

**International Academy of Oral Medicine and Toxicology (IAOMT)
Position Paper against Fluoride Use
in Water, Dental Materials, and Other Products
for Dental and Medical Practitioners, Dental and Medical Students,
Consumers, and Policy Makers**

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Section 1: Summary of the IAOMT's Position against Fluoride Use in Water, Dental Materials, and Other Products

Other than its natural existence in minerals, as well as in soil, water, and air, fluoride is also chemically synthesized for use in community water fluoridation, dental products, fertilizers, pesticides, and an array of other consumer items. For example, hydrogen fluoride is used to make aluminum, electrical components, fluorescent light bulbs, herbicides, high-octane gasoline, plastics, refrigerants, and etched metal and glass (such as that used in some electronic devices). Additionally, fluorinated compounds are present in a significant quantity of pharmaceutical drugs, and perfluorinated chemicals are used in carpets, cleaners, clothing, cookware, food packaging, paints, paper, and other products.

Unfortunately, all of these applications were introduced before the health risks of fluoride, safety levels for its use, and appropriate restrictions were adequately researched and established. Compounding this dangerous status quo is the fact that the National Research Council concluded the maximum contaminant level goals for fluoridated drinking water should be lowered in 2006, but the Environmental Protection Agency has yet to lower the level.

Fluoride is not a nutrient and has no biological function in the body. Furthermore, hundreds of research articles published over the past several decades have demonstrated potential harm to humans from fluoride at various levels of exposure, including levels currently deemed as safe. Scientific research has examined fluoride's effect on the skeletal system in detail and has indicated a definitive link between fluoride exposure and skeletal fluorosis, as well as dental fluorosis (which is permanent damage to the developing tooth, is the first visible sign of fluoride toxicity, and is currently on the rise in the United States). Fluoride is also known to impact the cardiovascular, central nervous, digestive, endocrine, immune, integumentary, renal, and respiratory systems, and exposure to fluoride has been linked to Alzheimer's disease, cancer, diabetes, heart disease, infertility, and many other adverse health outcomes.

The need to update previously established fluoride guidelines is extremely urgent, as fluoride exposures have dramatically increased for all Americans since the 1940's, when community water fluoridation was first introduced. In the subsequent decades, fluoride was also introduced for use in dental products applied in the office and at home, such as toothpaste and mouth rinse, and during this time frame, it was also added to other consumer products. Understanding fluoride exposure levels from all sources is crucial because recommended intake levels for fluoride in water and food should now be based upon these common multiple exposures.

However, accurate data currently does not exist for either collective sources or singular sources of fluoride exposure. Another concern is that fluoride has a synergistic interaction with other elements. Fluoride is also known to impact each individual differently based on allergies to fluoride, nutrient deficiencies, genetic factors, and other variables. Additionally, susceptible populations with low body weights, such as infants and children, and individuals who consume increased amounts of water, such as athletes, military personnel, outdoor laborers, and those with diabetes or kidney dysfunction, can be more intensely effected by fluoride. Therefore, recommending an optimal level of fluoride or "one dose fits all" level is unacceptable.

It is obvious that risk assessments must consider the total fluoride exposure from all sources, as well as individual susceptibility. Furthermore, there is a significant gap, if not a major void, in scientific literature that includes fluoride releases from products administered at the dental office, such as dental filling materials and varnishes, as part of overall fluoride intake. Part of this is likely due to the fact that the research attempting to evaluate singular exposures from these dental products has demonstrated that determining any type of “average” release rate is virtually impossible.

Moreover, there is even doubt about fluoride’s efficacy in preventing tooth decay. For example, research has indicated that fluoride does not aid in preventing pit and fissure decay (which is the most prevalent form of tooth decay in the U.S.) or in preventing baby bottle tooth decay (which is prevalent in poor communities). Also, research has suggested that in malnourished children and individuals of lower socio-economic status, fluoride can actually increase the risk of dental caries due to calcium depletion and other circumstances.

An important consideration is that the trend of decreased decayed, missing, and filled teeth over the past several decades has occurred both in countries with and without the systemic application of fluoridated water. This suggests that increased access to preventative hygiene services and more awareness of the detrimental effects of sugar are responsible for these improvements in dental health. Research has also documented decreases of tooth decay in communities that have discontinued water fluoridation.

Additionally, ethical questions have been raised in regard to the use of fluoride, especially because of fluoride’s ties to the phosphate fertilizer and dental industries. Researchers have reported difficulties with getting articles published that are critical of fluoride, and an urgent need for an appropriate application of the precautionary principle (i.e. first, do no harm) related to fluoride usage has emerged.

The issue of consumer choice is vital to fluoride usage for a variety of reasons. First, consumers have choices when it comes to utilizing fluoride-containing products; however, many over-the-counter products do not offer appropriate labeling. Second, materials used at the dental office provide virtually no consumer informed consent because the presence of fluoride (and its risks) in these dental materials is, in many cases, never mentioned to the patient. Third, the only choice consumers have when fluoride is added to their municipal water is to buy bottled water or costly filters. Concerns have been raised that fluoride is added only for allegedly preventing tooth decay, while other chemicals added to water serve a purpose of decontamination and elimination of pathogens.

Educating medical and dental practitioners, students, consumers, and policy makers about fluoride exposures and the associated potential health risks is essential to improving the dental and overall health of the public. Since a scientific understanding of the health effects of fluoride has been limited to promoting its benefits, the reality of its overexposure and potential harms must now be conveyed to healthcare workers and students, such as those in the medical, dental, and public health fields.

Although informed consumer consent and more informative product labels would contribute to increasing public awareness about fluoride intake, consumers also need to take a more active role in preventing caries. In particular, a better diet (with less sugar), improved oral health practices, and other measures would assist in reducing tooth decay.

Finally, policy makers are tasked with the obligation of evaluating the benefits and risks of fluoride. These officials have a responsibility to acknowledge the dated claims of fluoride's alleged purposes, many of which are based on limited evidence of safety and improperly formulated intake levels that fail to account for multiple exposures, fluoride's interaction with other chemicals, individual variances, and independent (non-industry sponsored) science.

In summary, given the elevated number of fluoride sources and the increased rates of fluoride intake in the American population, which have risen substantially since water fluoridation began in the 1940's, it has become a necessity to reduce and work toward eliminating avoidable sources of fluoride exposure, including water fluoridation, fluoride-containing dental materials, and other fluoridated products.

Section 2: Chemical Profile

Fluorine (F) is the ninth element on the periodic table and is a member of the halogen family. It has an atomic weight of 18.9984, is the most reactive of all of the elements, and forms strong electronegative bonds. It is particularly attracted to the divalent cations of calcium and magnesium. In its free state, fluorine is a highly toxic, pale yellow diatomic gas. However, fluorine is rarely found in its free state in nature because it almost always combines with other elements as a result of its high level of reactivity. Fluorine commonly occurs as the minerals fluor spar (CaF_2), cryolite (Na_3AlF_6), and fluorapatite ($3\text{Ca}_3(\text{PO}_4)_2 \text{Ca}(\text{F},\text{Cl})_2$), and it is the 13th most abundant element on earth.

Fluoride (F-) is a chemical ion of fluorine that contains an extra electron, thereby giving it a negative charge. Other than its natural existence in minerals, as well as in soil, water, and air, fluoride is also chemically synthesized for use in community water fluoridation, dental products, and other manufactured items. Fluoride is not essential for human growth and development.¹ In fact, it is not required for any physiological process in the human body; consequently, no one will suffer from a lack fluoride. In 2014, Dr. Philippe Grandjean of the Harvard School of Public Health and Dr. Philip J. Landrigan of Icahn School of Medicine at Mount Sinai identified fluoride as one of 12 industrial chemicals known to cause developmental neurotoxicity in humans.²

Section 3: Sources of Fluoride

Fluoride exposures in humans occur from both natural and anthropogenic sources. Table 1 is a listing of the most prevalent *natural* sources of fluoride exposure, while Table 2 is a listing of the most prevalent *chemically synthesized* sources of fluoride exposure.

Table 1: Natural sources of fluoride³

| NATURAL SOURCE | ADDITIONAL INFORMATION |
|--|--|
| Volcanic activity | This often occurs in the form of hydrogen fluoride. |
| Water (including groundwater, streams, rivers, lakes, and some well and drinking water) <i>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.</i> | 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 |
|--|--|
| Water: fluoridated municipal drinking water ⁴ | 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). ⁵ |
| Water: bottled water ⁶ | The levels of fluoride in bottled water vary depending on manufacturer and the source of the water. ⁷ |
| Water: perfluorinated compounds ⁸ | 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. ⁹ |

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| <p>Beverages: made with fluoridated water and/or made with water/ingredients exposed to fluoride-containing pesticide¹⁰</p> | <p>Significant levels of fluoride have been recorded in infant formula, tea, and commercial beverages, such as juice and soft drinks.¹¹ Significant levels of fluoride have also been recorded in alcoholic beverages, especially wine and beer.^{12 13}</p> |
| <p>Food: general¹⁴</p> | <p>Fluoride exposure can occur in food prepared with fluoridated water and/or food exposed to fluoride-containing pesticide/fertilizer.¹⁵ Significant fluoride levels have been recorded in grapes and grape products.¹⁶ Fluoride levels have also been reported in cow's milk due to livestock raised on fluoride-containing water, feed, and soil,^{17 18} as well as processed chicken¹⁹ (likely due to mechanical deboning, which leaves skin and bone particles in the meat).²⁰</p> |
| <p>Food: perfluorinated compounds²¹</p> | <p>Food can also be contaminated by perfluorinated compounds during preparation in certain types of cookware (i.e. non-stick coating)²² and/or by exposure to grease/oil/water resistant packaging (i.e. fast food wrappers, pizza boxes, and popcorn bags).²³</p> |
| <p>Pesticides²⁴</p> | <p>Cryolite (insecticide) and sulfuryl fluoride (fumigant) have been regulated due to the inorganic fluoride levels they add to food.²⁵</p> |
| <p>Soil: phosphate fertilizers and/or airborne emissions from industrial activities²⁶</p> | <p>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).²⁷</p> |
| <p>Air: fluoride releases from industry²⁸</p> | <p>Anthropogenic sources of atmospheric fluoride can result from coal combustion by electrical utilities and other industries.²⁹ Releases can also occur from refineries and metal ore smelters,³⁰ aluminum production plants, phosphate fertilizer plants, chemical production facilities, steel mills, magnesium plants, and brick and structural clay manufacturers,³¹ as well as copper and nickel producers, phosphate ore processors, glass manufacturers, and ceramic manufacturers.³²</p> |

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| Dental product: toothpaste ³³ | Fluoride added to toothpaste can be in the form of sodium fluoride (NaF), sodium monofluorophosphate (Na ₂ FPO ₃), stannous fluoride (tin fluoride, SnF ₂) or a variety of amines. ³⁴ Concerns have been raised about children's use of fluoridated toothpaste. ^{35 36} |
| Dental product: prophylaxis paste ³⁷ | This paste, used during teeth cleanings (prophylaxis) at the dental office, can contain over 20 times more fluoride than toothpaste sold directly to consumers. ³⁸ |
| Dental product: mouthwash/rinse ³⁹ | Mouthwashes (mouth rinses) can contain sodium fluoride (NaF) or acidulated phosphate fluoride (APF). ⁴⁰ |
| Dental product: dental floss ^{41 42} | Researchers have demonstrated that fluoride releases from dental floss are higher than those from fluoridated mouth rinses. ⁴³ Fluoridated dental floss is often associated with stannous fluoride (tin fluoride, SnF ₂), ⁴⁴ but flosses can also contain perfluorinated compounds. ⁴⁵ |
| Dental product: fluoridated toothpicks and interdental brushes ⁴⁶ | The amount of fluoride released from these products can be influenced by the saliva of the individual using the product. ⁴⁷ |
| Dental product: topical fluoride gel and foam ⁴⁸ | 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, SnF ₂). ⁴⁹ |
| Dental product: fluoride varnish ⁵⁰ | High-concentration fluoride varnish that is applied directly on the teeth by dental or healthcare professionals contains sodium fluoride (NaF) or difluorsilane. ⁵¹ |
| Dental material for fillings: glass ionomer cements ⁵² | 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. ⁵³ |

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| Dental material for fillings: resin-modified glass ionomer cements ⁵⁴ | 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. ⁵⁵ |
| Dental material for fillings: giomers ⁵⁶ | 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. ⁵⁷ |
| Dental material for fillings: polyacid-modified composites (compomers) ⁵⁸ | 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. ⁵⁹ |
| Dental material for fillings: composites ⁶⁰ | 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. ⁶¹ 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. ⁶² |
| Dental material for fillings: dental mercury amalgams ⁶³ | 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. ^{64 65 66} |
| Dental material for orthodontics: glass ionomer cement, resin-modified glass ionomer cement, and polyacid-modified composite resin (compomer) cement ⁶⁷ | These materials, used for orthodontic band cements, can all release fluoride at varying levels. ⁶⁸ |
| Dental material for pit and fissure sealants: resin-based, glass-ionomer, and giomers ⁶⁹ | Commercially available fluoride-releasing sealants can contain sodium fluoride (NaF), fluoride-releasing glass material, or both. ⁷⁰ |
| Dental material for tooth sensitivity/caries treatment: silver diamine fluoride ⁷¹ | 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. ⁷² |

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| <p>Pharmaceutical/prescription drugs: fluoride tablets, drops, lozenges, and rinses⁷³</p> | <p>These drugs, usually prescribed to children, contain varying levels of sodium fluoride (NaF).⁷⁴ These drugs are not approved by the FDA because there is no substantial evidence of drug effectiveness.^{75 76}</p> |
| <p>Pharmaceutical/prescription drugs: fluorinated chemicals⁷⁷</p> | <p>20-30% of pharmaceutical compounds have been estimated to contain fluorine.⁷⁸ Some of the most popular drugs include Prozac, Lipitor, and Ciprobay (ciprofloxacin),⁷⁹ 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]).⁸⁰ The fluorinated compound fenfluramine (fen-phen) was also used for many years as an anti-obesity drug,⁸¹ but it was removed from the market in 1997 due to its link with heart valve problems.⁸²</p> |
| <p>Consumer products made with perfluorinated compounds such as Teflon⁸³</p> | <p>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,⁸⁴ as well as leather, paper, and cardboard.⁸⁵</p> |
| <p>Household dust: perfluorinated compounds^{86 87}</p> | <p>Poly- and perfluoroalkyl substances (PFASs) can be found in household dust due to contamination from consumer products,⁸⁸ especially textiles and electronics.</p> |
| <p>Occupational⁸⁹</p> | <p>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</p> |

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| Cigarette smoke ⁹⁴ | Significant levels of fluoride have been associated with heavy smokers. ⁹⁵ |
| Fluoridated salt and/or milk ^{96 97} | 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, ⁹⁸ as well as Colombia, Costa Rica, and Jamaica. ⁹⁹ Fluoridated milk has been used in programs in Chile, Hungary, Scotland, and Switzerland. ¹⁰⁰ |
| Aluminum fluoride exposure from ingesting a fluoride source <i>with</i> an aluminum source ¹⁰¹ | 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. ¹⁰² |
| Nuclear reactors and nuclear weapons ¹⁰³ | Fluorine gas is used to make uranium hexafluoride, which separates isotopes of uranium in nuclear reactors and weapons. ¹⁰⁴ |

Section 4: Brief History of Fluoride

Human knowledge of the mineral fluor spar dates back centuries.¹⁰⁵ However, the discovery of how to isolate fluorine from its compounds is an essential date in the history of humankind's use of fluoride: Several scientists were killed in early experiments involving attempts to generate elemental fluorine, but in 1886, Henri Moissan reported the isolation of elemental fluorine, which earned him the Nobel Prize in chemistry in 1906.^{106 107}

This discovery paved the way for human experimentation to begin with chemically synthesized fluorine compounds, which were eventually utilized in a number of industrial activities. Notably, uranium fluoride and thorium fluoride were used during the years of 1942-1945 as part of the Manhattan Project¹⁰⁸ to produce the first atomic bomb. Data from reports about the Manhattan Project, some of which were initially classified and unpublished, include mention of fluoride poisoning and its role in the hazards of the uranium industry.¹⁰⁹ As industry expanded during the 20th century, so did the use of fluoride for industrial processes, and cases of fluoride poisoning likewise increased.¹¹⁰

Fluoride was not widely used for any dental purposes prior to the mid-1940's,¹¹¹ although it was studied for dental effects caused by its natural presence in community water supplies at varying levels. Early research in the 1930's by Frederick S. McKay, DDS, correlated high levels of fluoride with increased cases of dental fluorosis (a permanent damage to the enamel of the teeth that can occur in children from overexposure to fluoride) and demonstrated that reducing levels

of fluoride resulted in lower rates of dental fluorosis.^{112 113} This work led H. Trendley Dean, DDS, to research fluoride's minimal threshold of toxicity in the water supply.¹¹⁴ In work published in 1942, Dean suggested that lower levels of fluoride might result in lower rates of dental caries.¹¹⁵

While Dean worked to convince others to test his hypothesis about adding fluoride to community water supplies as a means of reducing caries, not everyone supported the idea. In fact, an editorial published in the *Journal of the American Dental Association* (JADA) in 1944 denounced purposeful water fluoridation and warned of its dangers:

We do know the use of drinking water containing as little as 1.2 to 3.0 parts per million of fluorine will cause such developmental disturbances in bones as osteosclerosis, spondylosis, and osteopetrosis, as well as goiter, and we cannot afford to run the risk of producing such serious systemic disturbances in applying what is at present a doubtful procedure intended to prevent development of dental disfigurements among children.

