



[cancer.org](http://cancer.org) | 1.800.227.2345

---

## Water Fluoridation and Cancer Risk

Many decades after fluoride was first added to drinking water in some parts of the United States, there is still controversy about the possible health effects of drinking water fluoridation. Many people have strong views either for or against water fluoridation. Their concerns are based on everything from legitimate scientific research, to freedom of choice issues, to government conspiracy theories.

This is a review of the possible link between water fluoridation and cancer. Other possible health effects of fluoridation (positive or negative) are not addressed here. This is not a position statement of the American Cancer Society.

### What is fluoride?

Fluorides are compounds that combine the element fluorine with another substance, usually a metal. Examples include sodium fluoride, stannous fluoride, and fluoride monofluorophosphate (MFP fluoride).

Some fluorides occur naturally in soil, air, or water, although the levels of fluoride can vary widely. Just about all water has some fluoride. Fluoride is also found in plant and animal food sources.

Once inside the body, fluorides are absorbed into the blood through the digestive tract. They travel through blood and tend to collect in areas high in calcium, such as the bones and teeth.

### How are people exposed to fluoride?

The major sources of fluoride for most people are water and other beverages, food, and fluoride-containing dental products (toothpastes, mouth rinses, etc.). Because dental

products are generally not swallowed (except, perhaps, by younger children), they cause less concern for possible health issues.

## Fluoride in drinking water

Water fluoridation began in some parts of the United States in 1945, after scientists noted that people living in areas with higher water fluoride levels had fewer cavities. Starting in 1962, the United States Public Health Service (PHS) recommended that public water supplies contain fluoride to help prevent tooth decay.

Fluoride is now used in the public drinking water supplied to about 3 out of 4 Americans. The decision to add fluoride to drinking water is made at the state or local level. The types of fluoride added to different water systems include fluorosilicic acid, sodium fluorosilicate, and sodium fluoride.

Natural drinking water sources in the US also have some fluoride in them, although the levels are much higher in some places than in others.

## How is fluoride in drinking water regulated?

Fluoride is not required in all drinking water sources in the United States, but the levels of fluoride in water are regulated by several government agencies.

Starting in 1962, the United States Public Health Service (PHS) recommended that public water supplies contain between 0.7 and 1.2 milligrams of fluoride per liter (mg/L) of drinking water to help prevent tooth decay. This recommendation was updated in 2015 to a fluoride level of 0.7 mg/L. The change was made in part to account for the fact that people now get more fluoride from other sources (such as toothpaste) than in the past. (Natural drinking water sources in the US have an average fluoride level of about 0.2 mg/L, although in some places it can be much higher.)

The US Environmental Protection Agency (EPA) has set a maximum amount of fluoride allowable in drinking water of 4.0 mg/L. Long-term exposure to levels higher than this can cause a condition called *skeletal fluorosis*, in which fluoride builds up in the bones. This can eventually result in joint stiffness and pain, and can also lead to weak bones or fractures in older adults.

The EPA has also set a secondary standard of no more than 2.0 mg/L to help protect children (under the age of 9) from *dental fluorosis*. In this condition, fluoride collects in developing teeth, preventing tooth enamel from forming normally. This can cause permanent staining or pitting of teeth. (The secondary standard is a guideline, as

opposed to an enforceable regulation, but public water systems must tell their customers if the fluoride level goes above it.)

States can set maximum fluoride levels in drinking water that are lower than the national 4.0 mg/L standard.

Bottled water standards are set by the US Food and Drug Administration (FDA). The fluoride levels allowed vary based on the annual average air temperature in the place where the water is sold.

For bottled water with no fluoride added, the maximum fluoride level allowed is 2.4 mg/L (in places with colder temperatures).

For water in which fluoride is added, the maximum allowed is 1.7 mg/L (in colder climates). However, if fluoride is added, the FDA recommends that manufacturers not go above 0.7 mg/L, which is in line with the PHS recommendation.

