

Fluoride in Drinking Water FAQ

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1. What is community water fluoridation (CWF)?

Community water fluoridation refers to the process of artificially adding fluoride (typically silicofluorides) to a community water system to prevent dental caries (tooth decay) in the population. The first public drinking water supply was fluoridated in 1945 and has been a controversial issue throughout its history.¹

As of 2018, just over 207 million people in the U.S. population received fluoridated drinking water (63.4% of the total U.S. population, 73.0% of the population on community water systems).² Decisions to fluoridate community water systems are made at the local or state level.³

2. What are other sources of fluoride exposure?

People are exposed to fluoride through a number of routes, but main routes include ingestion of food, water and beverages with fluoride and dental products containing fluoride, like toothpaste and mouthwash. Other less common routes include inhalation of fluoride in cigarette smoke and industrial emissions and ingestion of other drugs or soil that contain fluoride.⁴

In addition to fluoride being added to water systems, fluoride leaches into drinking water from natural soil erosion and from man-made sources such as discharge from fertilizer and aluminum factories.⁵

3. Don't we need CWF to prevent dental caries (tooth decay)?

No. While community water fluoridation has been hailed as a successful public health intervention that reduces tooth decay, dental products with fluoride (e.g. toothpaste) are sufficient in protecting against dental caries. Although public health agencies argue we need to fluoridate drinking water, research has indicated that the largest benefits of fluoride in preventing tooth decay comes primarily from topical application (e.g. toothpaste, mouthwash, etc.), not through systemic ingestion.⁶

Further, while the U.S. has seen considerable declines in tooth decay since the mid-1900s, countries that do not fluoridate their water systems have seen similar declines.⁷ Since the

start of water fluoridation, fluoride has been added to dental products like toothpaste and mouthwash which are effective alternatives to fluoridated drinking water.⁸

4. Prominent public health organizations have declared CWF a major public health accomplishment of the 21st century. Are they wrong?

Many public health organizations still support CWF, including the American Public Health Association (APHA), American Dental Association (ADA), the American Academy of Pediatrics (AAP), the U.S. Centers for Disease Control and Prevention (CDC) and Public Health Service.⁹ The reductions we've seen in dental caries are certainly an achievement, and we recognize community water fluoridation has played a role in that progress in the U.S. But fluoride in toothpaste and other dental products can accomplish those same goals as demonstrated by the reductions in tooth decay in countries without fluoridated water and research indicating topical fluoride is most beneficial.¹⁰

There has been a growing body of literature since we started fluoridating drinking water that shows fluoride is associated with neurotoxic effects like decreased IQ, ADHD, and cognitive impairment.¹¹ Despite the new studies, EPA has not formally reviewed or conducted a risk assessment evaluating fluoride as a neurotoxic risk.¹²

5. How is fluoride in drinking water regulated?

The EPA has set an enforceable Maximum Contaminant Level (MCL) and non-enforceable Maximum Contaminant Level Goal (MCLG) of 4.0 mg/L, which sets a limit for an allowable concentration of fluoride in a drinking water system. This limit was set to prevent "crippling skeletal fluorosis." The EPA has set a non-enforceable Secondary Maximum Contaminant Level (SMCL) at 2 mg/L, and was established to prevent "moderate dental fluorosis."¹³ Emerging research indicates that the EPA legal limit (4 mg/L) may not adequately protect public health. The 2006 National Research Council (NRC) report found that the enforceable fluoride level does not protect children against health effects.¹⁴ By comparison, the World Health Organization recommends a more protective limit of 1.5 mg/L.¹⁵

The U.S. Public Health Service (PHS) recommends (non-enforceable guidance) community water systems maintain a fluoride concentration of 0.7 mg/L for optimal protection against dental cavities, while preventing dental fluorosis.¹⁶

6. What are the risks of fluoridated drinking water?

Drinking water standards for fluoride were established to protect against damaging bones and teeth,¹⁷ but research since the 1990s have indicated there are other adverse health outcomes beyond the skeletal system.

The National Research Council's (NRC) 2006 review of EPA's drinking water standards concluded fluoride could potentially impact brain function, and additional studies were needed to assess the risk.¹⁸ Since the NRC study, around 200 human, animal, and cellular

academic studies have indicated fluoride could have adverse neurotoxic effects like a decrease in average IQ in children, ADHD, and cognitive impairment in older populations.¹⁹

In recent years, several studies in Canada and Mexico have found associations between concentrations of fluoride in pregnant women and adverse cognitive outcomes in their children, including lower IQ measures and a greater risk of ADHD or ADHD-like symptoms (e.g. inattention).²⁰ Another investigation of Canadian children found formula-fed infants living in regions with fluoridated drinking water had lower non-verbal intelligence scores, compared to those living in non-fluoridated regions.²¹ (*See Appendix for summary of select studies published since the 2016 Petition to EPA*).