[...] Because of our anxiety to find some therapeutic procedure that will promote mass prevention of caries, the seeming potentialities of fluorine appear speculatively attractive, but, in the light of our present knowledge or lack of knowledge of the chemistry of the subject, the potentialities for harm far outweigh those for good.¹¹⁶

A few months after this warning was issued, Grand Rapids, Michigan, became the first city to be artificially fluoridated on January 25, 1945. Dean had succeeded in his efforts to test his hypothesis, and in a landmark study, Grand Rapids was to serve as a test city, and its decay rates were to be compared with those of non-fluoridated Muskegon, Michigan. After only slightly more than five years, Muskegon was dropped as a control city, and the results published about the experiment only reported the decrease in caries in Grand Rapids.¹¹⁷ Because the results did not include the control variable from the incomplete Muskegon data, many have stated that the initial studies presented in favor of water fluoridation were not even valid.

Concerns were made to the United States Congress in 1952 about potential dangers of water fluoridation, the lack of evidence as to its alleged usefulness in controlling dental caries, and the need for more research to be conducted.¹¹⁸ Yet, in spite of these concerns and many others, experiments with fluoridated drinking water continued. By 1960, fluoridation of drinking water for alleged dental benefits had spread to over 50 million people in communities throughout the United States.¹¹⁹

The use of fluoride in pharmaceutical drugs appears to have begun at about the same time as water fluoridation. Prior to the 1940's, the use of fluoride in American medicine was virtually unknown, with the exception of its rare use as an externally applied antiseptic and antiperiodic.¹²⁰ There is a consensus among authors of scientific reviews about fluoride's addition to "supplements" that this pharmaceutical use was introduced no earlier than the mid-1940s and was not widely used until the late 1950s or early 1960s.¹²¹ Quinolones for clinical use were first discovered in 1962, and fluoroquinolones were created in the 1980's.^{122 123}

The production of perfluorinated carboxylates (PFCAs) and perfluorinated sulfonates (PFSA) for process aids and surface protection in products also began over sixty years ago.¹²⁴ Perfluorinated compounds (PFCs) are now used in a wide range of items including cookware, extreme weather military uniforms, ink, motor oil, paint, products with water repellent, and sports clothing.¹²⁵ Fluorotelomers, which consist of fluoride carbon foundations, are considered the most commonly used perfluorinated substances in consumer products.¹²⁶

Meanwhile, fluoridated toothpastes were introduced and their increase in the market occurred in the late 1960s and early 1970s.¹²⁷ By the 1980s, the vast majority of commercially available toothpastes in industrialized countries contained fluoride.¹²⁸

Other fluoridated materials for dental purposes were likewise promoted for more common commercial use in recent decades. Glass ionomer cement materials, used for dental fillings, were invented in 1969,¹²⁹ and fluoride-releasing sealants were introduced in the 1970s.¹³⁰ Studies on the use of salt fluoridation for reduction of caries took place from 1965-1985 in Colombia, Hungary, and Switzerland.¹³¹ Similarly, the use of fluoride in milk for caries management first began in Switzerland in 1962.¹³²

By reviewing the development of fluoride regulations provided in Section 5, it is apparent that these applications of fluoride were introduced before the health risks of fluoride, safety levels for its use, and appropriate restrictions were adequately researched and established.

Section 5: Overview of U.S. Fluoride Regulations

Section 5.1: Community Water Fluoridation

In western Europe, some governments have openly recognized hazards of fluoride, and only 3% of the western European population drinks fluoridated water.¹³³ In the United States, over 66% of Americans are drinking fluoridated water.¹³⁴ Neither the Environmental Protection Agency (EPA) nor the federal government mandate water fluoridation in America, and the decision to fluoridate community water is made by the state or local municipality.¹³⁵ ¹³⁶ However, the U.S. Public Health Service (PHS) establishes recommended fluoride concentrations in community drinking water for those who choose to fluoridate, and the Environmental Protection Agency (EPA) sets contaminant levels for public drinking water.

After water fluoridation in Grand Rapids, Michigan, began in 1945, the practice spread to locales across the country in the decades that followed. These efforts were encouraged by the Public Health Service (PHS) in the 1950s,¹³⁷ and in 1962, the PHS issued standards for fluoride in drinking water that would stand for 50 years. They stated that fluoride would prevent dental caries¹³⁸ and that optimal levels of fluoride added to drinking water should range between 0.7 to 1.2 milligrams per liter.¹³⁹ However, the PHS lowered this recommendation to the single level of 0.7 milligrams per liter in 2015 due to an increase in dental fluorosis (permanent damage to the teeth that can occur in children from overexposure to fluoride) and to the increase in sources of fluoride exposure to Americans.¹⁴⁰

Meanwhile, the Safe Drinking Water Act was established in 1974 to protect the quality of American drinking water, and it authorized the EPA to regulate public drinking water. Because of this legislation, the EPA can set *enforceable* maximum contaminant levels (MCLs) for drinking water, as well as *non-enforceable* maximum contaminant level goals (MCLGs) and *non-enforceable* drinking water standards of secondary maximum contaminant levels (SMCLs).¹⁴¹ The EPA specifies that the MCLG is “the maximum level of a contaminant in drinking water at which no known or anticipated adverse effect on the health of persons would occur, allowing an adequate margin of safety.”¹⁴² Additionally, the EPA qualifies that community water systems exceeding the MCL for fluoride “must notify persons served by that system as soon as practical, but no later than 30 days after the system learns of the violation.”¹⁴³

In 1975, the EPA set a maximum contaminant level (MCL) for fluoride in drinking water at 1.4 to 2.4 milligrams per liter.¹⁴⁴ They established this limit to prevent cases of dental fluorosis. In 1981, South Carolina argued that dental fluorosis is merely cosmetic, and the state petitioned the EPA to eliminate the MCL for fluoride.¹⁴⁵ As a result, in 1985, the EPA established a maximum contaminant level goal (MCLG) for fluoride at 4 milligrams per liter.¹⁴⁶ Rather than dental fluorosis serving as the protective endpoint (which would have required lower safety levels), this higher level was established as a means to protect against skeletal fluorosis, a bone disease caused by excess fluoride. Using skeletal fluorosis as the endpoint likewise resulted in a change for the MCL for fluoride, which was raised to 4 milligrams per liter in 1986.¹⁴⁷ Yet, dental fluorosis was applied as the endpoint for the SMCL for fluoride of 2 milligrams per liter, which was also set in 1986.¹⁴⁸

Controversy ensued over these new regulations and even resulted in legal actions against the EPA. South Carolina argued that there was no need for any MCLG (maximum contaminant level goal) for fluoride, while the Natural Resources Defense Council argued that the MCLG should be lowered based on dental fluorosis.¹⁴⁹ A court ruled in the EPA’s favor, but in a review of fluoride standards, the EPA enlisted the National Research Council (NRC) of the National Academy of Sciences to re-evaluate the health risks of fluoride.^{150 151}

The report from the National Research Council, released in 2006, concluded that the EPA’s MCLG (maximum contaminant level goal) for fluoride should be lowered.¹⁵² In addition to recognizing the potential for risk of fluoride and osteosarcoma (a bone cancer), the 2006 National Research Council report cited concerns about musculoskeletal effects, reproductive and developmental effects, neurotoxicity and neurobehavioral effects, genotoxicity and carcinogenicity, and effects on other organ systems.¹⁵³

The NRC concluded that the MCLG for fluoride should be lowered in 2006, but the EPA has yet to lower the level.¹⁵⁴ In 2016, the Fluoride Action Network, the IAOMT, and a number of other groups and individuals petitioned the EPA to protect the public, especially susceptible subpopulations, from the neurotoxic risks of fluoride by banning the purposeful addition of fluoride to drinking water.¹⁵⁵ The petition was denied by the EPA in February 2017.¹⁵⁶

Section 5.2: Bottled Water

The United States Food and Drug Administration (FDA) is responsible for making sure that standards for bottled water are consistent with standards for tap water set by the EPA¹⁵⁷ and the recommended levels set by the U.S. Public Health Service (PHS).¹⁵⁸ The FDA permits bottled water that meets its standards¹⁵⁹ to include language claiming that drinking fluoridated water may reduce the risk of tooth decay.¹⁶⁰

Section 5.3: Food

The FDA ruled to limit the addition of fluorine compounds to food in the interest of public health in 1977.¹⁶¹ However, fluoride is still present in food as a result of preparation in fluoridated water, exposure to pesticides and fertilizers, and other factors. In 2004, the United States Department of Agriculture (USDA) launched a database of fluoride levels in beverages and food, and a report with detailed documentation was published in 2005.¹⁶² While this report is still significant, the levels of fluoride in food and beverages have likely increased over the past decade due to the use of fluoride in more recently approved pesticides.¹⁶³ Some indirect food additives currently used also contain fluoride.¹⁶⁴

Additionally, in 2006, the National Research Council recommended that to "assist in estimating individual fluoride exposure from ingestion, manufacturers and producers should provide information on the fluoride content of commercial foods and beverages."¹⁶⁵ However, this will not be happening anytime in the near future. In 2016, the FDA revised its food labeling requirement for Nutrition and Supplement Facts labels and ruled that declarations of fluoride levels are voluntary both for products with intentionally added fluoride and products with naturally occurring fluoride.¹⁶⁶ At that time, the FDA also did not establish a Daily Reference Value (DRV) for fluoride.¹⁶⁷

On the contrary, in 2016, the FDA prohibited perfluoroalkyl ethyl containing food-contact substances (PFCSs), which are used as oil and water repellants for paper and paperboard.¹⁶⁸ This action was taken as a result of toxicological data and a petition filed by the Natural Resources Defense Council and other groups.

Other than these considerations for fluoride in food, establishing safe levels of fluoride in food due to pesticides is shared by FDA, EPA, and the Food Safety and Inspection Service of the U.S. Department of Agriculture.¹⁶⁹

Section 5.4: Pesticides

Pesticides sold or distributed in the U.S. must be registered with the EPA, and the EPA can establish tolerances for pesticide residue if exposures from food are deemed to be "safe."¹⁷⁰ In this regard, two fluoride-containing pesticides have been the subject of dispute:

1) Sulfuryl fluoride was first registered in 1959 for termite control in wood structures¹⁷¹ and in 2004/2005 for control of insects in processed foods, such as cereal grains, dried fruits, tree nuts, cocoa beans, coffee beans, as well as in food handling and food processing facilities.¹⁷² Cases of

human poisoning and even death, while rare, have been associated with sulfuryl fluoride exposure related to homes treated with the pesticide.¹⁷³ In 2011, due to updated research and concerns raised by the Fluoride Action Network (FAN), the EPA proposed that sulfuryl fluoride no longer meets safety standards and that the tolerances for this pesticide should be withdrawn.¹⁷⁴ In 2013, the pesticide industry mounted a massive lobbying effort to overturn EPA's proposal to phase-out sulfuryl fluoride, and the EPA proposal was reversed by a provision included in the 2014 Farm Bill.¹⁷⁵

2) Cryolite, which contains sodium aluminum fluoride, is an insecticide that was first registered with the EPA in 1957.¹⁷⁶ Cryolite is the major fluoride pesticide used in growing food in the U.S. (whereas sulfuryl fluoride is used as a fumigant on post-harvest food). Cryolite is used on citrus and stone fruits, vegetables, berries, and grapes,¹⁷⁷ and people can be exposed to it through their diet, as cryolite can leave fluoride residues on food to which it has been applied.¹⁷⁸ In its 2011 proposed order on sulfuryl fluoride, the EPA also proposed to withdraw all fluoride tolerances in pesticides.¹⁷⁹ This would therefore have included cryolite; however, as noted above, this proposal was overturned.

Section 5.5: Dental Products for Use at Home

The FDA requires labeling for "antidotal drug products" sold over-the-counter, such as toothpaste and mouthwash. Specific wording for the labeling is designated by the form of the product (i.e. gel or paste and rinse), as well as by the fluoride concentration (i.e. 850-1,150 ppm, 0.02% sodium fluoride, etc.).¹⁸⁰ Warnings also are divided by age groups (i.e. two years and older, under six, 12 years and older, etc.). Some warnings apply to all products, such as the following:

(1) For all fluoride dentifrice (gel, paste, and powder) products. "Keep out of reach of children under 6 years of age. [highlighted in bold type] If more than used for brushing is accidentally swallowed, get medical help or contact a Poison Control Center right away."¹⁸¹

(2) For all fluoride rinse and preventive treatment gel products. "Keep out of reach of children. [highlighted in bold type] If more than used for" (select appropriate word: "brushing" or "rinsing") "is accidentally swallowed, get medical help or contact a Poison Control Center right away."¹⁸²

A research article published in 2014 raised significant concerns about this labeling. Specifically, the authors established that over 90% of the products they evaluated listed the FDA warning for use only by children over the age of two on the back of the tube of toothpaste and in small font.¹⁸³ Similar circumstances were reported about warnings from the American Dental Association (ADA), which is a trade group and not a government entity. The researchers documented that all of the toothpastes with approval or acceptance by the ADA placed the ADA warning (that children should use a pea-sized amount of toothpaste and be supervised by an adult to minimize swallowing) on the back of the tube in small font.¹⁸⁴ Marketing strategies were further identified as promoting toothpaste as if it were a food product, which the researchers acknowledged was a tactic that could dangerously result in children swallowing the product.¹⁸⁵

Although dental floss is categorized by the FDA as a Class I device,¹⁸⁶ dental floss containing fluoride (usually stannous fluoride) is considered a combination product¹⁸⁷ and requires premarket applications.¹⁸⁸ Dental floss can also contain fluoride in the form of perfluorinated compounds;¹⁸⁹ however, no regulatory information about this type of fluoride in dental floss could be located by the authors of this position paper.