## **Does fluoride cause cancer?**

People have raised questions about the safety and effectiveness of water fluoridation since it first began. Over the years, many studies have looked at the possible link between fluoride and cancer.

Some of the controversy about the possible link stems from a study of lab animals reported by the US National Toxicology Program (NTP) in 1990. The researchers found “equivocal” (uncertain) evidence of cancer-causing potential of fluoridated drinking water in male rats, based on a higher than expected number of cases of [osteosarcoma](#)<sup>1</sup> (a type of bone cancer). There was no evidence of cancer-causing potential in female rats or in male or female mice.

Most of the concern about cancer seems to be around osteosarcoma. One theory on how fluoridation might affect the risk of osteosarcoma is based on the fact that fluoride tends to collect in parts of bones where they are growing. These areas, known as *growth plates*, are where osteosarcomas typically develop. The theory is that fluoride might somehow cause the cells in the growth plate to grow faster, which might make them more likely to eventually become cancerous.

## **What have studies found?**

More than 50 population-based studies have looked at the potential link between water fluoride levels and cancer. Most of these have not found a strong link to cancer. Just

about all of the studies have been retrospective (looking back in time). They have compared, for example, the rates of cancer in a community before and after water fluoridation, or compared cancer rates in communities with lower levels of fluoride in drinking water to those with higher levels (either naturally or due to fluoridation). Some factors are hard to control for in these types of studies (that is, the groups being compared may be different in ways other than just the drinking water), so the conclusions reached by any single study must be looked at with caution.

And there are other issues that make this topic hard to study. For example, if fluoridation is a risk factor, is the type of fluoride used important? Also, is there a specific level of fluoride above which the risk is increased, or a certain amount of time or an age range during which a person would need to be exposed?

Osteosarcoma is a rare cancer. Only about 400 cases are diagnosed in children and teens each year in the United States. This means it can be hard to gather enough cases to do large studies. Smaller studies can usually detect big differences in cancer rates between 2 groups, but they might not be able to detect small differences. If fluoride increased the risk only slightly, it might not be picked up by these types of studies.

### ***Assessments by expert groups***

Small studies by themselves might not provide the answers, but taken as a whole they tend to have more weight. Several systematic reviews over the past 25 years have looked at all of the studies published on this subject.

In its review published in 1987, the International Agency for Research on Cancer (IARC), part of the World Health Organization, labeled fluorides as “non-classifiable as to their carcinogenicity [ability to cause cancer] in humans.” While they noted that the studies “have shown no consistent tendency for people living in areas with high concentrations of fluoride in the water to have higher cancer rates than those living in areas with low concentrations,” they also noted that the evidence was inadequate to draw conclusions one way or the other.

In 1991, the US Public Health Service issued a report on the benefits and risks of fluoride. When looking at a possible link with cancer, they first reviewed the results of studies done with lab animals. They concluded that the few studies available “fail[ed] to establish an association between fluoride and cancer.” They also looked at population-based studies, including a large study conducted by the National Cancer Institute. They concluded: “Optimal fluoridation of drinking water does not pose a detectable cancer risk to humans as evidenced by extensive human epidemiological data available to date, including the new studies prepared for this report.”

The National Research Council (NRC), part of the National Academies, issued a report titled “Health Effects of Ingested Fluoride” in 1993. Its conclusion was that “the available laboratory data are insufficient to demonstrate a carcinogenic effect of fluoride in animals.” They also concluded that “the weight of the evidence from the epidemiological [population-based] studies completed to date does not support the hypothesis of an association between fluoride exposure and increased cancer risk in humans.” The report recommended that additional well-designed studies be done to look at the possible link to cancers, especially osteosarcomas.