Elevated fluoride levels have also been associated with greater rates of hypothyroidism which, given the role thyroid hormones play in nervous system development, could provide insight into how fluoride may impact IQ.²²

There is evidence that fluoride exposure at high concentrations is associated with discoloration of the teeth (enamel fluorosis), and under certain conditions can weaken bone and increase risks of fractures.²³

7. Are adverse neurotoxic effects from fluoride seen at levels that are relevant to the U.S. population? Aren't the impacts just seen at levels much higher than EPA standards?

As of 2016, there were over 20 academic studies that found statistically significant neurological effects from the consumption of fluoride at concentrations considered “safe” by the EPA – less than 4 mg/L. Average IQ reductions have been consistently observed where fluoride levels fall below EPA’s limits.²⁴

Academic studies have shown a clear relationship between fluoride and IQ in children, where greater daily fluoride intake and higher levels of fluoride in blood show a greater reduction in average IQ.²⁵

Studies in Canada have also assessed the relationship between fluoride and cognitive deficits, specifically comparing regions with “optimally fluoridated water” (0.7 mg/L) to non-fluoridated regions. These studies have found associations between increased fluoride levels and both lower IQ and greater risk of ADHD among children and youth.²⁶

Formula-fed infants living in fluoridated regions generally ingest *more* fluoride than breastfed infants, and could experience adverse IQ outcomes even when water is “optimally fluoridated.”²⁷ Additionally, some young children ingest fluoride when brushing their teeth, and when combined with fluoride from drinking water, their total intake could reach levels associated with IQ reductions. These impacts can be even worse among underweight children.²⁸

Though there is limited data available on serum (blood) fluoride levels in U.S. children, based on results from a national survey, roughly 350,000 American children could have fluoride levels in their blood close to the threshold for neurotoxic IQ deficits.²⁹

ADHD may also be associated with fluoridated drinking water within the U.S. A 2015 study found states and regions with a higher proportion of the population receiving fluoridated drinking water also saw higher prevalence of ADHD among children and teens, even after adjusting for socioeconomic differences.³⁰

8. Which subpopulations are the most vulnerable/susceptible to fluoride neurotoxicity?

Vulnerable groups include formula-fed infants, the elderly, African Americans, the undernourished, individuals with kidney disease, and those with certain genetic predispositions.³¹

9. Is community water fluoridation the most equitable way to prevent tooth decay?

Fluoridation proponents argue CWF is the most equitable way to prevent tooth decay among individuals, regardless of age or socioeconomic status.³² Roughly 63 percent of the U.S. population receives fluoridated drinking water from their tap; for non-fluoridated areas, proponents promote the “benefit” of fluoride diffusion through bottled beverages and food made with fluoridated water.³³ But clear evidence showing CWF reduces oral health disparities is limited.³⁴

And other sources of fluoride exist, eliminating the need to add it to drinking water. Most toothpastes in the U.S. contain fluoride, are used by most of the population, and are effective means of preventing tooth decay.³⁵ Mouthwash, gels, varnishes and other dental products can also serve as a source of fluoride.³⁶ Other sources of exposure can include cigarette smoke, industrial emissions, some pharmaceuticals, and soil contaminated with fluoride (see question 2).³⁷

Finally, while widespread drinking water fluoridation may distribute dental health benefits across the population, it also distributes the cost of potential adverse effects, including the neurotoxic effects and dental fluorosis that could disproportionately impact already vulnerable groups (see question 9).

10. Why can't we just lower the concentration of fluoride in drinking water?

Though we could decrease fluoride levels, the U.S. Public Health Service recommends water fluoridation at 0.7 mg/L to prevent tooth decay.³⁸ Lowering the fluoride content to below that recommendation could render water fluoridation ineffective and obsolete, especially when there are existing and effective alternatives like toothpaste and mouthwash.³⁹

Studies have found fluoridated drinking water at current “optimal levels” are associated with adverse neurodevelopmental outcomes,⁴⁰ suggesting a need to reduce the amount of fluoride in water. Using EPA’s own risk assessment guidelines, reference doses and concentrations* are generally determined by applying relevant uncertainty factors (e.g. for variability within the human population, animal-human differences, short term vs. long term studies, etc.) to the levels related to an adverse health effect.⁴¹ Applying even just one uncertainty factor to the levels at which neurotoxic effects have been observed would establish a reference dose/concentration “incompatible with water fluoridation,” though it should be noted that a single uncertainty factor may not be sufficiently protective under EPA’s own standards.⁴²

11. Isn’t community water fluoridation a cost-effective way to prevent tooth decay?

Though fluoridating drinking water systems may be cost-effective in preventing tooth decay,⁴³ the cost from the neurotoxic effects of fluoride cannot be ignored. A loss of just one IQ point is estimated to reduce lifetime earnings by an approximate average of \$24,000.⁴⁴ Given the widespread addition of fluoride to drinking water, the economic costs from fluoridation could be astronomical.

