# SOURCES OF FLUORIDE EXPOSURE

Table 1 shows natural sources of fluoride.
Table 2 shows chemically synthesized sources of fluoride.

*Table 1: Natural sources of fluoride*[1]

| NATURAL SOURCE | ADDITIONAL INFORMATION |
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| Volcanic activity | This often occurs in the form of hydrogen fluoride. |
| Water (including groundwater, streams, rivers, lakes, and some well and drinking water)<br>*The naturally occurring form of fluoride in water, which varies by geographic location, is different than community water fluoridation, which is done using a chemically synthesized form of fluoride.* | Naturally, this occurs when water run-off is exposed to fluoride containing rock. However, fluoride in water can also occur due to human activity through industrial emissions, such as releases from coal-fired power plants, and community water fluoridation. |
| Food | While negligible levels of fluoride in food can occur naturally, significant levels of fluoride in food occur due to human activity, especially through the use of pesticides. |
| Soil | While fluoride in soil can occur naturally, increased levels of fluoride in soil can occur due to human activity through the use of fertilizers, pesticides and/or industrial emissions. |

*Table 2: Chemically synthesized sources of fluoride*

| CHEMICALLY SYNTHESIZED SOURCE | ADDITIONAL INFORMATION |
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| Water: fluoridated municipal drinking water[2] | Most of the fluoride added to drinking water is in the form of fluorosilicates, also known as fluosilicic acid (fluorosilicic acid, $H_2SiF_6$) and sodium salt (sodium fluorosilicate, $Na_2SiF_6$).[3] |
| Water: bottled water[4] | The levels of fluoride in bottled water vary depending on manufacturer and the source of the water.[5] |

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| Water: perfluorinated compounds[6] | Concerns about health risks have led over 200 scientists from 38 countries to sign the Madrid Statement calling for government and manufacturer action on poly- and perfluoroalkyl substances (PFASs), which can be found in drinking water due to contamination in ground and surface water.[7] |
| Beverages: made with fluoridated water and/or made with water/ingredients exposed to fluoride-containing pesticide[8] | Significant levels of fluoride have been recorded in infant formula, tea, and commercial beverages, such as juice and soft drinks.[9] Significant levels of fluoride have also been recorded in alcoholic beverages, especially wine and beer.[10] [11] |
| Food: general[12] | Fluoride exposure can occur in food prepared with fluoridated water and/or food exposed to fluoride-containing pesticide/fertilizer.[13] Significant fluoride levels have been recorded in grapes and grape products.[14] Fluoride levels have also been reported in cow's milk due to livestock raised on fluoride-containing water, feed, and soil,[15] [16] as well as processed chicken[17] (likely due to mechanical deboning, which leaves skin and bone particles in the meat).[18] |
| Food: perfluorinated compounds[19] | Food can also be contaminated by perfluorinated compounds during preparation in certain types of cookware (i.e. non-stick coating)[20] and/or by exposure to grease/oil/water resistant packaging (i.e. fast food wrappers, pizza boxes, and popcorn bags).[21] |
| Pesticides[22] | Cryolite (insecticide) and sulfuryl fluoride (fumigant) have been regulated due to the inorganic fluoride levels they add to food.[23] |
| Soil: phosphate fertilizers and/or airborne emissions from industrial activities[24] | Releases from industrial activities can impact the levels of fluoride in food grown in the polluted soil. Soil contamination by fluoride is also relevant to children with pica (a condition characterized by an appetite for non-food items such as dirt).[25] |