In the United Kingdom, the National Health Service (NHS) Centre for Reviews and Dissemination, University of York, published a systematic review of water fluoridation in the year 2000. After searching through the medical literature, they included 26 studies in their analysis, all of which were considered to be of “low” to “moderate” quality. They concluded, “Overall, no clear association between water fluoridation and incidence or mortality of bone cancers, thyroid cancer, or all cancers was found.” However, they also noted, “Given the level of interest surrounding the issue of public water fluoridation, it is surprising to find that little high quality research has been undertaken.”

The National Research Council issued an update of its 1993 review in early 2006. While the review included some new data, the results of this report were essentially the same: “On the basis of the committee’s collective consideration of data from humans, genotoxicity assays, and studies of mechanisms of actions in cell systems, the evidence on the potential of fluoride to initiate or promote cancers, particularly of the bone, is tentative and mixed.”

The European Scientific Committee on Health and Environmental Risks (SCHER) reviewed the evidence on water fluoridation in 2010. It concluded that the evidence linking fluoride in water to osteosarcoma was “equivocal,” and that therefore “fluoride cannot be classified as to its carcinogenicity.”

In 2011, the state of California’s Carcinogen Identification Committee (CIC) reviewed the evidence and concluded that “fluoride and its salts has not been clearly shown to cause cancer.”

The general consensus among the reviews done to date is that there is no strong evidence of a link between water fluoridation and cancer. However, several of the reviews noted that further studies are needed to clarify the possible link.

### ***More recent research***

Several studies looking at a possible link between water fluoridation and cancer have been published in recent years.

A partial report of a study from the Harvard School of Public Health, published in 2006, found that exposure to higher levels of fluoride in drinking water was linked to a higher risk of osteosarcoma in boys but not in girls. However, researchers linked to the study noted that early results from a second part of the study did not appear to match those of the report. They therefore advised caution in interpreting the results.

The second part of the Harvard study, published in 2011, compared the fluoride levels in bones near tumors in people with osteosarcoma to the levels in people with other types of bone tumors. The researchers found no difference between the fluoride levels in the two groups.

More recent studies have compared the rates of osteosarcoma in areas with higher versus lower levels of fluoridation in Great Britain, Ireland, and the United States. These studies have not found an increased risk of osteosarcoma in areas of water fluoridation.

## Can you reduce your fluoride exposure?

Even without fluoridation, the natural levels of fluoride in water in some places can be even higher than 4 mg/L. Community water systems in such areas are required to lower the fluoride level below the acceptable standard. But the levels in private water sources, such as wells, may still be higher.

For people concerned that they or their families may be exposed to too much fluoride, there are some steps you can take to reduce your exposure.

- **Know the level of fluoride in your drinking water.** If your drinking water comes from a public source, you can find out about the levels of fluoride in your drinking water by contacting your local community water system. People who get their drinking water from a private source such as a well can have the fluoride levels tested by a reputable laboratory. Each system is also required to provide its customers with an annual report on water quality known as a *Consumer Confidence Report*. This report lists the levels of certain chemicals and other substances in the water, including fluoride. You can also contact the EPA's Safe Drinking Water Hotline at 1-800-426-4791 for more general information about drinking water safety.
- **People who live in areas with high levels of fluoride in the water might consider using alternate sources of drinking water, such as bottled water.** Most bottled water has some fluoride, with natural spring waters tending to have the least. You can contact the bottler to find out about fluoride levels. There are also several methods to filter fluoride out of water, although these can be expensive.

The US Centers for Disease Control and Prevention (CDC) recommends that parents give children under the age of 6 only a pea-sized amount of toothpaste for brushing, and should do their best to make sure their children are not swallowing, as this can be a significant source of fluoride. Speak to your child's dentist before using fluoride toothpaste in children under 2 years of age. Low- and no-fluoride toothpastes and other dental products are also available.