*Reference doses and concentrations are levels at which daily exposure at that level would be unlikely to result in an adverse effect over one’s lifetime.

Appendix: Select public health studies published since 2016 assessing fluoride neurotoxicity.

Study	Summary of Study
Bashash et al. (2017)	This study measured the association between urinary fluoride levels in pregnant women in Mexico and cognitive outcomes in their children. The researchers found a statistically significant negative association between fluoride and cognitive function – “higher prenatal exposure to fluoride...was associated with lower [General Cognitive Index] scores in children approximately 4 y old, and with lower Full-Scale IQ scores at 6-12 y old.” ⁴⁵ The estimated levels of fluoride in Mexico City’s water overlaps concentrations that are recommended for preventing tooth decay in the U.S. and within acceptable limits set by the EPA. ⁴⁶
Bashash et al. (2018)	This study assessed maternal urinary fluoride levels in pregnant women in Mexico and ADHD outcomes in their children at age 6 to 12. The researchers found an increase in some “ADHD-like” symptoms, particularly inattention, with elevated fluoride levels, but no association with hyperactivity. ⁴⁷
Till et al. (2019)	This study looked investigated water fluoride concentrations and its impact on IQ in formula-fed and breastfed Canadian children. Researcher found formula-fed infants living in regions with fluoridated drinking water had lower non-verbal intelligence scores, compared to those living in non-fluoridated regions. ⁴⁸
Green et al. (2019)	This study measured the association between urinary fluoride levels and fluoride intake in pregnant women in Canada, and IQ scores in their children at age 3 to 4 years. Women living in communities with fluoridated drinking water had elevated urinary fluoride and greater fluoride intake. Researchers found a statistically significant association showing an increase in maternal urinary fluoride levels predicts a lower IQ score among boys. There was no significant association for girls. Increased fluoride intake among pregnant mothers was also associated with lower IQ scores among children. ⁴⁹
Riddell et al. (2019)	This study looked at ADHD and hyperactive/inattentive symptoms in Canadian youth, as it relates to fluoride levels. The study did not find an association between urinary fluoride levels and ADHD or related symptoms, but did find higher levels of drinking water fluoride were associated with a greater risk of ADHD symptoms and diagnoses, particularly among older youth. ⁵⁰
Grandjean (2019)	This study is an updated systematic review evaluating fluoride and neurotoxicity studies published since 2012 (including those identified above). The review concludes recent epidemiology studies provide supporting evidence that elevated fluoride intake – especially during early developmental stages – holds neurotoxic risks such as reduced IQ. The review also includes information about how fluoride is absorbed in the body and may impact neurodevelopment. ⁵¹