Section 5.6: Dental Products for Use at the Dental Office

A vast majority of the materials used in the dental office that can release fluoride are regulated as medical/dental devices, such as some resin filling materials,¹⁹⁰ some dental cements,¹⁹² and some composite resin materials.¹⁹³ More specifically, most of these dental materials are classified by the FDA as Class II Medical Devices,¹⁹⁴ meaning that the FDA provides "reasonable assurance of the device's safety and effectiveness" without subjecting the product to the highest level of regulatory control.¹⁹⁵ Importantly, as part of the FDA's classification procedure, dental devices with fluoride are considered combination products,¹⁹⁶ and fluoride release rate profiles are expected to be provided as part of the pre-market notification for the product.¹⁹⁷ The FDA further states: "Claims of cavity prevention or other therapeutic benefits are permitted if supported by clinical data developed by an IDE [Investigational Device Exemption] investigation."¹⁹⁸ Moreover, while the FDA publicly mentions the fluoride-releasing mechanism of some dental restorative devices, the FDA does not publicly promote them on their website for use in caries prevention.¹⁹⁹

Similarly, while fluoride varnishes are approved as Class II Medical Devices for use as a cavity liner and/or tooth desensitizer, they are not approved for use in caries prevention.²⁰⁰ Therefore, when claims of caries prevention are made about a product that has been adulterated with added fluoride, this is considered by the FDA to be an unapproved, adulterated drug. In addition, FDA regulations make the physician/dentist personally liable for off-label use of approved drugs.²⁰¹

Additionally, in 2014, the FDA permitted the use of silver diamine fluoride for reducing tooth sensitivity.²⁰² In an article published in 2016, a committee at the University of California, San Francisco, School of Dentistry, recognized that, while the off-label use of silver diamine fluoride (such as in caries management) is now permissible by law, there is a need for a standardized guideline, protocol, and consent.²⁰³

Also essential to note is that fluoride-containing paste used during dental prophylaxis (cleaning) contains much higher levels of fluoride than commercially sold toothpaste (i.e. 850-1,500 ppm in standard toothpaste²⁰⁴ versus 4,000-20,000 ppm fluoride in prophylaxis paste²⁰⁵). Fluoride paste is not accepted by the FDA or the ADA as an efficient way to prevent dental caries.²⁰⁶

Section 5.7: Pharmaceutical Drugs (Including Supplements)

Fluoride is intentionally added to pharmaceutical drugs (drops, tablets, and lozenges often called "supplements" or "vitamins") that are routinely prescribed to children, allegedly to prevent cavities. In 1975, the FDA addressed the use of fluoride supplements by withdrawing the new drug application for ErnziFlur fluoride. After the FDA's actions on ErnziFlur lozenges were published in the *Federal Register*, an article appeared in *Drug Therapy* stating that the FDA

approval was withdrawn “because there is no substantial evidence of drug effectiveness as prescribed, recommended, or suggested in its labeling.”^{207 208} The article also stated: “The FDA has therefore advised manufacturers of combination fluoride and vitamin preparations that their continued marketing is in violation of the new drug provisions of the Federal Food, Drug, and Cosmetic Act; they have, therefore, requested that marketing of these products be discontinued.”^{209 210}

In 2016, the FDA sent yet another warning letter out about the same issue of unapproved new drugs in many forms including the fluoride supplements addressed in 1975. A letter, dated January 13, 2016, was sent to Kirkman Laboratories in regard to four different types of pediatric fluoride concoctions labeled as aids in the prevention of dental caries.²¹¹ The FDA warning letter offered the company 15 days to become compliant with law²¹² and serves as a yet another example of children hazardously receiving unapproved fluoride preparations, which has now been an issue in the U.S. for over 40 years.

Meanwhile, fluorine is also *permissibly* added to other pharmaceutical drugs. Some reasons that have been identified for its addition to drugs include claims that it can “increase the drug's selectivity, enable it to dissolve in fats, and decrease the speed at which the drug is metabolized, thus allowing it more time to work.”²¹³ 20-30% of pharmaceutical compounds have been estimated to contain fluorine.²¹⁴ Some of the most popular drugs include Prozac, Lipitor, and Ciprobay (ciprofloxacin),²¹⁵ 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]).²¹⁶

In regard to fluoroquinolones, the FDA issued a new warning about disabling side effects in 2016, years after these drugs were first introduced to the market. In their July 2016 announcement, the FDA stated:

These medicines are associated with disabling and potentially permanent side effects of the tendons, muscles, joints, nerves, and central nervous system that can occur together in the same patient. As a result, we revised the Boxed Warning, FDA’s strongest warning, to address these serious safety issues. We also added a new warning and updated other parts of the drug label, including the patient Medication Guide.²¹⁷

Because of these debilitating side effects, the FDA advised that these drugs should only be used when there is no other treatment option available for patients because the risks outweigh the benefits.²¹⁸ At the time of this 2016 FDA announcement, it was estimated that over 26 million Americans were taking these drugs annually.²¹⁹

Section 5.8: Perfluorinated Compounds

Per- and polyfluoroalkyl substances (PFASs), also referred to as perfluorinated compounds or perfluorinated chemicals (PFCs), are substances used in carpets, cleaners, clothing, cookware, food packaging, paints, paper, and other products because they provide fire resistance and oil, stain, grease, and water repellency.^{220 221} For example, perfluorooctanoic acid (PFOA) is used to

make polytetrafluoroethylene (PTFE), which is used in Teflon, Gore-tex, Scotchguard, and Stainmaster.²²²

However, when over 200 scientists from 38 countries signed on to the “Madrid Statement” in 2015,²²³ concerns about such substances and their possible link to ill-health were publicized.²²⁴ Additionally, in 2016, the EPA stated of PFSAs:

Studies indicate that exposure to PFOA and PFOS over certain levels may result in adverse health effects, including developmental effects to fetuses during pregnancy or to breast-fed infants (e.g., low birth weight, accelerated puberty, skeletal variations), cancer (e.g., testicular, kidney), liver effects (e.g., tissue damage), immune effects (e.g., antibody production and immunity), and other effects (e.g., cholesterol changes).²²⁵

Thus, in the U.S., efforts have only recently begun to decrease the use of these chemicals. For example, in 2016, the EPA issued health advisories for PFOA and PFOS in drinking water, identifying the level at or below which adverse health effects are not anticipated to occur over a lifetime of exposure as 0.07 parts per billion (70 parts per trillion) for PFOA and PFOS.²²⁶ As another example, in 2006, the EPA joined forces with eight companies through a stewardship program for these eight companies to reduce and eliminate PFOA by 2015.²²⁷ Yet, the EPA has also written that they “remain concerned” about the companies producing these products that did not participate in this program.²²⁸

Section 5.9: Occupational

Exposure to fluorides (fluoride, perfluoride) in the workplace is regulated by the Occupational Safety & Health Administration (OSHA). The health factor most taken into consideration for these standards is skeletal fluorosis, and the limit values for occupational exposure to fluorides are consistently listed as 2.5 mg/m³.²²⁹

In a 2005 article published in the *International Journal of Occupational and Environmental Health* and presented in part at the American College of Toxicology Symposium, author Phyllis J. Mullenix, PhD, identified the need for better workplace protection from fluorides.²³⁰ Specifically, Dr. Mullenix wrote that while fluoride standards have remained consistent:

Only recently have data become available suggesting not only that these standards have provided inadequate protection to workers exposed to fluorine and fluorides, but that for decades industry has possessed the information necessary to identify the standards’ inadequacy and to set more protective threshold levels of exposure.²³¹

Section 6: Health Effects of Fluoride

In a 2006 report by the National Research Council (NRC) of the National Academy of Sciences in which the health risks of fluoride were evaluated, concerns were raised about potential associations between fluoride and osteosarcoma (a bone cancer), bone fractures, musculoskeletal effects, reproductive and developmental effects, neurotoxicity and neurobehavioral effects, genotoxicity and carcinogenicity, and effects on other organ systems.²³²

Since the NRC report was released in 2006, a number of other relevant research studies have been published. In fact, in a 2016 citizen petition to the EPA from the Fluoride Action Network (FAN), the IAOMT, and other groups, Michael Connett, Esq., Legal Director of FAN, provided a list of the newer research demonstrating harm from fluoride, which is highly relevant, especially due to the number of additional human studies:²³³

In total, Petitioners have identified and attached 196 published studies that have addressed the neurotoxic effects of fluoride exposure subsequent to the NRC's review, including 61 human studies, 115 animal studies, 17 cell studies, and 3 systematic reviews.

The post-NRC human studies include:

- 54 studies investigating fluoride's effect on cognitive performance, including but not limited to IQ, with all but 8 of these studies finding statistically significant associations between fluoride exposure and cognitive deficits.²³⁴
- 3 studies investigating fluoride's effect on fetal brain, with each of the 3 studies reporting deleterious effects.²³⁵
- 4 studies investigating fluoride's association with other forms of neurotoxic harm, including ADHD, altered neonatal behavior, and various neurological symptoms.²³⁶

The post-NRC animal studies include:

- 105 studies investigating fluoride's ability to produce neuroanatomical and neurochemical changes, with all but 2 of the studies finding at least one detrimental effect in at least one of the tested dosage levels.²³⁷
- 31 studies investigating fluoride's effect on learning and memory, with all but one of the studies finding at least one deleterious effect in the fluoride-treated groups.²³⁸
- 18 studies investigating fluoride's impact on other parameters of neurobehavior besides learning and memory, with all but one of the studies finding effects.²³⁹

The post-NRC cell studies include:

- 17 studies, including 2 studies that investigated and found effects at fluoride levels that chronically occur in the blood of Americans living in fluoridated communities.²⁴⁰

In addition to the above studies, Petitioners are submitting three post-NRC systematic reviews of the literature, including two that address the human/IQ literature, and one that addresses the animal/cognition literature.²⁴¹

It is clear that numerous research articles have already identified potential harm to humans from fluoride at various levels of exposure, including levels currently deemed as safe. Although each of these articles merit attention and discussion, an abbreviated list is included below in the form of a general description of health effects related to fluoride exposure, which features highlights of pertinent reports and studies.

Section 6.1: Skeletal System

Fluoride taken into the human body enters the bloodstream through the digestive tract.²⁴² Most of the fluoride that is not released through urine is stored in the body. It is generally stated that 99% of this fluoride resides in the bone,²⁴³ where it is incorporated into the crystalline structure and accumulates over time.²⁴⁴ Thus, it is indisputable that the teeth and bones are tissues of the body that concentrate the fluoride to which we are exposed.

In fact, in its 2006 report, the National Research Council (NRC)'s discussion on the danger of bone fractures from excessive fluoride was substantiated with significant research. Specifically, the report stated: "Overall, there was consensus among the committee that there is scientific evidence that under certain conditions fluoride can weaken bone and increase the risk of fractures."²⁴⁵

Section 6.1.1: Dental Fluorosis

Exposure to excess fluoride in children is known to result in dental fluorosis, a condition in which the teeth enamel becomes irreversibly damaged and the teeth become permanently discolored, displaying a white or brown mottling pattern and forming brittle teeth that break and stain easily.²⁴⁶ It has been scientifically recognized since the 1940's that overexposure to fluoride causes this condition, which can range from very mild to severe. According to data from the Centers for Disease Control and Prevention (CDC) released in 2010, 23% of Americans aged 6-49 and 41% of children aged 12-15 exhibit fluorosis to some degree.²⁴⁷ These drastic increases in rates of dental fluorosis were a crucial factor in the Public Health Service's decision to lower its water fluoridation level recommendations in 2015.²⁴⁸

*Figure 1: Dental Fluorosis Ranging from Very Mild to Severe
(Photos from Dr. David Kennedy and are used with permission from victims of dental fluorosis.)*



Section 6.1.2: Skeletal Fluorosis and Arthritis

Like dental fluorosis, skeletal fluorosis is an undeniable effect of overexposure to fluoride. Skeletal fluorosis causes denser bones, joint pain, a limited range of joint movement, and in severe cases, a completely rigid spine.²⁴⁹ Although considered rare in the U.S., the condition does occur,²⁵⁰ and it has been recently suggested that skeletal fluorosis could be more of a public health issue than previously recognized.²⁵¹

As research published in 2016 noted, there is not yet a scientific consensus as to how much fluoride and/or how long levels of fluoride need to be taken in before skeletal fluorosis occurs.²⁵² While some authorities have suggested skeletal fluorosis only occurs after 10 years or more of exposure, research has shown that children can develop the disease in as little as six months,²⁵³ and some adults have developed it in as little as two to seven years.²⁵⁴ Similarly, while some authorities have suggested that 10 mg/day of fluoride is necessary to develop skeletal fluorosis, research has reported that much lower levels of exposure to fluoride (in some cases less than 2ppm) can also cause the disease.²⁵⁵ Furthermore, research published in 2010 confirmed that skeletal tissue response to fluoride varies by individual.²⁵⁶

In patients with skeletal fluorosis, fluoride has also been suspected of causing secondary hyperparathyroidism and/or causing bone damage resembling secondary hyperparathyroidism. The condition, which commonly results from kidney disease, is triggered when the levels of calcium and phosphorous in the blood are too low.²⁵⁷ A number of studies that have been collected by the Fluoride Action Network (FAN) examine the possibility that fluoride is one contributor to this health effect.²⁵⁸

Because arthritic symptoms are associated with skeletal fluorosis, arthritis is another area of concern in relation to fluoride exposures. Notably in this regard, research has linked fluoride to osteoarthritis, both with or without skeletal fluorosis.²⁵⁹ Additionally, temporomandibular joint disorder (TMJ) has been associated with dental and skeletal fluorosis.²⁶⁰

Section 6.1.3: Cancer of the Bone, Osteosarcoma

In 2006, the NRC discussed a potential link between fluoride exposure and osteosarcoma. This type of bone cancer has been recognized as “the sixth most common group of malignant tumors in children and the third most common malignant tumor for adolescents.”²⁶¹ The NRC stated that while evidence was tentative, fluoride appeared to have the potential to promote cancers.²⁶² They elucidated that osteosarcoma was of significant concern, especially because of fluoride deposition in bone and the mitogenic effect of fluoride on bone cells.²⁶³

While some studies have failed to find an association between fluoride and osteosarcoma, according to the research completed by Dr. Elise Bassin while at Harvard School of Dental Medicine, exposure to fluoride at recommended levels correlated with a seven-fold increase in osteosarcoma when boys were exposed between the ages of five and seven.²⁶⁴ Bassin’s research, published in 2006, is the only study about osteosarcoma that has taken age-specific risks into account.²⁶⁵

Section 6.2: Central Nervous System

The potential for fluorides to impact the brain have been well-established. In their 2006 report, the NRC explained: “On the basis of information largely derived from histological, chemical, and molecular studies, it is apparent that fluorides have the ability to interfere with the functions of the brain and the body by direct and indirect means.”²⁶⁶ Both dementia and Alzheimer’s disease are also mentioned in the NRC report for consideration as being potentially linked to fluoride.²⁶⁷

These concerns have been substantiated. Studies about water fluoridation and IQ effects were closely examined in research published in October of 2012 in *Environmental Health Perspectives*.²⁶⁸ In this meta-review, 12 studies demonstrated that communities with fluoridated water levels below 4 mg/L (average of 2.4 mg/L) had lower IQs than the control groups.²⁶⁹ Since the publication of the 2012 review, a number of additional studies finding reduced IQs in communities with less than 4 mg/L of fluoride in the water have become available.²⁷⁰ To be more precise, in a citizen petition to the EPA in 2016, Michael Connett, Esq., Legal Director of FAN, identified 23 studies reporting reduced IQ in areas with fluoride levels currently accepted as safe by the EPA.²⁷¹

Moreover, in 2014, a review was published in *The Lancet* entitled “Neurobehavioral effects of developmental toxicity.” In this review, fluoride was listed as one of 12 industrial chemicals known to cause developmental neurotoxicity in human beings.²⁷² The researchers warned: “Neurodevelopmental disabilities, including autism, attention-deficit hyperactivity disorder, dyslexia, and other cognitive impairments, affect millions of children worldwide, and some diagnoses seem to be increasing in frequency. Industrial chemicals that injure the developing brain are among the known causes for this rise in prevalence.”²⁷³

Section 6.3: Cardiovascular System

According to statistics published in 2016, heart disease is the leading cause of death for both men and women in the U.S., and it costs the country \$207 billion annually.²⁷⁴ Thus, recognizing the potential relationship between fluoride and cardiovascular problems is essential not only for safe measures to be established for fluoride but also for preventative measures to be established for heart disease.