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| Air: fluoride releases from industry[26] | Anthropogenic sources of atmospheric fluoride can result from coal combustion by electrical utilities and other industries.[27] Releases can also occur from refineries and metal ore smelters,[28] aluminum production plants, phosphate fertilizer plants, chemical production facilities, steel mills, magnesium plants, and brick and structural clay manufacturers,[29] as well as copper and nickel producers, phosphate ore processors, glass manufacturers, and ceramic manufacturers.[30] |
| Dental product: toothpaste[31] | Fluoride added to toothpaste can be in the form of sodium fluoride (NaF), sodium monofluorophosphate ($Na_2FPO_3$), stannous fluoride (tin fluoride, $SnF_2$) or a variety of amines.[32] Concerns have been raised about children's use of fluoridated toothpaste.[33] [34] |
| Dental product: prophy paste[35] | This paste, used during teeth cleanings (prophylaxis) at the dental office, can contain over 20 times more fluoride than toothpaste sold directly to consumers.[36] |
| Dental product: mouthwash/rinse[37] | Mouthwashes (mouth rinses) can contain sodium fluoride (NaF) or acidulated phosphate fluoride (APF).[38] |
| Dental product: dental floss[39] [40] | Researchers have demonstrated that fluoride releases from dental floss are higher than those from fluoridated mouth rinses.[41] Fluoridated dental floss is often associated with stannous fluoride (tin fluoride, $SnF_2$),[42] but flosses can also contain perfluorinated compounds.[43] |
| Dental product: fluoridated toothpicks and interdental brushes[44] | The amount of fluoride released from these products can be influenced by the saliva of the individual using the product.[45] |
| Dental product: topical fluoride gel and foam[46] | Used in a dental office or at home, these dental products are applied directly on the teeth and can contain acidulated phosphate fluoride (APF), sodium fluoride (NaF), or stannous fluoride (tin fluoride, SnF2).[47] |

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| Dental product: fluoride varnish[48] | High-concentration fluoride varnish that is applied directly on the teeth by dental or healthcare professionals contains sodium fluoride (NaF) or difluorsilane.[49] |
| Dental material for fillings: glass ionomer cements[50] | These materials, used for dental fillings, are made of fluoride-containing silicate glass and polyalkenoic acids that release an initial burst of fluoride and then a long-term lower release.[51] |
| Dental material for fillings: resin-modified glass ionomer cements[52] | These materials, used for dental fillings, are created with methacrylate components and release an initial burst of fluoride and then a long-term lower release.[53] |
| Dental material for fillings: giomers[54] | These newer hybrid materials, used for dental fillings, include pre-reacted glass ionomers and usually have lower amounts of fluoride released than glass ionomers but higher amounts than compomers and composites.[55] |
| Dental material for fillings: polyacid-modified composites (compomers)[56] | The fluoride in these materials, used for dental fillings, is in the filler particles, and while there is no initial burst of fluoride, fluoride is released continually over time.[57] |
| Dental material for fillings: composites[58] | Not all, but some of these materials, used for dental fillings, can contain different types of fluoride such as inorganic salts, leachable glasses, or organic fluoride.[59] The fluoride released is generally considered to be lower than that from glass ionomers and compomers, although releases vary depending on the commercial brand of the composites.[60] |
| Dental material for fillings: dental mercury amalgams[61] | Low levels of fluoride have been recorded in the types of dental mercury amalgam fillings that are lined with glass ionomer cement and other materials.[62] [63] [64] |
| Dental material for orthodontics: glass ionomer cement, resin-modified glass ionomer cement, and polyacid-modified composite resin (compomer) cement[65] | These materials, used for orthodontic band cements, can all release fluoride at varying levels.[66] |