Endnotes

- ¹ National Research Council (NRC). (2006). *Fluoride in Drinking Water: A Scientific Review of EPA's Standards*. Washington, DC: The National Academies Press at 15.
- ² Centers for Disease Control and Prevention (CDC). "Community Water Fluoridation: 2018 Fluoridation Statistics." September 8, 2020. Available at <https://www.cdc.gov/fluoridation/statistics/2018stats.htm>. Accessed September 2020 and on file with Food & Water Watch.
- ³ NRC. (2006). *Fluoride in Drinking Water: A Scientific Review of EPA's Standards*. Washington, DC: The National Academies Press at 15.
- ⁴ NRC. (2006). *Fluoride in Drinking Water: A Scientific Review of EPA's Standards*. Washington, DC: The National Academies Press at 23.
- ⁵ U.S. Environmental Protection Agency (EPA). "National Primary Drinking Water Regulations." EPA 816-F-09-04. May 2009 at 4.
- ⁶ NRC. (2006). *Fluoride in Drinking Water: A Scientific Review of EPA's Standards*. Washington, DC: The National Academies Press at 15 to 16; CDC. "Recommendations for using fluoride to prevent and control dental caries in the United States." *MMWR Recommendations and Reports*. Vol 50, No. RR14. August 17, 2001 at pdf 5.
- ⁷ Cheng, K.K. et al. "Adding fluoride to water supplies." *British Medical Journal*. Vol. 335. October 2007 at 699 and 700; Pizzo, Giuseppe et al. "Community water fluoridation and caries prevention: A critical review." *Clinical Oral Investigations*. Vol. 11. October 2007 at 2 and 3.
- ⁸ CDC. "Recommendations for using fluoride to prevent and control dental caries in the United States." *MMWR Recommendations and Reports*. Vol 50, No. RR14. August 17, 2001 at pdf 3 and 11.
- ⁹ American Public Health Association (APHA). [Policy statement.] "Community Water Fluoridation in the United States." Policy Number 20087. October 2008; American Dental Association (ADA). "Fluoridation Facts." 2018 at 1 and 62; Jenco, Melissa. American Academy of Pediatrics. [Press release]. "AAP continues to recommend fluoride following new study on maternal intake and child IQ." 2019; Murthy, Vivek H. "Community water fluoridation: One of CDC's '10 great public health achievements of the 20th century.'" *Public Health Reports*. Vol. 130. July-August 2015 at 296 and 297.
- ¹⁰ NRC. (2006). *Fluoride in Drinking Water: A Scientific Review of EPA's Standards*. Washington, DC: The National Academies Press at 15 to 16; Pizzo, Giuseppe et al. "Community water fluoridation and caries prevention: A critical review." *Clinical Oral Investigations*. Vol. 11. October 2007 at 2 and 3; Cheng, K.K. et al. "Adding fluoride to water supplies." *British Medical Journal*. Vol. 335. October 2007 at 700.
- ¹¹ Connett, Michael. Prepared for Fluoride Action Network et al. "TSCA Section 21 Petition to EPA re: Fluoride Neurotoxicity." November 2016 at 5 to 12 and 16; Grandjean, Philippe. "Developmental fluoride neurotoxicity: An updated review" *Environmental Health*. Vol. 18. December 2019 at 1, 2, 11 and 13; Riddell, Julia K. et al. "Association of water fluoride and urinary fluoride concentrations with attention deficit hyperactivity disorder in Canadian youth." *Environment International*. Vol. 133, Part B. December 2019 at 2 and 4 to 6.
- ¹² EPA. "New Fluoride Risk Assessment and Relative Source Contribution Documents." EPA-822-F-11-001. January 2011 at 1 to 2.
- ¹³ EPA. "New Fluoride Risk Assessment and Relative Source Contribution Documents." EPA-822-F-11-001. January 2011 at 1.
- ¹⁴ NRC. (2006). *Fluoride in Drinking Water: A Scientific Review of EPA's Standards*. Washington, DC: The National Academies Press at 2 to 3 and 10.
- ¹⁵ Fawell, J.K. World Health Organization. "Fluoride in Drinking-Water: Background Document for Development of WHO Guidelines for Drinking-Water Quality." WHO/SDE/WSH/03.04/96. 2004 at 7.
- ¹⁶ Murthy, Vivek H. "Community water fluoridation: One of CDC's '10 great public health achievements of the 20th century.'" *Public Health Reports*. Vol. 130. July-August 2015 at 297.
- ¹⁷ EPA. "New Fluoride Risk Assessment and Relative Source Contribution Documents." EPA-822-F-11-001. January 2011 at 1.
- ¹⁸ NRC. (2006). *Fluoride in Drinking Water: A Scientific Review of EPA's Standards*. Washington, DC: The National Academies Press at 222.