An association between fluoride and cardiovascular problems has been suspected for decades. The 2006 NRC report described a study from 1981 by Hanhijärvi and Penttilä that reported elevated serum fluoride in patients with cardiac failure.²⁷⁵ Fluoride has also been related to arterial calcification,²⁷⁶ arteriosclerosis,²⁷⁷ cardiac insufficiency,²⁷⁸ electrocardiogram abnormalities,²⁷⁹ hypertension,²⁸⁰ and myocardial damage.²⁸¹ Additionally, researchers of a study from China published in 2015 concluded: “The results showed that, NaF [sodium fluoride], in a concentration dependent-manner and even at the low concentration of 2 mg/L, changed the morphology of the cardiomyocytes, reduced cell viability, increased the cardiac arrest rate, and enhanced the levels of apoptosis.”²⁸²

Section 6.4: Endocrine System

Fluoride's effects on the endocrine system, which consists of glands that regulate hormones, have also been studied. In the 2006 NRC report, it was stated: "In summary, evidence of several types indicates that fluoride affects normal endocrine function or response; the effects of the fluoride-induced changes vary in degree and kind in different individuals."²⁸³ The 2006 NRC report further included a table demonstrating how extremely low doses of fluoride have been found to disrupt thyroid function, especially when there was a deficiency in iodine present.²⁸⁴ In more recent years, the impact of fluoride on the endocrine system has been re-emphasized. A study published in 2012 included sodium fluoride on a list of endocrine disrupting chemicals (EDCs) with low-dose effects,²⁸⁵ and the study was cited in a 2013 report from the United Nations Environment Programme and the World Health Organization.²⁸⁶

Meanwhile, increased rates of thyroid dysfunction have been associated with fluoride.²⁸⁷ Research published in 2015 by researchers at the University of Kent in Canterbury, England, noted that higher levels of fluoride in drinking water could predict higher levels of hypothyroidism.²⁸⁸ They further explained: "In many areas of the world, hypothyroidism is a major health concern and in addition to other factors—such as iodine deficiency— fluoride exposure should be considered as a contributing factor. The findings of the study raise particular concerns about the validity of community fluoridation as a safe public health measure."²⁸⁹ Other studies have supported the association between fluoride and hypothyroidism,²⁹⁰ an increase in thyroid stimulating hormone (THS),²⁹¹ and iodine deficiency.²⁹²

According to statistics released by the Centers for Disease Control and Prevention (CDC) in 2014, 29.1 million people or 9.3% of the population have diabetes.²⁹³ Again, the potential role of fluoride in this condition is essential to consider. The 2006 NRC report warned:

The conclusion from the available studies is that sufficient fluoride exposure appears to bring about increases in blood glucose or impaired glucose tolerance in some individuals and to increase the severity of some types of diabetes. In general, impaired glucose metabolism appears to be associated with serum or plasma fluoride concentrations of about 0.1 mg/L or greater in both animals and humans (Rigalli et al. 1990, 1995; Trivedi et al. 1993; de al Sota et al. 1997).²⁹⁴

Research has also associated diabetes with a reduced capacity to clear fluoride from the body,²⁹⁵ as well as a syndrome (polydispsia-polyurea) that results in increased intake of fluoride,²⁹⁶ and research has also linked insulin inhibition and resistance to fluoride.²⁹⁷

Also of concern is that fluoride appears to interfere with functions of the pineal gland, which helps control circadian rhythms and hormones, including the regulation of melatonin and reproductive hormones. Jennifer Luke of the Royal Hospital of London has identified high levels of fluoride accumulated in the pineal gland²⁹⁸ and further demonstrated that these levels could reach up to 21,000 ppm, rendering them higher than the fluoride levels in the bone or teeth.²⁹⁹ Other studies have linked fluoride to melatonin levels,³⁰⁰ insomnia,³⁰¹ and early puberty in girls,³⁰² as well as lower fertility rates (including men) and reduced testosterone levels.³⁰³

Section 6.5: Renal System

Urine is a major route of excretion for fluoride taken into the body, and the renal system is essential for the regulation of fluoride levels in the body.^{304 305} Urinary excretion of fluoride is influenced by urine pH, diet, presence of drugs, and other factors.³⁰⁶ Researchers of a 2015 article published by the Royal Society of Chemistry explained: “Thus, plasma and the kidney excretion rate constitutes the physiologic balance determined by fluoride intake, uptake to and removal from bone and the capacity of fluoride clearance by the kidney.”³⁰⁷

The 2006 NRC report likewise recognized the role of the kidney in fluoride exposures. They noted that it is not surprising for patients with kidney disease to have increased plasma and bone fluoride concentrations.³⁰⁸ They further stated that human kidneys “have to concentrate fluoride as much as 50-fold from plasma to urine. Portions of the renal system may therefore be at higher risk of fluoride toxicity than most soft tissues.”³⁰⁹

In light of this information, it makes sense that researchers have indeed linked fluoride exposures to problems with the renal system. More specifically, researchers from Toronto, Canada, demonstrated that dialysis patients with renal osteodystrophy had high levels of fluoride in the bone and concluded that “bone fluoride may diminish bone microhardness by interfering with mineralization.”³¹⁰ Additionally, a study on workers exposed to cryolite by Philippe Grandjean and Jørgen H. Olsen published in 2004 suggested that fluoride be considered as a possible cause of bladder cancer and a contributory cause in lung cancer.³¹¹

Section 6.6: Respiratory System

The effects of fluoride on the respiratory system are most clearly documented in literature about occupational exposures. Obviously, workers in industries involving fluoride are at a much higher risk of inhaling fluoride than those who do not work in the industry; however industrial usage can also impact the respiratory systems of average citizens through a variety of exposure routes.

Inhalation of hydrogen fluoride serves as a prime example of the dually evidenced occupational and non-occupational health risk. Hydrogen fluoride is used to make refrigerants, herbicides, pharmaceuticals, high-octane gasoline, aluminum, plastics, electrical components, fluorescent light bulbs, and etched metal and glass (such as that used in some electronic devices),³¹² as well as uranium chemicals production and quartz purification.³¹³ The Centers for Disease Control and Prevention (CDC) has explained that in addition to exposures at the workplace, non-occupational exposures to hydrogen fluoride can also occur at retail locations and through hobbies involving items made with the substance, as well as the rare event of exposure to a chemical terrorism agent.³¹⁴

Health effects from hydrogen fluoride can damage multiple different organs, including those involved with the respiratory system. Breathing the chemical can harm lung tissue and cause swelling and fluid accumulation in the lungs (pulmonary edema).³¹⁵ High levels of exposure to

hydrogen fluoride can cause death from the buildup in the lungs,³¹⁶ while chronic, low level inhalation can cause irritation and congestion of the nose, throat, and lungs.³¹⁷

Strictly from an occupational standpoint, the aluminum industry has been the subject of an array of investigations into fluoride's impact on the respiratory systems of workers. Evidence from a series of studies indicates a correlation between workers at aluminum plants, exposures to fluoride, and respiratory effects, such as emphysema, bronchitis, and diminished lung function.³¹⁸

Section 6.7: Digestive System

Upon ingestion, including through fluoridated water, fluoride is absorbed by the gastrointestinal system where it has a half-life of 30 minutes.³¹⁹ The amount of fluoride absorbed is dependent upon calcium levels, with higher concentrations of calcium lowering gastrointestinal absorption.^{320 321} Also, according to research published in 2015 by the American Institute of Chemical Engineers, fluoride's interaction in the gastrointestinal system "results in formation of hydrofluoric [HF] acid by reacting with hydrochloric [HCL] acid present in the stomach. Being highly corrosive, the HF acid so formed will destroy the stomach and intestinal lining with the loss of microvilli."³²²

Another area of research related to fluoride's impact on the gastrointestinal tract is the accidental ingestion of toothpaste. In 2011, the Poison Control Center received 21,513 calls related to overconsumption of fluoridated toothpaste.³²³ The numbers of impacted individuals are likely to be much higher, however. Concerns have been raised that some gastrointestinal symptoms might not be readily considered as related to fluoride ingestion, as researchers explained in 1997:

Parents or caregivers may not notice the symptoms associated with mild fluoride toxicity or may attribute them to colic or gastroenteritis, particularly if they did not see the child ingest fluoride. Similarly, because of the nonspecific nature of mild to moderate symptoms, a physician's differential diagnosis is unlikely to include fluoride toxicity without a history of fluoride ingestion.³²⁴

Other areas of the digestive system are also known to be impacted by fluoride. For example, the 2006 NRC report called for more information about fluoride's effect on the liver: "It is possible that a lifetime ingestion of 5-10 mg/day from drinking water containing fluoride at 4 mg/L might turn out to have long-term effects on the liver, and this should be investigated in future epidemiologic studies."³²⁵ As another example, fluoride toothpaste may cause stomatitis, such as mouth and canker sores in some individuals.³²⁶

Section 6.8: Immune System

The immune system is yet another part of the body that can be impacted by fluoride. An essential consideration is that immune cells develop in the bone marrow, so the effect of fluoride on the immune system could be related to fluoride's prevalence in the skeletal system. The 2006 NRC report elaborated on this scenario:

Nevertheless, patients who live in either an artificially fluoridated community or a community where the drinking water naturally contains fluoride at 4 mg/L have all accumulated fluoride in their skeletal systems and potentially have very high fluoride concentrations in their bones. The bone marrow is where immune cells develop and that could affect humoral immunity and the production of antibodies to foreign chemicals.³²⁷

Allergies and hypersensitivities to fluoride are another risk component related to the immune system. Research published in 1950's, 1960's, and 1970's showed that some people are hypersensitive to fluoride.³²⁸ Interestingly, authors of research published in 1967 pointed out that while some still questioned the fact that fluoride in toothpaste and "vitamins" could cause sensitivities, the case reports presented in their publication established that allergic reactions to fluoride do exist.³²⁹ More recent studies have confirmed this reality.³³⁰

Section 6.9: Integumentary System

Fluoride can also impact the integumentary system, which consists of the skin, exocrine glands, hair, and nails. In particular, reactions to fluoride, including fluoride used in toothpaste, have been linked to acne and other dermatological conditions.^{331 332 333} Moreover, a potentially life-threatening condition known as fluoroderma is caused by a hypersensitive reaction to fluorine,³³⁴ and this type of skin eruption (a halogenoderma) has been associated with patients using fluoridated dental products.³³⁵ Additionally, hair and nails have been studied as biomarkers of fluoride exposure.³³⁶ Nail clippings are capable of demonstrating chronic fluoride exposures³³⁷ and exposures from toothpaste,³³⁸ and using fluoride concentrations in nails to identify children at risk for dental fluorosis has been examined.³³⁹

Section 6.10: Fluoride Toxicity

The first large scale case of alleged industrial poisoning from fluorine involved a disaster at Meuse Valley in Belgium in the 1930s. Fog and other conditions in this industrialized area were associated with 60 deaths and several thousand people becoming ill. Evidence has since related these casualties to fluorine releases from the nearby factories.³⁴⁰

Another case of industrial poisoning occurred in 1948 in Donora, Pennsylvania, due to fog and temperature inversion. In this instance, gaseous releases from zinc, steel, wire, and nail galvanizing industries have been suspected of causing 20 deaths and six thousand people to become ill as a result of fluoride poisoning.³⁴¹

Fluoride toxicity from a dental product in the United States occurred in 1974 when a three-year old Brooklyn boy died due to a fluoride overdose from dental gel. A reporter for the *New York Times* wrote of the incident: "According to a Nassau County toxicologist, Dr. Jesse Bidanset, William ingested 45 cubic centimeters of 2 percent stannous fluoride solution, triple an amount sufficient to have been fatal."³⁴²

Several major cases of fluoride poisoning in the United States have achieved attention in recent decades, such as the 1992 outbreak in Hooper Bay, Alaska, as a result of high levels of fluoride

in the water supply³⁴³ and the 2015 poisoning of a family in Florida as a result of sulfuryl fluoride used in a termite treatment on their home.³⁴⁴

While the examples provided above are cases of acute (high dose, short-term) poisoning, chronic (low dose, long-term) poisoning must also be considered. At least information about fluoride poisoning is becoming available to help form a better understanding of the issue. In work published in 2015, researchers reviewed the facts that the first sign of fluoride toxicity is dental fluorosis and that fluoride is a known enzyme disruptor.³⁴⁵ Additionally, a review published in 2012 provided a detailed account of the hazards of fluoride toxicity's effect on cells: "It activates virtually all known intracellular signaling pathways including G protein-dependent pathways, caspases, and mitochondria- and death receptors-linked mechanisms, as well as triggers a range of metabolic and transcription alterations, including the expression of several apoptosis-related genes, ultimately leading to cell death."³⁴⁶

The urgency for fluoride toxicity to be more widely recognized was explored in a 2005 publication entitled "Fluoride poisoning: a puzzle with hidden pieces." Author Phyllis J. Mullenix, PhD, began the article, which was presented in part at the American College of Toxicology Symposium, by warning: "A history of enigmatic descriptions of fluoride poisoning in the medical literature has allowed it to become one of the most misunderstood, misdiagnosed, and misrepresented health problems in the United States today."³⁴⁷

Section 7: Exposure Levels

Due to increased rates of dental fluorosis and increased sources of exposure to fluoride, the Public Health Service (PHS) lowered its recommended levels of fluoride set at 0.7 to 1.2 milligrams per liter in 1962³⁴⁸ to 0.7 milligrams per liter in 2015.³⁴⁹ The need to update previously established fluoride levels is extremely urgent, as fluoride exposures have obviously surged for Americans since the 1940's, when community water fluoridation was first introduced.

Table 2, provided in Section 3 of this document, helps identify just how many sources of fluoride exposure are relevant to modern-day consumers. Similarly, a history of fluoride, as provided in Section 4 of this document, helps firmly demonstrate the number of fluoride-containing products developed over the past 75 years. Furthermore, the health effects of fluoride, as provided in Section 6 of this document, offer details about the damages of fluoride exposures inflicted upon all systems of the human body. When viewed in context with the history, sources, and health effects of fluoride, the uncertainty of exposure levels described in this section provides overwhelming evidence of potential harm to human health.

Section 7.1: Fluoride Exposure Limits and Recommendations

Generally, the optimal exposure for fluoride has been defined as between 0.05 and 0.07 mg of fluoride per kilogram of body weight.³⁵⁰ However, this level has been criticized for failing to directly assess how intake of fluoride is related to the occurrence or severity of dental caries and/or dental fluorosis.³⁵¹ To elaborate, in a 2009 longitudinal study, researchers at the University of Iowa noted the lack of scientific evidence for this intake level and concluded: "Given the overlap among caries/fluorosis groups in mean fluoride intake and extreme variability in individual fluoride intakes, firmly recommending an 'optimal' fluoride intake is problematic."³⁵²

In light of this disparity, as well as the fact that the established levels directly influence the amounts of fluoride to which consumers are exposed, it is essential to evaluate some of the established limits and recommendations for fluoride exposures. While a detailed description of fluoride regulations is provided in Section 5 of this document, recommendations issued by other government groups are also important to consider. Comparing regulations and recommendations helps to exemplify the complexity of establishing levels, of enforcing levels, of utilizing them to protect *all* individuals, and of applying them to everyday life. To illustrate this point, Table 3 provides a comparison of recommendations from the Public Health Service (PHS), recommendations from the Institute of Medicine (IOM), and regulations from the Environmental Protection Agency (EPA).