## Hyperlinks

1. [www.cancer.org/cancer/osteosarcoma.html](http://www.cancer.org/cancer/osteosarcoma.html)
2. <http://www.cdc.gov/>
3. <http://www.cdc.gov/fluoridation/>
4. <https://www.epa.gov/>
5. <https://water.epa.gov/drink/>
6. <http://www.cancer.gov/>
7. <http://www.cancer.gov/about-cancer/causes-prevention/risk/myths/fluoridated-water-fact-sheet>

## Additional resources

Along with the American Cancer Society, other sources of information include:

**Centers for Disease Control and Prevention (CDC)** Toll-free number: 1-800-CDC-INFO (1-800-232-4636) Website: [www.cdc.gov](http://www.cdc.gov/) (<http://www.cdc.gov/>)<sup>2</sup>

Community water fluoridation page: [www.cdc.gov/fluoridation](http://www.cdc.gov/fluoridation) (<http://www.cdc.gov/fluoridation/>)<sup>3</sup>

**Environmental Protection Agency** Toll-free number (Safe Drinking Water Hotline): 1-800-426-4791 Website: [www.epa.gov](http://www.epa.gov/) ([www.epa.gov/](http://www.epa.gov/))<sup>4</sup>

Epa: Ground water & Drinking Water ([water.epa.gov/drink/](https://water.epa.gov/drink/))<sup>5</sup>

**National Cancer Institute** Toll-free number: 1-800-4-CANCER (1-800-422-6237) Website: [www.cancer.gov](http://www.cancer.gov/) (<http://www.cancer.gov/>)<sup>6</sup>

Fluoridated water page (<http://www.cancer.gov/about-cancer/causes-prevention/risk/myths/fluoridated-water-fact-sheet>)<sup>7</sup>

*\*Inclusion on this list does not imply endorsement by the American Cancer Society.*

## References

Agency for Toxic Substances and Disease Registry, Centers for Disease Control and Prevention. ToxFAQs for Fluorine, Hydrogen Fluoride, and Fluorides. 2003. Accessed at [www.atsdr.cdc.gov/toxfaqs/tf.asp?id=211&tid=38](http://www.atsdr.cdc.gov/toxfaqs/tf.asp?id=211&tid=38) on May 20, 2015.

Bassin EB, Wypij D, Davis RB, Mittleman MA. Age-specific fluoride exposure in drinking water and osteosarcoma (United States). *Cancer Causes Control*. 2006;17:421–428.

Blakey K, Feltbower RG, Parslow RC, et al. Is fluoride a risk factor for bone cancer? Small area analysis of osteosarcoma and Ewing sarcoma diagnosed among 0-49-year-olds in Great Britain, 1980-2005. *Int J Epidemiol*. 2014;43:224–234.

California Office of Environmental Health Hazard Assessment. Meeting synopsis and slide presentations: Carcinogen Identification Committee meeting held on October 12, 2011. Accessed at [http://oehha.ca.gov/prop65/public\\_meetings/cic101211synop.html](http://oehha.ca.gov/prop65/public_meetings/cic101211synop.html) on July 24, 2015.

Centers for Disease Control and Prevention. Community Water Fluoridation: Frequently Asked Questions. 2015. Accessed at [www.cdc.gov/fluoridation/faqs/index.htm](http://www.cdc.gov/fluoridation/faqs/index.htm) on May 20, 2015.

Comber H, Deady S, Montgomery E, Gavin A. Drinking water fluoridation and osteosarcoma incidence on the island of Ireland. *Cancer Causes Control*. 2011;22:919–924.

Douglass CW, Joshipura K. Caution needed in fluoride and osteosarcoma study. *Cancer Causes Control*. 2006;17:481–482.

Environmental Protection Agency. Questions and Answers on Fluoride. 2011. Accessed at [http://water.epa.gov/lawsregs/rulesregs/regulatingcontaminants/sixyearreview/upload/2011\\_Fluoride\\_QuestionsAnswers.pdf](http://water.epa.gov/lawsregs/rulesregs/regulatingcontaminants/sixyearreview/upload/2011_Fluoride_QuestionsAnswers.pdf) on May 20, 2015.