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- ²⁰ Bashash, Morteza et al. "Prenatal fluoride exposure and cognitive outcomes in children at 4 and 6-12 years of age in Mexico." *Environmental Health Perspectives*. Vol. 125, No. 9. September 2017 at 2 and 8 to 11; Bashash, Morteza et al. "Prenatal fluoride exposure and attention deficit hyperactivity disorder (ADHD) symptoms in children at 6-12 years of age in Mexico City." *Environment International*. Vol. 121, Part 1. December 2018 at 658, 661 and 665; Green, Rivka et al. "Association between maternal fluoride exposure during pregnancy and IQ scores in offspring in Canada." *JAMA Pediatrics*. Vol. 173, No. 10. August 2019 at 940 and 944.
- ²¹ Till, Christine et al. "Fluoride exposure from infant formula and child IQ in a Canadian birth cohort." *Environment International*. Vol. 135. January 2020 at 1, 2, 5 and 6.
- ²² Peckham, Stephen et al. "Are fluoride levels in drinking water associated with hypothyroidism prevalence in England? A large observational study of GP practice data and fluoride levels in drinking water." *Journal of Epidemiology and Community Health*. Vol. 69, Iss. 7. February 2015 at Abstract; Connett, Michael. Prepared for Fluoride Action Network et al. "TSCA Section 21 Petition to EPA re: Fluoride Neurotoxicity." November 2016 at 17.
- ²³ NRC. (2006). *Fluoride in Drinking Water: A Scientific Review of EPA's Standards*. Washington, DC: The National Academies Press at 2 and 4 to 7.
- ²⁴ Connett, Michael. Prepared for Fluoride Action Network et al. "TSCA Section 21 Petition to EPA re: Fluoride Neurotoxicity." November 2016 at 5 to 6.
- ²⁵ Connett, Michael. Prepared for Fluoride Action Network et al. "TSCA Section 21 Petition to EPA re: Fluoride Neurotoxicity." November 2016 at 7 to 8 and 11 to 12.
- ²⁶ Green, Rivka et al. "Association between maternal fluoride exposure during pregnancy and IQ scores in offspring in Canada." *JAMA Pediatrics*. Vol. 173, No. 10. August 2019 at 940, 944 and 946; Till, Christine et al. "Fluoride exposure from infant formula and child IQ in a Canadian birth cohort." *Environment International*. Vol. 135. January 2020 at 1, 2, 5 and 6; Riddell, Julia K. et al. "Association of water fluoride and urinary fluoride concentrations with attention deficit hyperactivity disorder in Canadian youth." *Environment International*. Vol. 133, Part B. December 2019 at 2 and 4 to 6.
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- ³⁰ Malin, Ashley J. and Christine Till. "Exposure to fluoridated water and attention deficit hyperactivity disorder prevalence among children and adolescents in the United States: An ecological association." *Environmental Health*. Vol. 14, No. 17. February 2015 at 6 to 7.
- ³¹ Connett, Michael. Prepared for Fluoride Action Network et al. "TSCA Section 21 Petition to EPA re: Fluoride Neurotoxicity." November 2016 at 18.
- ³² ADA. "Fluoridation Facts." 2018 at 1 and 86; APHA. [Policy statement.] "Community Water Fluoridation in the United States." Policy Number 20087. October 2008.
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- ³⁵ NRC. (2006). *Fluoride in Drinking Water: A Scientific Review of EPA's Standards*. Washington, DC: The National Academies Press at 41; Pizzo, Giuseppe et al. "Community water fluoridation and caries prevention: A critical review." *Clinical Oral Investigations*. Vol. 11. October 2007 at 4; CDC. "Recommendations for using fluoride to

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³⁶ CDC. “Recommendations for using fluoride to prevent and control dental caries in the United States.” *MMWR Recommendations and Reports*. Vol 50, No. RR14. August 17, 2001 at pdf 8.

³⁷ NRC. (2006). *Fluoride in Drinking Water: A Scientific Review of EPA’s Standards*. Washington, DC: The National Academies Press at 23.

³⁸ Murthy, Vivek H. “Community water fluoridation: One of CDC’s ’10 great public health achievements of the 20th century.” *Public Health Reports*. Vol. 130. July-August 2015 at 297.

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⁴³ ADA. “Fluoridation Facts.” 2018 at 1; Ran, Tao and Sajal Chattopadhyah. “Economic evaluation of community water fluoridation: A community guide systematic review.” *American Journal of Preventative Medicine*. Vol. 50, No. 6. June 2016 at 790.

⁴⁴ Spadaro, Joseph V. and Ari Rabl. “Global health impacts and costs due to mercury emissions.” *Risk Analysis*. Vol. 28, No. 3. June 2008 at 604 and 609. Note: Spadaro and Rabl (2008) calculated an average drop of \$18,000 in 2005 dollars. Food & Water adjusted for inflation with the Bureau of Labor and Statistics inflation calculator, converting 2005 dollars to 2020 dollars.

⁴⁵ Bashash, Morteza et al. “Prenatal fluoride exposure and cognitive outcomes in children at 4 and 6-12 years of age in Mexico.” *Environmental Health Perspectives*. Vol. 125, No. 9. September 2017 at 2 and 8 to 11.

⁴⁶ Bashash, Morteza et al. “Prenatal fluoride exposure and cognitive outcomes in children at 4 and 6-12 years of age in Mexico.” *Environmental Health Perspectives*. Vol. 125, No. 9. September 2017 at 2; EPA. “New Fluoride Risk Assessment and Relative Source Contribution Documents.” EPA-822-F-11-001. January 2011 at 1; Murthy, Vivek H. “Community water fluoridation: One of CDC’s ’10 great public health achievements of the 20th century.” *Public Health Reports*. Vol. 130. July-August 2015 at 297.

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