Table 3: Comparison of PHS Recommendations, IOM Recommendations, and EPA Regulations for Fluoride Intake

| TYPE OF FLUORIDE LEVEL | SPECIFIC FLUORIDE RECOMMENDATION/REGULATION | SOURCE OF INFORMATION AND NOTES |
|---|--|--|
| Recommendation for Fluoride Concentration in Drinking Water for the Prevention of Dental Caries | 0.7 mg per liter | U.S. Public Health Service (PHS) ³⁵³ <i>This is a non-enforceable recommendation.</i> |
| Dietary Reference Intake: Tolerable Upper Intake Level of Fluoride | Infants 0-6 mo. 0.7 mg/d Infants 6-12 mo. 0.9 mg/d Children 1-3 y 1.3 mg/d Children 4-8 y 2.2 mg/d Males 9->70 y 10 mg/d Females 9->70 y* 10 mg/d (*includes pregnancy and lactation) | Food and Nutrition Board, Institute of Medicine (IOM), National Academies ³⁵⁴ <i>This is a non-enforceable recommendation.</i> |
| Dietary Reference Intake: Recommended Dietary Allowances and Adequate Intakes | Infants 0-6 mo. 0.01 mg/d Infants 6-12 mo. 0.5 mg/d Children 1-3 y 0.7 mg/d Children 4-8 y 1.0 mg/d Males 9-13 y 2.0 mg/d Males 14-18 y 3.0 mg/d Males 19->70 y 4.0 mg/d Females 9-13 y 2.0 mg/d Females 14->70 y* 3.0 mg/d (*includes pregnancy and lactation) | Food and Nutrition Board, Institute of Medicine (IOM), National Academies ³⁵⁵ <i>This is a non-enforceable recommendation.</i> |
| Maximum Contaminant Level (MCL) of Fluoride from Public Water Systems | 4.0 mg per liter | U.S. Environmental Protection Agency (EPA) ³⁵⁶ <i>This is an enforceable regulation.</i> |

| | | |
|---|------------------|---|
| Maximum Contaminant Level Goal (MCLG) of Fluoride from Public Water Systems | 4.0 mg per liter | U.S. Environmental Protection Agency (EPA) ³⁵⁷ <i>This is a non-enforceable regulation.</i> |
| Secondary Standard of Maximum Contaminant Levels (SMCL) of Fluoride from Public Water Systems | 2.0 mg per liter | U.S. Environmental Protection Agency (EPA) ³⁵⁸ <i>This is a non-enforceable regulation.</i> |

By interpreting the selected examples above, it is obvious that the limits and recommendations for fluoride in food and water vary tremendously and, in their current state, would be nearly impossible for consumers to incorporate into daily life. It is also obvious that these levels do not consider a multitude of other fluoride exposures. This means that consumers are reliant upon policy makers to protect them by enacting *enforceable regulations* based upon accurate data. One issue is that accurate data does not exist for either collective sources or singular sources of fluoride exposure. Another issue is that fluoride is known to impact each individual differently.

Section 7.2: Multiple Sources of Exposure

Understanding fluoride exposure levels from *all sources* is crucial because recommended intake levels for fluoride in water and food should be based upon these common multiple exposures. However, it is clear that these levels are *not* based on collective exposures because the authors of this document could not locate a single study or research article that included estimates of combined exposure levels from all of the sources identified in Table 2 in Section 3 of this position paper.

The concept of evaluating fluoride exposure levels from multiple sources was addressed in the 2006 National Research Council (NRC) report, which acknowledged the difficulties with accounting for all sources and individual variances.³⁵⁹ Yet, the NRC authors attempted to calculate combined exposures from pesticides/air, food, toothpaste, and drinking water.³⁶⁰ While these calculations did not include exposures from other dental materials, pharmaceutical drugs, and other consumer products, the NRC still recommended to lower the MCLG for fluoride,³⁶¹ which has not yet been accomplished.

The American Dental Association (ADA), which is a trade group and not a government entity, has recommended that collective sources of exposure should be taken into account. In particular, they have recommended that research should “estimate the total fluoride intake from all sources individually and in combination.”³⁶² Furthermore, in an article about the use of fluoride “supplements” (prescription drugs given to patients, usually children, that contain additional fluoride), the ADA mentioned that all sources of fluoride should be evaluated and that “patient exposure to multiple water sources can make proper prescribing complex.”³⁶³

Several studies conducted in the U.S. have offered data about multiple exposures to fluoride, as well as warnings about this current situation. A study published in 2005 by researchers at the University of Illinois at Chicago evaluated fluoride exposures in children from drinking water, beverages, cow's milk, foods, fluoride "supplements," toothpaste swallowing, and soil ingestion.³⁶⁴ They found that the reasonable maximum exposure estimates exceeded the upper tolerable intake and concluded that "some children may be at risk for fluorosis."³⁶⁵

Additionally, a study published in 2015 by researchers at the University of Iowa considered exposures from water, toothpaste, fluoride "supplements," and foods.³⁶⁶ They found considerable individual variation and offered data showing that some children exceeded the optimal range. They specifically stated: "Thus, it's doubtful that parents or clinicians could adequately track children's fluoride intake and compare it [to] the recommended level, rendering the concept of an 'optimal' or target intake relatively moot."³⁶⁷

Section 7.3: Individualized Responses and Susceptible Subgroups

Setting one universal level of fluoride as a recommended limit is also problematic because it does not take individualized responses into account. While age, weight, and gender are *sometimes* considered in recommendations, the current EPA regulations for water prescribe one level that applies to everyone, regardless of infants and children and their known susceptibilities to fluoride exposures. Such a "one dose fits all" level also fails to address allergies to fluoride,³⁶⁸ genetic factors,³⁶⁹ ³⁷⁰ ³⁷¹ nutrient deficiencies,³⁷² and other personalized factors known to be pertinent to fluoride exposures.

The NRC recognized such individualized responses to fluoride numerous times in their 2006 publication,³⁷³ and other research has affirmed this reality. For example, urine pH, diet, presence of drugs, and other factors have been identified as relative to the amount of fluoride excreted in the urine.³⁷⁴ As another example, fluoride exposures of non-nursing infants were estimated to be 2.8-3.4 times that of adults.³⁷⁵ The NRC further established that certain subgroups have water intakes that greatly vary from any type of assumed average levels:

These subgroups include people with high activity levels (e.g., athletes, workers with physically demanding duties, military personnel); people living in very hot or dry climates, especially outdoor workers; pregnant or lactating women; and people with health conditions that affect water intake. Such health conditions include diabetes mellitus, especially if untreated or poorly controlled; disorders of water and sodium metabolism, such as diabetes insipidus; renal problems resulting in reduced clearance of fluoride; and short-term conditions requiring rapid rehydration, such as gastrointestinal upsets or food poisoning.³⁷⁶

Considering that the rate of diabetes is on the rise in the U.S., with over 9% (29 million) Americans impacted,³⁷⁷ this particular subgroup is especially essential to factor into account. Furthermore, when added to the other subgroups mentioned in the NRC report above (including infants and children), it is apparent that hundreds of millions of Americans are at risk from the current levels of fluoride added to community drinking water.

The American Dental Association (ADA), a trade-based group that promotes water fluoridation,³⁷⁸ has also recognized the issue of individual variance in fluoride intake. They have recommended for research to be conducted to “[i]dentify biomarkers (that is, distinct biological indicators) as an alternative to direct fluoride intake measurement to allow the clinician to estimate a person’s fluoride intake and the amount of fluoride in the body.”³⁷⁹

Additional comments from the ADA provide even more insight into individualized responses related to fluoride intake. The ADA has recommended to “[c]onduct metabolic studies of fluoride to determine the influence of environmental, physiological and pathological conditions on the pharmacokinetics, balance and effects of fluoride.”³⁸⁰ Perhaps most notably, the ADA has also acknowledged the susceptible subgroup of infants. In regard to infant exposure from fluoridated water used in baby formula, the ADA recommends following the American Academy of Pediatrics guideline that breastfeeding should be exclusively practiced until the child is six months old and continued until 12 months, unless contraindicated.³⁸¹

While suggesting to exclusively breastfeed infants is certainly protective of their fluoride exposures, it is simply not practical for many American women today. The authors of a study published in 2008 in *Pediatrics* reported that only 50% of women continued to breast feed at six months and only 24% of women continued to breast feed at 12 months.³⁸²

What these statistics mean is that, due to infant formula mixed with fluoridated water, millions of infants most certainly exceed the optimal intake levels of fluoride based on their low weight, small size, and developing body. Hardy Limeback, PhD, DDS, a member of a 2006 National Research Council (NRC) panel on fluoride toxicity, and former President of the Canadian Association of Dental Research, has elaborated: “Newborn babies have undeveloped brains, and exposure to fluoride, a suspected neurotoxin, should be avoided.”³⁸³

Section 7.4: Water and Food

Fluoridated water, including its direct consumption and its use in other beverages and food preparation, is generally considered the main source of fluoride exposure for Americans. The U.S. Public Health Service (PHS) has estimated that the average dietary intake (including water) of fluoride for adults living in areas with 1.0 mg/L fluoride in the water as between 1.4 to 3.4 mg/day (0.02-0.048 mg/kg/day) and for children in fluoridated areas as between 0.03 to 0.06 mg/kg/day.³⁸⁴ Additionally, the Centers for Disease Control and Prevention (CDC) has reported that water and processed beverages can comprise 75% of a person’s fluoride intake.³⁸⁵

The 2006 NRC report came to similar conclusions. The authors estimated just how much of overall fluoride exposures are attributable to water when compared to pesticides/air, background food, and toothpaste, and they wrote: “Assuming that all drinking-water sources (tap and non-tap) contain the same fluoride concentration and using the EPA default drinking-water intake rates, the drinking-water contribution is 67-92% at 1 mg/L, 80-96% at 2 mg/L, and 89-98% at 4 mg/L.”³⁸⁶ Yet, the levels of NRC’s estimated fluoridated water intake rates were higher for athletes, workers, and individuals with diabetes.³⁸⁷

It is important to reiterate, however, that the fluoride added to water is not only taken in through drinking tap water. The water is also used for growing crops, tending to livestock (and domestic pets), food preparation, and bathing. It is also used to create other beverages, and for this reason, significant levels of fluoride have been recorded in infant formula and commercial beverages, such as juice and soft drinks.³⁸⁸ Significant levels of fluoride have also been recorded in alcoholic beverages, especially wine and beer.^{389 390}

In the exposure estimates provided in the 2006 NRC report, fluoride in food consistently ranked as the second largest source behind water.³⁹¹ Increased levels of fluoride in food can occur due to human activity, especially through food preparation and the use of pesticides and fertilizers.³⁹² Significant fluoride levels have been recorded in grapes and grape products.³⁹³ Fluoride levels have also been reported in cow's milk due to livestock raised on fluoride-containing water, feed, and soil,³⁹⁴ as well as processed chicken³⁹⁵ (likely due to mechanical deboning, which leaves skin and bone particles in the meat.)³⁹⁶

An essential question about these levels of fluoride intake is just how much is harmful. A study about water fluoridation published in 2016 by Kyle Fluegge, PhD, of Case Western University, was conducted at the county level in 22 states from 2005-2010. Dr. Fluegge reported that his findings suggested that “a 1 mg increase in the county mean added fluoride significantly positively predicts a 0.23 per 1,000 person increase in age-adjusted diabetes incidence ($P < 0.001$) and a 0.17% increase in age-adjusted diabetes prevalence percent ($P < 0.001$).”³⁹⁷ This led him to reasonably conclude that community water fluoridation is associated with epidemiological outcomes for diabetes.

Other studies have produced equally concerning results. A study published in 2011 found that children with 0.05 to 0.08 mg/L of fluoride in their serum had a 4.2 drop in IQ when compared to other children.³⁹⁸ Meanwhile, a study published in 2015 found that IQ points dropped at urinary fluoride levels between 0.7 and 1.5 mg/L,³⁹⁹ and another study published in 2015 linked fluoride at levels >0.7 mg/L with hyperthyroidism.⁴⁰⁰ Additional research has established the threat of health effects of fluoride in the water at levels currently considered as safe.⁴⁰¹

Section 7.5: Fertilizers, Pesticides, and Other Industrial Releases

Exposures to fertilizers and pesticides have been associated with serious health effects. For example, the Toxics Action Center has explained: “Pesticides have been linked to a wide range of human health hazards, ranging from short-term impacts, such as headaches and nausea, to chronic impacts like cancer, reproductive harm, and endocrine disruption.”⁴⁰² Scientific studies have also associated exposure to pesticides with antibiotic resistance⁴⁰³ and loss of IQ.⁴⁰⁴

Fluoride is an ingredient in phosphate fertilizers and certain types of pesticides. The use of these fluoride-containing products, in addition to irrigating with fluoridated water and industrial fluoride emissions, can raise the level of fluoride in topsoil.⁴⁰⁵ What this means is that humans can be exposed to fluoride from fertilizers and pesticides both primarily and secondarily: a primary exposure can occur from the initial pollution emitted in a specific geographic area where the product was applied, and secondary exposures can occur from contamination brought to

livestock who feed in the area, as well as water in the area that takes on the contamination from the soil.

It is therefore apparent that pesticides and fertilizers can constitute a significant portion of overall fluoride exposures. The levels vary based upon the exact product and the individual exposure, but in the 2006 NRC report, an examination of *only* dietary fluoride exposure levels from two pesticides found: “Under the assumptions for estimating the exposure, the contribution from pesticides plus fluoride in the air is within 4% to 10% for all population subgroups at 1 mg/L in tap water, 3-7% at 2 mg/L in tap water, and 1-5% at 4 mg/L in tap water.”⁴⁰⁶ Furthermore, as a result of concerns raised about the dangers of these exposures, the EPA proposed to withdraw all fluoride tolerances in pesticides in 2011,⁴⁰⁷ although this proposal was later overturned.⁴⁰⁸

Meanwhile, the environment is contaminated by fluoride releases from additional sources, and these releases likewise impact water, soil, air, food, and human beings in the vicinity. Industrial releases of fluoride can result from coal combustion by electrical utilities and other industries.⁴⁰⁹ Releases can also occur from refineries and metal ore smelters,⁴¹⁰ aluminum production plants, phosphate fertilizer plants, chemical production facilities, steel mills, magnesium plants, and brick and structural clay manufacturers,⁴¹¹ as well as copper and nickel producers, phosphate ore processors, glass manufacturers, and ceramic manufacturers.⁴¹² Concerns about the fluoride exposures generated from these industrial activities, especially when combined with other exposures, led researchers to state in 2014 that “industrial safety measures need to be tightened in order to reduce unethical discharge of fluoride compounds into the environment.”⁴¹³

Section 7.6: Dental Products for Use at Home

Fluoride from dental products used at home likewise contribute to overall exposure levels. These levels are highly significant and occur at rates which vary by person due to the frequency and amount of use, as well as individual response. However, they also vary not only by the type product used, but also by the specific brand of the product used. To add to the complexity, these products contain different types of fluoride, and the average consumer is unaware of what the concentrations listed on the labels actually mean. Additionally, most of the studies that have been done on these products involve children, and even the Centers for Disease Control and Prevention (CDC) has explained that research involving adult exposures to toothpaste, mouth rinse, and other products is lacking.⁴¹⁴

Fluoride added to toothpaste can be in the form of sodium fluoride (NaF), sodium monofluorophosphate (Na₂FPO₃), stannous fluoride (tin fluoride, SnF₂) or a variety of amines.⁴¹⁵ Toothpaste used at home generally contains between 850 to 1,500 ppm fluoride,⁴¹⁶ while prophylactic paste used in the office during a dental cleaning generally contains 4,000 to 20,000 ppm fluoride.⁴¹⁷ Brushing with fluoridated toothpaste is known to raise fluoride concentration in saliva by 100 to 1,000 times, with effects lasting one to two hours.⁴¹⁸ The U.S. FDA requires specific wording for the labeling of toothpaste, including strict warnings for children.⁴¹⁹

Yet, in spite of these labels and directions for use, research suggests that toothpaste significantly contributes to daily fluoride intake in children.⁴²⁰ Part of this is due to swallowing toothpaste, and a study published in 2014 established that small fonts used for the required labeling (often

placed on the back of the tube), intentional food-like flavoring, and the way in which children's toothpastes are marketed intensify this hazard.⁴²¹ While the CDC has acknowledged that overconsumption of toothpaste is associated with health risks to children, researchers from William Paterson University in New Jersey have noted that no clear definition of "overconsumption" exists.⁴²²

Some research has even suggested that, due to swallowing, toothpaste can account for greater amounts of fluoride intake in children than water.⁴²³ In light of the significant fluoride exposures in children from toothpaste and other sources, researchers at the University of Illinois at Chicago concluded that their findings raised "questions about the continued need for fluoridation in the U.S. municipal water supply."⁴²⁴

Mouth rinses (and mouthwash) also contribute to overall fluoride exposures. Mouth rinses can contain sodium fluoride (NaF) or acidulated phosphate fluoride (APF),⁴²⁵ and a 0.05% sodium fluoride solution of mouth rinse contains 225 ppm of fluoride. Like toothpaste, accidental swallowing of this dental product can raise fluoride intake levels even higher.