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| Dental material for pit and fissure sealants: resin-based, glass-ionomer, and giomers[67] | Commercially available fluoride-releasing sealants can contain sodium fluoride (NaF), fluoride-releasing glass material, or both.[68] |
| Dental material for tooth sensitivity/caries treatment: silver diamine fluoride[69] | This material, recently introduced to the U.S. market, contains silver and fluoride and is being used as an alternative to conventional cavity treatment with dental fillings.[70] |
| Pharmaceutical/prescription drugs: fluoride tablets, drops, lozenges, and rinses[71] | These drugs, usually prescribed to children, contain varying levels of sodium fluoride (NaF).[72] These drugs are not approved by the FDA because there is no substantial evidence of drug effectiveness.[73] [74] |
| Pharmaceutical/prescription drugs: fluorinated chemicals[75] | 20-30% of pharmaceutical compounds have been estimated to contain fluorine.[76] Some of the most popular drugs include Prozac, Lipitor, and Ciprobay (ciprofloxacin),[77] as well as the rest of fluoroquinolone family (gemifloxacin [marketed as Factive], levofloxacin [marketed as Levaquin], moxifloxacin [marketed as Avelox], norfloxacin [marketed as Noroxin], and ofloxacin [marketed as Floxin and generic ofloxacin]).[78] The fluorinated compound fenfluramine (fen-phen) was also used for many years as an anti-obesity drug,[79] but it was removed from the market in 1997 due to its link with heart valve problems.[80] |
| Consumer products made with perfluorinated compounds such as Teflon[81] | Products made with perfluorinated compounds include protective coatings for carpets and clothing (such as stain-resistant or water-proof fabric), paints, cosmetics, non-stick coatings for cookware, and paper coatings for oil and moisture resistance,[82] as well as leather, paper, and cardboard.[83] |
| Household dust: perfluorinated compounds[84] [85] | Poly- and perfluoroalkyl substances (PFASs) can be found in household dust due to contamination from consumer products,[86] especially textiles and electronics. |
| Cigarette smoke[87] | Significant levels of fluoride have been associated with heavy smokers.[88] |

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| Occupational[89] | Occupational exposure can occur for workers at industries with fluoride emissions. This includes work that involves welding, aluminum, and water treatment,[90] as well as work that involves electronics and fertilizers.[91] Additionally, fire-fighters are exposed to perfluorinated chemicals in foams applied to fires.[92] Warnings have been made that workers can carry fluorides home on clothing, skin, hair, tools, or other items and that this can contaminate cars, homes, and other locations.[93] |
| Fluoridated salt and/or milk[94 95] | Some countries have opted to use fluoridated salt and milk (instead of water) as a means to offer consumers the choice of whether they would like to consume fluoride or not. Fluoridated salt is sold in Austria, the Czech Republic, France, Germany, Slovakia, Spain, and Switzerland,[96] as well as Colombia, Costa Rica, and Jamaica.[97] Fluoridated milk has been used in programs in Chile, Hungary, Scotland, and Switzerland.[98] |
| Aluminofluoride exposure from ingesting a fluoride source *with* an aluminum source[99] | This synergistic exposure to fluoride and aluminum can occur through water, tea, food residue, infant formulas, aluminum-containing antacids or medications, deodorants, cosmetics, and glassware.[100] |
| Nuclear reactors and nuclear weapons[101] | Fluorine gas is used to make uranium hexafluoride, which separates isotopes of uranium in nuclear reactors and weapons.[102] |

[1] *Source of most of the information on Table 1:* National Research Council. Fluoride in Drinking Water: A Scientific Review of EPA's Standards. The National Academies Press: Washington, D.C. 2006.
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*The Erdal study cited above is contraindicated by surveys done by fluoride activists in San Francisco area. When they tested commercial milk, they found fluoride, but when they tested organic milk, they did not. Professor Lennart Krook was consulted, and he opined that the fluorinated drugs such as antibiotic usage in commercial milk production was the actual source of the fluoride since fluoride is normally excluded from milk. In research published in 1986 about fluoride-containing feed and mineral mix introduced into a dairy herd, Krook and his co-authors noted: "The tolerance levels set by the National Academy of Sciences for fluoride ingestion by lactating cow [sic] were found to be inadequate." [Eckerlin RH, Maylin GA, Krook LE. Milk production of cows fed fluoride contaminated commercial feed. The Cornell Veterinarian. 1986 Oct;76(4):403-14.]*
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