fluorosis* between 1987 and 2004, with rates of 41% for children aged 12-15 and 9% for adults aged 40-49. These exact numbers are disputed, but the upward trend is not. (Beltran-Aguilar et al., 2010)
37. In 2006, the ADA recommended that infant formulas be mixed with fluoride-free water to reduce risk of *dental fluorosis*. (CRS, 2013)
38. The USA baby food industry has voluntarily reduced fluoride content to < 0.3 ppm. (CRS, 2013)
39. Worldwide, 30 of 195 nations practice CWF and/or have fluoridated table salt, including Argentina, Australia, Brazil, Canada, Chile, Colombia, Malaysia, New Zealand, Singapore, Ireland, Spain, UK, USA, and others. (CRS, 2013)
40. European nations that have banned or ended involuntary CWF, and/or which have chosen the alternative of voluntary fluoridated table salt: Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Hungary, Israel, Norway, Spain, Sweden, Switzerland, The Netherlands. (CRS, 2013)
41. EU regulations as of 2017 permit the fluoridation of water and table salt, but "the majority of EU countries favor the twice daily use of fluoride toothpaste as the most important measure for improving the public's dental health." (ADA, 2018)
42. "In the late 1980s, water fluoridation was widely available in the German Democratic Republic [East Germany] and Czechoslovakia and to a lesser extent in Poland. With the end of the Communist regimes, efforts related to public health dentistry were largely discontinued." (ADA, 2018)
43. Japan treats sodium fluoride as harmful and instead uses calcium fluoride for dental health purposes to help prevent fluoride from substituting for calcium in teeth and bones. (CRS, 2013)
44. Many toothpaste and mouthwash products today use sodium fluoride because it tastes better, but it does not have the antimicrobial properties of stannous fluoride, which was used in the original formulation of Crest fluoride toothpaste in 1955, and which is still available today in "deep cleaning" variants of over-the-counter products and in some medically-prescribed formulations. Both versions of fluoride in combination with the abrasives in toothpaste provide decay-prevention benefits.
45. A recurring theme in study comments in the reputable scientific literature is that there is a gross lack of statistically significant data on the effects of specific doses of fluoride on individuals – particularly on systemic dosing effects to the skeletal and neurological systems. The data that exists is mostly from "environmental studies" which look at large populations and average doses, and mostly focus on dental effects. "[R]esearch gaps regarding the potential health effects of exposure to increased amounts of fluoride and among different age groups continue to add controversy to decisions

regarding water fluoridation. . . . Scientific uncertainty regarding the health effects of exposure to higher levels of fluoride adds controversy to decisions regarding water fluoridation." (CRS, 2013)

46. The scientifically prestigious Cochrane group of the UK in 2015 surveyed all 4,677 studies on water fluoridation they could find worldwide and found only 155 that satisfied all fundamental requirements of scientific rigor. 70% of these studies were done before 1975. Within these studies, they could find no evidence for benefits of water fluoridation in adults, nor could they find any data on the effects of discontinuing water fluoridation. They did find a 26% reduction in permanent tooth decay for children, but noted that these results were based on old studies that may not be applicable today. They also found that fluoridation at the lowest recommended level of 0.7 ppm was correlated with a 12% rate of dental fluorosis. (Iheozor-Ejiofor, 2015)
47. *Skeletal fluorosis* ranges from a slight increase in bone mass to crippling joint deformities and calcification of ligaments at very high doses that are extremely rare in the scientific literature. The very few studies of bone fracture incidence correlated with mild *fluorosis* have yielded conflicting results. (CRS, 2013)
48. Cancer risk from fluoride exposure is inconclusive due to a small body of research and evidence that is "tentative and mixed." (CRS, 2013)
49. "In 2016, NTP [National Toxicology Program] completed a systematic review of the published animal literature looking at neurobehavioral effects of exposure to fluoride during development and adulthood in rats and mice. The assessment found a low to moderate level of evidence that support adverse effects on learning and memory in animals exposed to fluoride in the diet or drinking water." (HHS, 2016)
50. "The NRC committee evaluated scientific studies that assessed . . . fluoride's potential neurotoxicity and neurobehavioral effects, endocrine effects, and effects on the gastrointestinal system, kidneys, liver, and immune system. Although various studies in these areas suggested an association between fluoride exposure and adverse effects, the committee generally concluded that the research on these topics was insufficient to assess their significance. Overall, the committee noted that more research was needed." (CRS, 2013)
51. A longitudinal study published in *JAMA Pediatrics* of a cohort of 512 mother-child pairs found a statistical correlation between the mother's fluoride intake during pregnancy and reduced IQ of the child as tested at age 3-4, at the 1.0 ppm dosage level recommended for CWF. (Green et al., 2019)