Fluoridated dental floss is yet another product that contributes to overall fluoride exposures. Flosses that have added fluoride, most often reported as 0.15mgF/m,⁴²⁶ release fluoride into the tooth enamel⁴²⁷ at levels greater than mouth rinse.⁴²⁸ Elevated fluoride in saliva has been documented for at least 30 minutes after flossing,⁴²⁹ but like other over-the-counter dental products, a variety of factors influence the fluoride release. Research from the University of Gothenburg in Sweden published in 2008 noted that saliva (flow rate and volume), intra- and inter-individual circumstances, and variation between products impact fluoride releases from dental floss, fluoridated toothpicks, and interdental brushes.⁴³⁰ Additionally, dental floss can contain fluoride in the form of perfluorinated compounds, and a 2012 Springer publication identified 5.81 ng/g liquid as the maximum concentration of perfluorinated carboxylic acid (PFCA) in dental floss and plaque removers.⁴³¹

Many consumers utilize toothpaste, mouthwash, and floss in combination on a daily basis, and thus, these multiple routes of fluoride exposure are even more relevant when estimating overall intakes. In addition to these over-the-counter dental products, some of the materials used at the dental office can result in even higher fluoride exposure levels for millions of Americans.

Section 7.7: Dental Products for Use at the Dental Office

There is a significant gap, if not a major void, in scientific literature that includes fluoride releases from procedures and products administered at the dental office as part of overall fluoride intake. Part of this is likely due to the fact that the research attempting to evaluate singular exposures from these products has demonstrated that establishing any type of average release rate is virtually impossible.

A prime example of this scenario is the use of dental "restorative" materials, which are used to fill cavities. Because 92% of adults aged 20 to 64 have had dental caries in their permanent teeth,⁴³² and these products are also used on children, consideration of the fluoridated materials used to fill cavities is crucial to hundreds of millions of Americans. Many of the options for

filling materials contain fluoride, including *all* glass ionomer cements,⁴³³ *all* resin-modified glass ionomer cements,⁴³⁴ *all* giomers,⁴³⁵ *all* polyacid-modified composites (compomers),⁴³⁶ *certain types of* composites,⁴³⁷ and *certain types of* dental mercury amalgams.⁴³⁸ Fluoride-containing glass ionomer cements, resin-modified glass ionomer cements, and polyacid-modified composite resin (compomer) cements are also used in orthodontic band cements.⁴³⁹

Generally speaking, composite and amalgam filling materials release much lower levels of fluoride than the glass ionomer-based materials.⁴⁴⁰ Glass ionomers and resin-modified glass ionomers release an “initial burst” of fluoride and then give off lower levels of fluoride long-term.⁴⁴¹ The long-term cumulative emission also occurs with giomers and compomers, as well as fluoride-containing composites and amalgams.⁴⁴² To put these releases in perspective, a Swedish study demonstrated that the fluoride concentration in glass ionomer cements was approximately 2-3 ppm after 15 minutes, 3-5 ppm after 45 minutes, 15-21 ppm within twenty-four hours, and 2-12 mg of fluoride per ml of glass cement during the first 100 days.⁴⁴³

As with other fluoride products, however, the rate of fluoride release is impacted by a wide range of factors. Some of these variables include the media used for storage, the change rate for the storage solution, and the composition and pH-value of saliva, plaque, and pellicle formation.⁴⁴⁴ Other factors that can influence the release rate of fluoride from filling materials are the cement matrix, porosity, and composition of the filling material, such as the type, amount, particle size, and silane treatment.⁴⁴⁵

To complicate matters, these dental materials are designed to “recharge” their fluoride releasing capacity, thereby boosting the amounts of fluoride released. This increase in fluoride release is initiated because the materials are constructed to serve as a fluoride reservoir that can be refilled. Thus, by utilizing another fluoride-containing product, such as a gel, varnish, or mouthwash, more fluoride can be retained by the material and thereafter released over time. Glass ionomers and compomers are most recognized for their recharging effects, but a number of variables influence this mechanism, such as the composition of the material and the age of the material,⁴⁴⁶ in addition to the frequency of recharging and the type of agent used for recharging.⁴⁴⁷

In spite of the many factors that influence fluoride release rates in dental devices, attempts have been made to establish fluoride release profiles for these products. The result is that researchers have produced a vast array of measurements and estimations. Researchers from Belgium wrote in 2001: “However, it was impossible to correlate the fluoride release of materials by their type (conventional or resin-modified glass-ionomers, polyacid-modified resin composite and resin composite) except if we compared the products from the same manufacturer.”⁴⁴⁸

Other materials used at the dental office likewise fluctuate in fluoride concentration and release levels. Currently, there are over 30 products on the market for fluoride varnish, which, when used, is usually applied to the teeth during two dental visits per year. These products have different compositions and delivery systems⁴⁴⁹ that vary by brand.⁴⁵⁰ Typically, varnishes contain either 2.26% (22,600 ppm) sodium fluoride or 0.1% (1,000 ppm) difluorsilane.⁴⁵¹

Gels and foams can also be used at the dentist office, and sometimes even at home. The ones used at the dentist office are usually very acidic and can contain 1.23% (12,300 ppm) acidulated

phosphate fluoride or 0.9% (9,040 ppm) sodium fluoride.⁴⁵² Gels and foams used at home can contain 0.5% (5,000 ppm) sodium fluoride or 0.15% (1,000 ppm) stannous fluoride.⁴⁵³ Brushing and flossing before applying gel can result in higher levels of fluoride retained in the enamel.⁴⁵⁴

Silver diamine fluoride is now also used in dental procedures, and the brand used in the U.S. contains 5.0-5.9% fluoride.⁴⁵⁵ This is a relatively new procedure that was FDA approved in 2014 for treating tooth sensitivity but not dental caries.⁴⁵⁶ Concerns have been raised about risks of silver diamine fluoride, which can permanently stain teeth black.^{457 458} Additionally, in a randomized control trial published in 2015, the researchers concluded: “There are some lingering concerns as the authors do not suggest adequate safety information regarding this preparation or the potential toxicity levels for children, but it provides a basis for future research.”⁴⁵⁹

Section 7.8: Pharmaceutical Drugs (Including Supplements)

20-30% of pharmaceutical compounds have been estimated to contain fluorine.⁴⁶⁰ Fluorine is used in drugs as anesthetics, antibiotics, anti-cancer and anti-inflammatory agents, psychopharmaceuticals,⁴⁶¹ and in many other applications. Some of the most popular fluorine-containing drugs include Prozac and Lipitor, as well as the fluoroquinolone family (ciprofloxacin [marketed as Ciprobay],⁴⁶² gemifloxacin [marketed as Factive], levofloxacin [marketed as Levaquin], moxifloxacin [marketed as Avelox], norfloxacin [marketed as Noroxin], and ofloxacin [marketed as Floxin and generic ofloxacin]).⁴⁶³ The fluorinated compound fenfluramine (fen-phen) was also used for many years as an anti-obesity drug,⁴⁶⁴ but it was removed from the market in 1997 due to its link with heart valve problems.⁴⁶⁵

Fluoride accumulation in tissue as a result of exposure to these pharmaceuticals is one potential culprit in quinolone chondrotoxicity,⁴⁶⁶ and fluoroquinolones have received media attention as a result of their serious health risks. Reported side effects from fluoroquinolones include retinal detachment, kidney failure, depression, psychotic reactions, and tendinitis.⁴⁶⁷ In a *New York Times* article published in 2012 about the controversial family of drugs, writer Jane E. Brody revealed that more than 2,000 lawsuits have been filed over the fluoroquinolone Levaquin.⁴⁶⁸ In 2016, the FDA acknowledged “disabling and potentially permanent side effects” caused by fluoroquinolones and advised that these drugs only be used when there is no other treatment option available for patients because the risks outweigh the benefits.⁴⁶⁹

Defluorination of any type of fluorinated drug can occur, and this, among other risks, led researchers to conclude in a 2004 review: “No one can responsibly predict what happens in a human body after administration of fluorinated compounds. Large groups of people, including neonates, infants, children, and ill patients serve thus as the subjects of pharmacological and clinical research.”⁴⁷⁰

One other major type of prescription drug is essential to consider in regard to overall fluoride exposure levels. Many dentists prescribe fluoride tablets, drops, lozenges, and rinses, which are often referred to as fluoride “supplements” or “vitamins.” These products contain 0.25, 0.5, or 1.0 mg fluoride,⁴⁷¹ and they are **not approved** as safe and effective for caries prevention by the FDA.⁴⁷²

The dangers of these fluoride “supplements” have been made clear. The author of a 1999 publication warned: “Fluoride supplements, when ingested for a pre-eruptive effect by infants and young children in the United States, therefore, now carry more risk than benefit.”⁴⁷³ Similarly, the 2006 NRC report established that age, risk factors, ingestion of fluoride from other sources, inappropriate use, and other considerations should be taken into account for these products.⁴⁷⁴ The NRC report further included statistics that “all children through age 12 who take fluoride supplements (assuming low water fluoride) will reach or exceed 0.05-0.07 mg/kg/day.”⁴⁷⁵

Yet, these products continue to be prescribed by dentists and regularly used by consumers, especially children,⁴⁷⁶ even as concerns about fluoride “supplements” continue to be repeated. For example, researchers of a Cochrane Collaboration review published in 2011 advised: “No data were available concerning adverse effects related to fluoride supplementation in children aged less than 6 years. The ratio benefit/risk of fluoride supplementation was thus unknown for young children.”⁴⁷⁷ Moreover, in 2015, scientists conducting an analysis of fluoride in toothpaste and fluoride supplements wrote: “Taking into consideration the toxicity of fluorides, more strict control of fluoride content in pharmaceutical product[s] for oral hygiene is proposed.”⁴⁷⁸

Section 7.9: Perfluorinated Compounds

In 2015, over 200 scientists from 38 countries signed on to the “Madrid Statement,”⁴⁷⁹ a research-based call for action by governments, scientists, and manufacturers to address the signatories’ concerns about “production and release into the environment of an increasing number of poly- and perfluoroalkyl substances (PFASs).”⁴⁸⁰ Products made with perfluorinated compounds (PFCs) include protective coatings for carpets and clothing (such as stain-resistant or water-proof fabric), paints, cosmetics, insecticides, non-stick coatings for cookware, and paper coatings for oil and moisture resistance,⁴⁸¹ as well as leather, paper, and cardboard,⁴⁸² deck stains,⁴⁸³ and a wide variety of other consumer items.

In research published in 2012, dietary intake was identified as the major source of exposure to perfluorinated compounds (PFCs),⁴⁸⁴ and additional scientific investigation has supported this claim. In an article published in 2008, researchers stated that in North America and Europe, contaminated food (including drinking water) is the most essential exposure route of perfluorooctane sulfonate (PFOS) and perfluorooctanoic acid (PFOA).⁴⁸⁵ The researchers also concluded that children have increased uptake doses due to their smaller body weight, and they provided the following statistics for average consumers: “We find that North American and European consumers are likely to experience ubiquitous and long-term uptake doses of PFOS and PFOA in the range of 3 to 220 ng per kg body weight per day (ng/kg(bw)/day) and 1 to 130 ng/kg(bw)/day, respectively.”⁴⁸⁶

A chapter in *The Handbook of Environmental Chemistry* published in 2012 explored some of the other common exposures to PFCs. In particular, data was offered that commercial carpet-care liquids, household carpet and fabric-care liquids and foams, and treated floor waxes and stone/wood sealants had higher concentrations of PFCs when compared to other PFC-containing

products.⁴⁸⁷ The author also specified that the exact compositions of PFCs in consumer products are often kept confidential and that knowledge about these compositions is “very limited.”⁴⁸⁸

Section 7.10: Interactions of Fluoride with Other Chemicals

The concept of multiple chemicals interacting within the human body to produce ill-health should now be an essential understanding required for practicing modern-day medicine. Researchers Jack Schubert, E. Joan Riley, and Sylvanus A. Tyler addressed this highly relevant aspect of toxic substances in a scientific article published in 1978. Considering the prevalence of chemical exposures, they noted: “Hence, it is necessary to know the possible adverse effects of two or more agents in order to evaluate potential occupational and environmental hazards and to set permissible levels.”⁴⁸⁹

The need to study the health outcomes caused by exposures to a variety of chemicals has also been reported by researchers affiliated with a database which tracks associations between approximately 180 human diseases or conditions and chemical contaminants. Supported by the Collaborative on Health and the Environment, the researchers for this project, Sarah Janssen, MD, PhD, MPH, Gina Solomon, MD, MPH, and Ted Schettler, MD, MPH, clarified:

More than 80,000 chemicals have been developed, distributed, and discarded into the environment over the past 50 years. The majority of them have not been tested for potential toxic effects in humans or animals. Some of these chemicals are commonly found in air, water, food, homes, work places, and communities. Whereas the toxicity of one chemical may be incompletely understood, an understanding of the effect from exposures to mixtures of chemicals is even less complete.⁴⁹⁰

Clearly, the interaction of fluoride with other chemicals is crucial to understanding exposure levels and their impacts. While countless interactions have yet to be examined, several hazardous combinations have been established.

Aluminum fluoride exposure occurs from ingesting a fluoride source *with* an aluminum source.⁴⁹¹ 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.⁴⁹² Authors of a research report published in 1999 described the hazardous synergy between these two chemicals: “In view of the ubiquity of phosphate in cell metabolism and together with the dramatic increase in the amount of reactive aluminum now found in ecosystems, aluminum fluoride complexes represent a strong potential danger for living organisms including humans.”⁴⁹³

Examples of ingredients in dental products dangerously interacting with fluoride also exist in the scientific literature. Authors of a 1994 publication suggested avoiding oral treatment involving high fluoride ions concentration and dental mercury amalgam fillings due to increased corrosion.⁴⁹⁴ Similarly, a publication from 2015 found that certain orthodontic wires and brackets had increased levels of corrosion due to fluoride mouthwash.⁴⁹⁵ Essential to note is that galvanic corrosion of dental materials has been linked to other health effects such as oral lesions,⁴⁹⁶ as well as metallic tastes in the mouth, irritation, and even allergies.⁴⁹⁷

Furthermore, fluoride, in its form of hydrofluosilicic acid (which is added to many water supplies to fluoridate the water), attracts manganese and lead (both of which can be present in certain types of plumbing pipes). Likely because of the affinity for lead, fluoride has been linked to higher blood lead levels in children,⁴⁹⁸ especially in minority groups.⁴⁹⁹ Lead is known to lower IQs in children,⁵⁰⁰ and lead has even been linked to violent behavior.^{501 502} Other research supports the potential association of fluoride with violence.⁵⁰³

Section 8: Lack of Efficacy, Lack of Evidence, and Lack of Ethics

Upon reading the preceding Section 7 about exposures to fluoride, it becomes glaringly obvious just how much additional research is required before any “safe” level for fluoride exposures can be adequately established. This lack of evidence reaches far beyond what is currently *unknown*, however. The lack of evidence is also predominant in what is already known about humankind’s use of fluoride, especially in regard to its alleged “benefit” of preventing caries.