European Commission Directorate-General for Health and Consumers, Scientific Committees. Critical review of any new evidence on the hazard profile, health effects, and human exposure to fluoride and the fluoridating agents of drinking water. 2010. Accessed at



[http://ec.europa.eu/health/scientific\\_committees/environmental\\_risks/docs/scher\\_o\\_122.pdf](http://ec.europa.eu/health/scientific_committees/environmental_risks/docs/scher_o_122.pdf) on July 24, 2015.

International Agency for Research on Cancer. Fluorides (Inorganic, Used in Drinking-water). 1987; Supp 7: 208-210. Accessed at <http://monographs.iarc.fr/ENG/Monographs/suppl7/Suppl7-83.pdf> on May 20, 2015.

Kim FM, Hayes C, Williams PL, et al. An assessment of bone fluoride and osteosarcoma. *J Dent Res*. 2011; 90:1171–1176.

Levy M, Leclerc BS. Fluoride in drinking water and osteosarcoma incidence rates in the continental United States among children and adolescents. *Cancer Epidemiol*. 2012;36:e83–88.

McDonagh MS, Whiting PF, Wilson PM, et al. Systematic review of water fluoridation. *BMJ*. 2000;321:855–859. (Full report available online at: [www.york.ac.uk/media/crd/crdreport18.pdf](http://www.york.ac.uk/media/crd/crdreport18.pdf). Accessed May 20, 2015.)

National Cancer Institute. Fluoridated Water. 2012. Accessed at [www.cancer.gov/about-cancer/causes-prevention/risk/myths/fluoridated-water-fact-sheet](http://www.cancer.gov/about-cancer/causes-prevention/risk/myths/fluoridated-water-fact-sheet) on May 20, 2015.

National Research Council. Fluoride in Drinking Water: A Scientific Review of EPA's Standards. 2006. Accessed at [www.nap.edu/catalog/11571/fluoride-in-drinking-water-a-scientific-review-of-epas-standards#toc](http://www.nap.edu/catalog/11571/fluoride-in-drinking-water-a-scientific-review-of-epas-standards#toc) on May 20, 2015.

National Research Council. Health Effects of Ingested Fluoride. 1993. Accessed at [www.nap.edu/catalog/2204/health-effects-of-ingested-fluoride](http://www.nap.edu/catalog/2204/health-effects-of-ingested-fluoride) on May 20, 2015.

National Toxicology Program. Toxicology and Carcinogenesis Studies of Sodium Fluoride (CAS No. 7681-49-4) in F344/N Rats and B6C3F1 Mice (Drinking Water Studies). 1990. Accessed at [http://ntp.niehs.nih.gov/ntp/htdocs/LT\\_rpts/tr393.pdf](http://ntp.niehs.nih.gov/ntp/htdocs/LT_rpts/tr393.pdf) on May 20, 2015.

US Department of Health and Human Services Federal Panel on Community Water Fluoridation. US Public Health Service recommendation for fluoride concentration in drinking water for the prevention of dental caries. *Public Health Rep*. 2015 Jun-Jul;130(4):1-14.

United States Public Health Service. Review of Fluoride: Benefits and Risks. 1991. Accessed at [www.health.gov/environment/ReviewofFluoride/default.htm](http://www.health.gov/environment/ReviewofFluoride/default.htm) on May 20, 2015.

Last Medical Review: July 24, 2015 Last Revised: July 28, 2015

**Written by**

The American Cancer Society medical and editorial content team  
([www.cancer.org/cancer/acs-medical-content-and-news-staff.html](http://www.cancer.org/cancer/acs-medical-content-and-news-staff.html))

Our team is made up of doctors and oncology certified nurses with deep knowledge of cancer care as well as journalists, editors, and translators with extensive experience in medical writing.

American Cancer Society medical information is copyrighted material. For reprint requests, please see our Content Usage Policy ([www.cancer.org/about-us/policies/content-usage.html](http://www.cancer.org/about-us/policies/content-usage.html)).

**cancer.org | 1.800.227.2345**