NLWA interpretation. Pro-fluoride literature generally focuses on the single dimension of dental health, but all drugs and supplements have multi-dimensional effects. Besides teeth, fluoride also certainly affects bones and may affect the brain and other organs. CWF is an indiscriminate approach that targets people of all ages and medical conditions. Due diligence requires considering known effects and plausible risks across all dimensions of physiology and all populations as illuminated by quality research. Research to date on fluoride in the dosage range of CWF has found no solid evidence of bone health problems, but there is growing evidence of negative neurological effects. Scientific opinion has shifted from emphasizing the internal (systemic) benefits of fluoride, to its topical (surface) application benefits. Also, there is now a strong emphasis on providing fluoride-free water to infants. Finally, a recurring theme in the research literature is the lack of data on specific dosages in individuals and the need for more research. On balance, more caution with fluoride seems appropriate, and reduction in EPA MCL legal limits seems overdue.

52. 2016 poll data indicates approximately 1/3 of Americans drink bottled water at home, 1/3 drink filtered tap water, and 1/3 drink unfiltered tap water. (Tobin, 2017)
53. Common faucet, pitcher, countertop, and under-sink filters purchased by consumers for home use contain membranes and activated charcoal that do not remove fluoride from water. Reverse osmosis filtration, distillation, or a special filter containing hydroxyapatite (activated bone char) or activated alumina media is required. (ADA, 2018), (Alkurdi et al., 2019)

54. CWF motivation is primarily socio-economic – to "reduce inequalities in dental health" for those of "lower socio-economic status (SES)" by putting fluoride in "as many mouths as possible," particularly in "poorer communities where children may be less likely to receive adequate dental care," because of less "motivation to maintain oral hygiene or willingness to attend or pay for dental treatment." (quotes from WHO, ADA, CDC, HHS)
55. The impoverished populations most at risk of poor dental care and dental hygiene tend to also be the most distrustful of public water supplies, and the most likely to drink bottled water at home. (Tobin, 2017)
56. People who primarily drink bottled water do not receive the direct dental health benefits of CWF. (ADA, 2018)
57. As of 2016, Americans on average consume 39.3 gallons of bottled water per person per year. (ADA, 2018)
58. As of 2017, Americans are #2 in the world in soft drink consumption, drinking an average of 628 8-ounce servings (39.3 gallons) per person per year. (Kunst, 2019)

NLWA interpretation. People who drink bottled water do not directly benefit from CWF. People who drink lots of soda are unlikely to get much of their hydration from tap water. People who are not diligent about dental hygiene are also unlikely to be diligent about avoiding fluoridated tap water for baby formula. Sugar drinks are one of the principal culprits in tooth decay. Logic argues that a much more effective strategy for reaching the most at-risk population with the right amount of fluoride in the right place at the right time, while not putting infants and young children involuntarily at risk of from possible skeletal and neurological effects, would be to mandate fluoride in soft drinks rather than in the public water supply. ADA and others should shift to this strategy. Why have they not already?

59. NLWA well water natural fluoride level is 0.077 ppm. (MSDH, 2013).
60. NLWA serves 3,950 meters and approximately 10,000 people.
61. NLWA 2021 annual cost for CWF: $15,100 chemicals + $8,200 labor = $23,300.
62. NLWA 2021 annual cost of CWF is $5.90/meter, $2.33/person.
63. NLWA can currently obtain granulated fluoride from only two sources: China and Belgium.

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