Section 8.1: Lack of Efficacy

The fluoride in toothpastes and other consumer products is added because it allegedly reduces dental caries. The suggested benefits of this form of fluoride are related to its activity on teeth of inhibiting bacterial respiration of *Streptococcus mutans*, the bacterium that turns sugar and starches into a sticky acid that dissolves enamel.⁵⁰⁴ In particular, the interaction of fluoride with the mineral component of teeth produces a fluorohydroxyapatite (FHAP or FAP), and the result of this action is said to be enhanced remineralization and reduced demineralization of the teeth. While there is scientific support for this mechanism of fluoride, it has also been established that fluoride primarily works to reduce tooth decay *topically* (i.e. scrubbing it directly onto to teeth with a toothbrush), as opposed to *systemically* (i.e. drinking or ingesting fluoride through water or other means).⁵⁰⁵

Although the *topical* benefits of fluoride have been distinctly expressed in scientific literature, research has likewise questioned these benefits. For example, researchers from the University of Massachusetts Lowell explained several controversies associated with topical uses of fluoride in an article published in the *Journal of Evidence-Based Dental Practice* in 2006. After citing a 1989 study from the National Institute of Dental Research that found minimal differences in children receiving fluoride and those not receiving fluoride, the authors referenced other studies demonstrating that cavity rates in industrialized countries have decreased without fluoride use.⁵⁰⁶ The authors further referenced studies indicating that fluoride does not aid in preventing pit and fissure decay (which is the most prevalent form of tooth decay in the U.S.) or in preventing baby bottle tooth decay (which is prevalent in poor communities).⁵⁰⁷

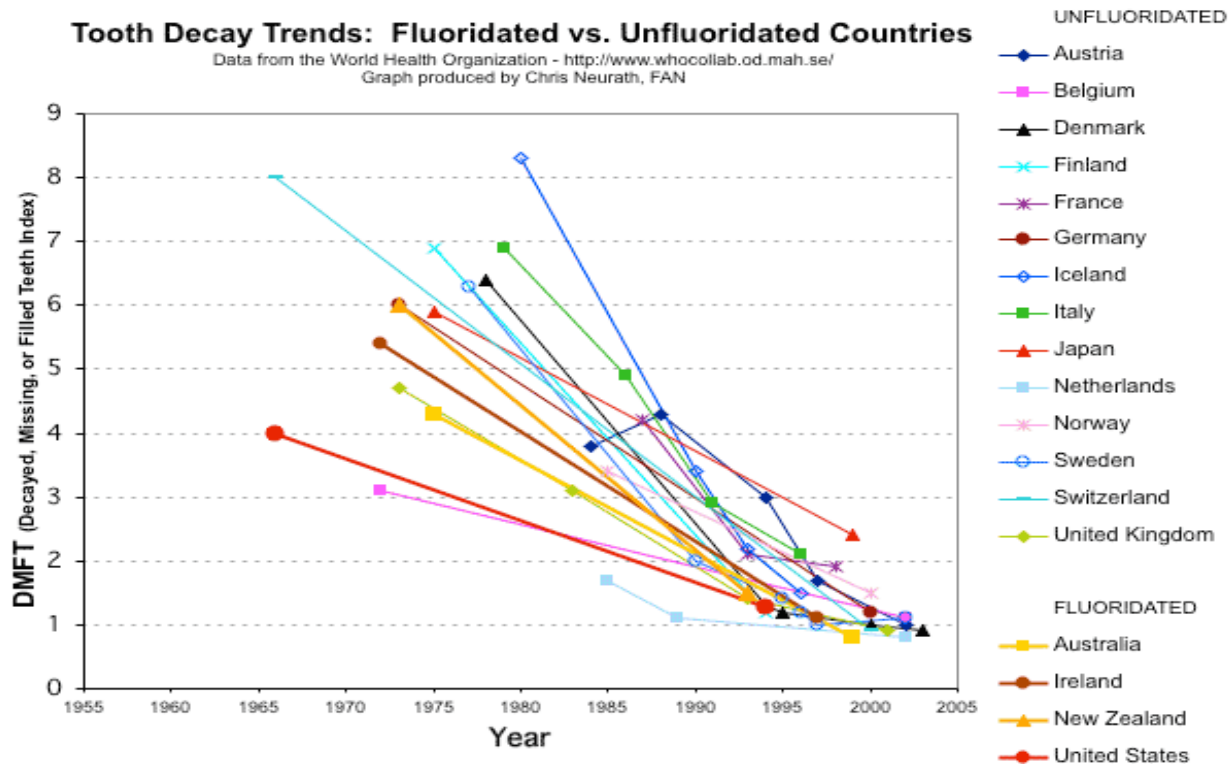
As another example, early research used to support water fluoridation as a means of reducing dental caries was later re-examined, and the potential of misleading data was identified. Initially, the reduction of decayed and filled deciduous teeth (DFT) collected in research was interpreted as proof for the efficacy of water fluoridation. However, subsequent research by Dr. John A. Yiamouyiannis suggested that water fluoridation could have contributed to the delayed eruption of teeth.⁵⁰⁸ Such delayed eruption would result in less teeth and therefore, the absence of decay,

meaning that the lower rates of DFT were actually caused by the lack of teeth as opposed to the alleged effects of fluoride on dental caries.

Other examples in the scientific literature have questioned fluoride’s use in preventing tooth decay. A 2014 review affirmed that fluoride’s anti-caries effect is reliant upon calcium and magnesium in the tooth enamel but also that the remineralization process in tooth enamel is not dependent on fluoride.⁵⁰⁹ Research published in 2010 identified that the concept of “fluoride strengthening teeth” could no longer be deemed as clinically significant to any decrease in caries linked to fluoride use.⁵¹⁰ Furthermore, research has suggested that *systemic* fluoride exposure has minimal (if any) effect on the teeth,^{511 512} and researchers have also offered data that dental fluorosis (the first sign of fluoride toxicity⁵¹³) is higher in U.S. communities with fluoridated water as opposed to those without it.⁵¹⁴

Still other reports show that as countries were developing, decay rates in the general population rose to a peak of four to eight decayed, missing, or filled teeth (in the 1960’s) and then showed a dramatic decrease (today’s levels), regardless of fluoride use. It has been hypothesized that increased oral hygiene, access to preventative services, and more awareness of the detrimental effects of sugar are responsible for the visible decrease of tooth decay. Whatever the reasons might be, it should be noted that this trend of decreased tooth decay occurred with and without the systemic application of fluoridated water,⁵¹⁵ so it would appear that factors other than fluoride caused this change. Figure 2 below exhibits the tooth decay trends by fluoridated and non-fluoridated countries from 1955-2005.

Figure 2: Tooth Decay Trends in Fluoridated and Unfluoridated Countries, 1955-2005



Several other considerations are relevant in any decision about using fluoride to prevent caries. First, it should also be noted that fluoride is not an essential component for human growth and development.⁵¹⁶ Second, fluoride has been recognized as one of 12 industrial chemicals “known to cause developmental neurotoxicity in human beings.”⁵¹⁷ And finally, the American Dental Association (ADA) called for more research in 2013 in regard to the mechanism of fluoride action and effects:

Research is needed regarding various topical fluorides to determine their mechanism of action and caries-preventive effects when in use at the current level of background fluoride exposure (that is, fluoridated water and fluoride toothpaste) in the United States. Studies regarding strategies for using fluoride to induce arrest or reversal of caries progression, as well as topical fluoride's specific effect on erupting teeth, also are needed.⁵¹⁸

Section 8.2: Lack of Evidence

References to the unpredictability of levels at which fluoride’s effects on the human system occur have been made throughout this position paper. However, it is important to reiterate the lack of evidence associated with fluoride usage, and thus, Table 4 provides an abbreviated list of stringent warnings from governmental, scientific, and other pertinent authorities about the dangers and uncertainties related to utilizing fluoridated products.

Table 4: Selected Quotes about Fluoride Warnings Categorized by Product/Process and Source

| PRODUCT/ PROCESS REFERENCED | QUOTE/S | SOURCE OF INFORMATION |
|--|---|---|
| Fluoride for dental uses, including water fluoridation | <p>“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.”</p> <p>“Few studies evaluating the effectiveness of fluoride toothpaste, gel, rinse, and varnish among adult populations are available.”</p> | Centers for Disease Control and Prevention (CDC). Kohn WG, Maas WR, Malvitz DM, Presson SM, Shaddik KK. Recommendations for using fluoride to prevent and control dental caries in the United States. <i>Morbidity and Mortality Weekly Report: Recommendations and Reports</i> . 2001 Aug 17:i-42. |
| Fluoride in drinking water | <p>“Overall, there was consensus among the committee that there is scientific evidence that under certain conditions fluoride can weaken bone and increase the risk of fractures.”</p> | National Research Council. <i>Fluoride in Drinking Water: A Scientific Review of EPA’s Standards</i> . The National Academies Press: Washington, D.C. 2006. |

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| Fluoride in drinking water | “The recommended Maximum Contaminant Level Goal (MCLG) for fluoride in drinking water should be zero.” | Carton RJ. Review of the 2006 United States National Research Council Report: Fluoride in Drinking Water. <i>Fluoride</i> . 2006 Jul 1;39(3):163-72. |
| Water fluoridation | “Fluoride exposure has a complex relationship in relation to dental caries and may increase dental caries risk in malnourished children due to calcium depletion and enamel hypoplasia...” | Peckham S, Awofeso N. Water fluoridation: a critical review of the physiological effects of ingested fluoride as a public health intervention. <i>The Scientific World Journal</i> . 2014 Feb 26; 2014. |
| Fluoride in dental products, food, and drinking water | “Because the use of fluoridated dental products and the consumption of food and beverages made with fluoridated water have increased since HHS recommended optimal levels for fluoridation, many people now may be exposed to more fluoride than had been anticipated.” | Tiemann M. Fluoride in drinking water: a review of fluoridation and regulation issues. <i>BiblioGov</i> . 2013 Apr 5. Congressional Research Service Report for Congress. |
| Fluoride intake in children | <p>“The ‘optimal’ intake of fluoride has been widely accepted for decades as between 0.05 and 0.07 mg fluoride per kilogram of body weight but is based on limited scientific evidence.”</p> <p>“These findings suggest that achieving a caries-free status may have relatively little to do with fluoride intake, while fluorosis is clearly more dependent on fluoride intake.”</p> | Warren JJ, Levy SM, Broffitt B, Cavanaugh JE, Kanellis MJ, Weber-Gasparoni K. Considerations on optimal fluoride intake using dental fluorosis and dental caries outcomes—a longitudinal study. <i>Journal of Public Health Dentistry</i> . 2009 Mar 1;69(2):111-5. |
| Fluoride-releasing dental restorative materials (i.e. dental fillings) | “However, it is not proven by prospective clinical studies whether the incidence of secondary caries can be significantly reduced by the fluoride release of restorative materials.” | Wiegand A, Buchalla W, Attin T. Review on fluoride-releasing restorative materials—fluoride release and uptake characteristics, antibacterial activity and influence on caries formation. <i>Dental Materials</i> . 2007 Mar 31;23(3):343-62. |

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| <p>Dental material: silver diamine fluoride</p> | <p>“Because silver diamine fluoride is new to American dentistry and dental education, there is a need for a standardized guideline, protocol, and consent.”</p> <p>“It is unclear what will happen if treatment is stopped after 2-3 years and research is needed.”</p> | <p>Horst JA, Ellenikiotis H, Milgrom PM, UCSF Silver Caries Arrest Committee. UCSF Protocol for Caries Arrest Using Silver Diamine Fluoride: Rationale, Indications, and Consent. <i>Journal of the California Dental Association</i>. 2016 Jan;44(1):16.</p> |
| <p>Topical fluoride for dental use</p> | <p>“The panel had a low level of certainty regarding the benefit of 0.5 percent fluoride paste or gel on the permanent teeth of children and on root caries because there were few data on the home use of these products.”</p> <p>“Research is needed concerning the effectiveness and risks of specific products in the following areas: self-applied, prescription-strength, home-use fluoride gels, toothpastes or drops; 2 percent professionally applied sodium fluoride gel; alternative delivery systems, such as foam; optimal application frequencies for fluoride varnish and gels; one-minute applications of APF gel; and combinations of products (home-use and professionally applied).”</p> | <p>Weyant RJ, Tracy SL, Anselmo TT, Beltrán-Aguilar ED, Donly KJ, Frese WA, Hujoel PP, Iafolla T, Kohn W, Kumar J, Levy SM. Topical fluoride for caries prevention: Executive summary of the updated clinical recommendations and supporting systematic review. <i>Journal of the American Dental Association</i>. 2013;144(11):1279-1291.</p> |
| <p>Fluoride “supplements” (tablets)</p> | <p>“Evident disagreements among the results show that there’s a limited effectiveness on fluoride tablets.”</p> | <p>Tomasin L, Pusinanti L, Zerman N. The role of fluoride tablets in the prophylaxis of dental caries. A literature review. <i>Annali di Stomatologia</i>. 2015 Jan;6(1):1.</p> |
| <p>Pharmaceuticals, fluorine in medicine</p> | <p>“No one can responsibly predict what happens in a human body after administration of fluorinated compounds.”</p> | <p>Strunecká A, Patočka J, Connett P. Fluorine in medicine. <i>Journal of Applied Biomedicine</i>. 2004; 2:141-50.</p> |

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| Drinking water with poly- and perfluoroalkyl substances (PFASs) | <p>“Drinking water contamination with poly- and perfluoroalkyl substances (PFASs) poses risks to the developmental, immune, metabolic, and endocrine health of consumers.”</p> <p>“...information about drinking water PFAS exposures is therefore lacking for almost one-third of the U.S. population.”</p> | <p>Hu XC, Andrews DQ, Lindstrom AB, Bruton TA, Schaidler LA, Grandjean P, Lohmann R, Carignan CC, Blum A, Balan SA, Higgins CP. Detection of Poly-and Perfluoroalkyl Substances (PFASs) in US Drinking Water Linked to Industrial Sites, Military Fire Training Areas, and Wastewater Treatment Plants. <i>Environmental Science & Technology Letters</i>. 2016 Oct 11.</p> |
| Occupational exposures to fluoride and fluoride toxicity | <p>“Review of unpublished information regarding the effects of chronic inhalation of fluoride and fluorine reveals that current occupational standards provide inadequate protection.”</p> | <p>Mullenix PJ. Fluoride poisoning: a puzzle with hidden pieces. <i>International Journal of Occupational and Environmental Health</i>. 2005 Oct 1;11(4):404-14.</p> |
| Review of safety standards for exposure to fluorine and fluorides | <p>“If we were to consider only fluoride’s affinity for calcium, we would understand fluoride’s far-reaching ability to cause damage to cells, organs, glands, and tissues.”</p> | <p>Prystupa J. Fluorine—a current literature review. An NRC and ATSDR based review of safety standards for exposure to fluorine and fluorides. <i>Toxicology Mechanisms and Methods</i>. 2011 Feb 1;21(2):103-70.</p> |

Section 8.3: Lack of Ethics

Another major concern about fluoride exposure from drinking water and food is related to the production of the fluorides used in community water supplies. According to the Centers for Disease Control and Prevention (CDC), three types of fluoride are generally used for community water fluoridation:

- Fluorosilicic acid: a water-based solution used by most water systems in the United States. Fluorosilicic acid is also referred to as hydrofluorosilicate, FSA, or HFS.
- Sodium fluorosilicate: a dry additive, dissolved into a solution before being added to water.
- Sodium fluoride: a dry additive, typically used in small water systems, dissolved into a solution before being added to water.⁵¹⁹

Controversy has arisen over the industrial ties to these ingredients. The CDC has explained that phosphorite rock is heated with sulfuric acid to create 95% of the fluorosilicic acid used in water fluoridation.⁵²⁰ The CDC has further explained: “Because the supply of fluoride products is related to phosphate fertilizer production, fluoride product production can also fluctuate depending on factors such as unfavorable foreign exchange rates and export sales of fertilizer.”⁵²¹ A government document from Australia has more openly stated that hydrofluosilicic acid, sodium silicofluoride and sodium fluoride are *all* “commonly sourced from phosphate fertilizer manufacturers.”⁵²² Safety advocates for fluoride exposures have questioned if such industrial ties are ethical and if the industrial connection with these chemicals might result in a cover-up of the health effects caused by fluoride exposure.

A specific ethical issue that arises with such industry involvement is that profit-driven groups seem to define the evolving requirements of what constitutes the “best” evidence-based research, and in the meantime, unbiased science becomes difficult to fund, produce, publish, and publicize. This is because funding a large-scale study can be very expensive, but industrial-based entities can easily afford to support their own researchers. They can also afford to spend time examining different ways of reporting the data (such as leaving out certain statistics to obtain a more favorable result), and they can further afford to publicize any aspect of the research that supports their activities. Unfortunately, history has shown that corporate entities can even afford to harass independent scientists as a means of ending their work if that work shows harm generated by industrial pollutants and contaminants.

Indeed, this scenario of unbalanced science has been recognized in fluoride research. Authors of a review published in *the Scientific World Journal* in 2014 elaborated: “Although artificial fluoridation of water supplies has been a controversial public health strategy since its introduction, researchers—whom include internationally respected scientists and academics—have consistently found it difficult to publish critical articles of community water fluoridation in scholarly dental and public health journals.”⁵²³

Additionally, a conflict of interest can be directly related to studies about dietary exposures to perfluorinated compounds (PFCs). In an article published in 2012, research about food intake from PFCs was examined by country. The author revealed that data from the U.S. was very limited, consisting only of a 2010 publication by a number of American academic researchers, as well as a 3M sponsored survey that served as the primary research prior to the 2010 publication (and alleged that most samples of food had contaminant levels below detection.)⁵²⁴ Yet, the academic researchers produced different findings than the 3M report and wrote in their 2010 publication: “Despite product bans, we found POPs [persistent organic pollutants] in U.S. food, and mixtures of these chemicals are consumed by the American public at varying levels. This suggests the need to expand testing of food for chemical contaminants.”⁵²⁵

Conflicts of interest have also been known to infiltrate government agencies involved in toxic chemical regulation. A 2014 *Newsweek* article by Zoë Schlanger entitled “Does the EPA Favor Industry When Assessing Chemical Dangers?” included a quote from ecologist Michelle Boone that alleged ““all or most of the data used in risk assessments may come from industry-supplied research, despite clear [conflicts of interest].””⁵²⁶

It is easily recognizable that the dental industry has a major conflict of interest with fluoride because profits are made by corporations that produce fluoride-containing dental products. Additionally, procedures involving fluoride administered by the dentist and dental staff can also earn profits for dental offices,^{527 528} and ethical questions have been raised about pushing these fluoride procedures on patients.⁵²⁹

In relation to the ethics of medical and dental practices, a cornerstone of public health policy known as the precautionary principle must be considered as well. The basic premise of this policy is built upon the centuries-old medical oath to “first, do no harm.” Yet, the modern application of the precautionary principle is actually supported by an international agreement.

In January 1998, at an international conference involving scientists, lawyers, policy makers, and environmentalists from the U.S., Canada and Europe, a formalized statement was signed and became known as the “Wingspread Statement on the Precautionary Principle.”⁵³⁰ In it, the following advice is given: “When an activity raises threats of harm to human health or the environment, precautionary measures should be taken even if some cause and effect relationships are not fully established scientifically. In this context the proponent of an activity, rather than the public, should bear the burden of proof.”⁵³¹

Not surprisingly, the need for the appropriate application of the precautionary principle has been associated with fluoride usage. Authors of a 2006 article entitled “What Does the Precautionary Principle Mean for Evidence-Based Dentistry?” suggested the need to account for cumulative exposures from all fluoride sources and population variability, while also stating that consumers can reach “optimal” fluoridation levels without ever drinking fluoridated water.⁵³² Additionally, researchers of a review published in 2014 addressed the obligation for the precautionary principle to be applied to fluoride usage, and they took this concept one step further when they suggested that our modern-day understanding of dental caries “diminishes any major future role for fluoride in caries prevention.”⁵³³

Section 9: Alternatives to Fluoride Use

Based upon the elevated number of fluoride sources and the increased rates of fluoride intake in the American population, which have risen substantially since water fluoridation began in the 1940’s, lowering exposures to fluoride has become a necessary and viable alternative. For example, the author of a 2013 Congressional Report noted that significant levels of fluoride can be obtained from sources other than water.⁵³⁴ As another example, researchers from the University of Kent in Canterbury, England, considered the quantity of fluoride sources and wrote in 2014 that “the prime public health priority in relation to fluoride is how to reduce ingestion from multiple sources, rather than adding this abundant and toxic chemical to water or food.”⁵³⁵

Section 9.1: Caries Prevention

There are many ways to prevent caries without fluoride. The American Dental Association (ADA) Council on Scientific Affairs has stated that some strategies for caries prevention are “altering the bacteria flora in the mouth, modifying the diet, increasing the resistance of tooth enamel to acid attack or reversing the demineralization process.”⁵³⁶ Other strategies of preventing caries can be deduced by the factors that cause them, which include high levels of

cariogenic bacteria and/or intake of fermentable carbohydrates; inadequate salivary flow, dental care, and/or oral hygiene; inappropriate methods of feeding of infants; and the presence of poverty and/or malnutrition.⁵³⁷ (Interestingly, while some proponents of water fluoridation believe they are helping those of lower socio-economic status, as well as malnourished children, fluoride can actually increase the risk of dental caries in these populations due to calcium depletion and other circumstances.⁵³⁸)

At any extent, it is essential to understand that tooth decay is a disease caused by specific bacteria called *Streptococcus mutans*. Many bacteria do not process their food into carbon dioxide and water, but, rather, they “ferment” their foods into other kinds of waste products, such as alcohols or acids. *Streptococcus mutans* lives in microscopic colonies on the surface of the teeth, and it has the distinction of being able to produce concentrated acid waste that can dissolve the tooth enamel on which it resides. In other words, these germs can create holes in teeth, and all they require to do so is a fuel such as sugar, processed foods, and/or other carbohydrates.

Thus, utilizing the knowledge of what causes tooth decay is instrumental in developing ways to prevent it without fluoride. Some simple methods to prevent caries include eating less sugar-containing foods, drinking less sugar-containing beverages such as soft drinks, improving oral hygiene, and establishing a nutritious diet and lifestyle that strengthens the teeth and bones.

In support of such strategies to prevent dental caries without fluoride, the trend of decreased decayed, missing, and filled teeth over the past few decades has occurred both in countries *with and without* the systemic application of fluoridated water.⁵³⁹ This suggests that increased access to preventative services and more awareness of the detrimental effects of sugar are responsible for these improvements in dental health.⁵⁴⁰ Furthermore, research has documented decreases of tooth decay in communities that have discontinued water fluoridation.⁵⁴¹

Section 9.2: Consumer Choice and Consent

The issue of consumer choice is essential in relation to fluoride for a variety of reasons. First, consumers have many choices when it comes to utilizing fluoride-containing products; however, many of these products do not require informed consumer consent or labeling that provides the levels of fluoride in the item. Second, the only choice consumers have when fluoride is added to their municipal water is to buy bottled water or costly filters. In regard to water fluoridation, concerns have been raised that fluoride is added allegedly for the prevention tooth decay, while other chemicals added to water serve a purpose of decontamination and elimination of pathogens. Researchers wrote in 2014: “In addition, community water fluoridation provides policy makers with important questions about medication without consent, the removal of individual choice and whether public water supplies are an appropriate delivery mechanism.”⁵⁴²

Furthermore, in a 2013 Congressional Report, it was established that the practice of adding fluoride to water for dental reasons should not be imposed by the government, especially because it means that consumers are not able to exercise choice without buying bottled water or treating their tap water.⁵⁴³ Filtration systems are available to consumers for purchase to take the fluoride out of their water, but these filters are expensive, and some of the consumers who could benefit from them (i.e. individuals with diabetes, renal problems, or infants) cannot afford them. The

EPA has acknowledged that charcoal-based water filtration systems do not remove fluoride and that distillation and reverse osmosis systems, which can remove fluoride, are costly.⁵⁴⁴

97% of western Europe does not use water fluoridation, and governments from this region of the world have identified consumer consent as one reason for not adding fluoride to community drinking water. The following are just a few statements from these countries:

- “Fluoride has never been added to the public water supplies in Luxembourg. In our views, the drinking water isn’t the suitable way for medicinal treatment and that people needing an addition of fluoride can decide by their own to use the most appropriate way, like the intake of fluoride tablets, to cover their [daily] needs.”⁵⁴⁵
- “This water treatment has never been of use in Belgium and will never be (we hope so) into the future. The main reason for that is the fundamental position of the drinking water sector that it is not its task to deliver medicinal treatment to people.”⁵⁴⁶
- “In Norway we had a rather intense discussion on this subject some 20 years ago, and the conclusion was that drinking water should not be fluoridated.”⁵⁴⁷

Some of the countries that do not use fluoridated water have opted to use fluoridated salt and milk 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,⁵⁴⁸ as well as Colombia, Costa Rica, and Jamaica.⁵⁴⁹ Fluoridated milk has been used in programs in Chile, Hungary, Scotland, and Switzerland.⁵⁵⁰

On the contrary, a major issue in the U.S. is that consumers simply are not aware of the fluoride added to hundreds of products they routinely use. Some citizens do not even know that fluoride is added to their water, and because there are no food or bottled water labels, consumers are likewise not aware of those sources of fluoride. While toothpaste and other over-the-counter dental products include disclosure of fluoride contents and warning labels, the average person has no context for what these ingredients or contents mean (if they are fortunate enough to read the small font on the back of their product). Materials used at the dental office provide even less consumer awareness as informed consent is generally not practiced, and the presence and risks of fluoride in dental materials is, in many instances, never mentioned to the patient.⁵⁵¹ For example, in the case of silver diamine fluoride, the product was introduced to the U.S. market in 2014 without a standardized guideline, protocol, or consent.⁵⁵²

Section 9.3: Education for Medical/Dental Professionals, Student, Patients, and Policy Makers

Educating medical and dental practitioners, students of medicine and dentistry, patients, and policy makers about fluoride exposures and the associated potential health risks is essential to improving the dental and overall health of the public. Since a scientific understanding of the health effects of fluoride has been limited to promoting its benefits, the reality of its overexposure and potential harms must now be conveyed to healthcare workers and students, such as those in the medical, dental, and public health fields. This concept was supported in a 2005 publication in which the authors explained that their findings emphasized “the significance of educating parents and child-care specialists about fluorosis risk by public health practitioners, physicians, and dentists.”⁵⁵³

Although informed consumer consent and more informative product labels would contribute to increasing patient awareness about fluoride intake, consumers also need to take a more active role in preventing caries. Better diet, improved oral health practices, and other measures would assist in reducing tooth decay, as well as many other ailments that not only drain the human body but also drain the financial resources of individuals and the government due to rising healthcare costs.

Finally, policymakers are tasked with the obligation of evaluating the benefits and risks of fluoride. These officials are often bombarded by dated claims of fluoride's alleged purposes, many of which are constructed upon limited evidence of safety and improperly formulated intake levels that fail to account for multiple exposures, individual variances, fluoride's interaction with other chemicals, and independent (non-industry sponsored) science. Authors of a 2011 publication linked parents and policymakers to the basics of fluoride's impact on the human system:

Safe, responsible, and sustainable use of fluorides is dependent on decision makers (whether they be politicians or parents) having a firm grasp on three key principles: (i) fluorine is not so much 'essential' as it is 'everywhere,' (ii) recent human activities have significantly increased fluorine exposures to the biosphere, and (iii) fluorine has biogeochemical effects beyond bones and teeth.⁵⁵⁴

Section 10: Conclusion

The sources of human exposure to fluoride have drastically increased since community water fluoridation began in the U.S. in the 1940's. In addition to water, these sources now include food, air, soil, pesticides, fertilizers, dental products used at home and in the dental office (some of which are implanted in the human body), pharmaceutical drugs, cookware, clothing, carpeting, and an array of other consumer items used on a regular basis. Official regulations and recommendations on fluoride use, many of which are not enforced, have been based on limited research and have only been updated after evidence of harm has been produced and reported.

Exposure to fluoride is suspected of impacting nearly every part of the human body, including the cardiovascular, central nervous, digestive, endocrine, immune, integumentary, renal, respiratory, and skeletal systems. Susceptible subpopulations, such as infants, children, and individuals with diabetes or renal problems, are known to be more severely impacted by intake of fluoride. Accurate fluoride exposure levels to consumers are unavailable; however, estimated exposure levels suggest that millions of people are at risk of experiencing the harmful effects of fluoride and even toxicity, the first visible sign of which is dental fluorosis. A lack of efficacy, lack of evidence, and lack of ethics are apparent in the current status quo of fluoride usage.

Informed consumer consent is needed for all uses of fluoride, and this pertains to water fluoridation, as well as all dental-based products, whether administered at home or in the dental office. Providing education about fluoride risks and fluoride toxicity to medical and dental professionals, medical and dental students, consumers, and policy makers is crucial to improving the future of public health.

There are fluoride-free strategies in which to prevent dental caries. Given the current levels of exposure, policies should reduce and work toward eliminating avoidable sources of fluoride, including water fluoridation, fluoride-containing dental materials, and other fluoridated products, as means to promote dental and overall health.

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Post-NRC Human Studies Investigating Fluoride's Impact on Fetal Brain

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- ⁵⁵⁰ Jones S, Burt BA, Petersen PE, Lennon MA. The effective use of fluorides in public health. *Bulletin of the World Health Organization*. 2005 Sep;83(9):670-6. Online at http://www.scielosp.org/scielo.php?pid=S0042-96862005000900012&script=sci_arttext&tlng=e. Accessed November 2, 2016.
- ⁵⁵¹ In the United States, brochures have been created to educate patients about their choices for dental fillings (mainly because of concerns related to dental amalgam mercury) in California, Connecticut, Maine, and Vermont. Only Connecticut and Maine even mention that fluoride is in some fillings, and both states only mention its presence in glass ionomer fillings. Some of these brochures are legally required to be presented to dental patients, but there is an apparent lack of enforcement for this measure.
- To view the brochures in Connecticut and Maine, see*
- State of Connecticut Department of Environmental Protection. Fillings: The Choices You Have. Hartford, CT; Revised May 2011. Online at <http://www.csd.a.com/docs/default-source/regulations/amalgam>. Accessed November 8, 2016.
- And Maine Bureau of Health. Filling Materials Brochure. 2002. Available from: http://www.vce.org/mercury/Maine_AmalBrochFinal2.pdf. Accessed November 8, 2016.
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