Update on fluoride prophylaxis

P. Defabianis

CIR Dental School, Dipartimento di Scienze Chirurgiche, University of Turin

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email: patrizia.defabianis@unito.it

Abstract

Fluoride is a chemical element widely distributed throughout nature. In our bodies, fluoride is considered a trace element, meaning mineral salts that, although present only in small quantities or even trace amounts, perform important biological functions. Fluoride is present in the body primarily associated with calcium, for which it has a high affinity, in teeth and bones. It is rapidly absorbed in the stomach and proximal small intestine, and peak serum levels are reached within 40–60 minutes. Fluoride absorption from water in the form of fluoride ions is faster and more complete than that bound to proteins, the form in which it is found in foods. Fluoride is excreted in urine. In children, 20% of the fluoride is eliminated, with 80–90% retained by bone tissue and developing teeth. The main benefits of fluoride are obtained through local administration, on the tooth surface. Fluoride is considered safe when consumed at recommended levels, but excessive fluoride exposure will lead to the occurrence of fluorosis [Srivastava et al., 2020] with detrimental effects on teeth, bone strength [Wei et al., 2019; Helte et al., 2021; Lindsay et al., 2023] thyroid function and cognitive development [Iamandii et al., 2023; Granjean, 2019; Taylor et al., 2025]. Efforts to develop safe and effective strategies to prevent this common disease are critical, particularly among lower-to-middle-income countries. The aim of this work is to discuss evidence that excessive fluoride exposure is not essential for caries prevention, offers little benefit to the fetus and young infant, and is particularly hazardous for young children due to the vulnerability of their developing brain.

KEYWORDS Fluoride, risk-benefit, systemic exposure, neurotoxicity, pregnancy, dental caries, fluoridation.

Introduction

Fluorine belongs to the halogen family in the periodic table being the lightest member and most electronegative and reactive of all elements [Rafique et al., 2015]. It ranked 13th most abundant element, which makes up 0.06–0.09% of the total earth crust [Armienta et al., 2009]. Sources of fluoride in the body include food, water and air, but drinking water is the most common source [Dhar and Bhatnagar, 2009]. Fluoride has long been recognised as one of the most effective and cost-efficient measures for preventing dental caries. Dental caries is the most common infectious disease, affecting approximately 60 to 90% of the world population, especially young children, and disadvantaged communities. Despite advances in caries prevention and management over the past 75 years, untreated caries affect 43% of the world population [WHO, 2022]. Despite the improvement of policies to promote oral health care in the past decades, dental caries is still a healthcare challenge, characterised by increasing disparities among different social groups between and within countries. Due to extremely high prevalence and the significant negative impact on general health, well-being, and quality of life, dental caries is still considered a global public health problem. Fluoride has long been recognised as a cornerstone in caries prevention due to its multifaceted mechanisms of action, including topical effects on enamel, systemic effects on dental development, antibacterial properties, and the ability to promote remineralisation of early carious lesions. It not only prevents the formation of caries, but also inhibits the process by which cariogenic bacteria metabolize carbohydrates and produce acids. Fluoride can exert its protective effects through various routes of administration, including topical application (e.g., toothpaste, mouth rinses, and professional treatments) and systemic exposure (e.g., community water fluoridation and dietary sources) [O'Mullane et al., 2016]. Community water fluoridation (CWF) was introduced in the 1940s to counteract the rise in dental caries (i.e., tooth decay) following an increase in sugar consumption. Nowadays about 420 million people worldwide have access to naturally fluoridated water supplies (50 million) or artificially fluoridated drinking water (370 million) [O'Mullane et al., 2016]. The United States, Brazil, Malaysia, Australia, and Canada have the largest populations of people supplied with artificially fluoridated water, while other countries, including over 97% of Europe, have opted for targeted strategies, including fluoride-containing toothpaste and/or community-level fluoridation of salt or milk [O'Mullane et al., 2016]. Fluoride is considered safe when consumed at recommended levels, but excessive fluoride exposure will result in the occurrence of fluorosis1 with detrimental effects on teeth, bone strength [Wei et al., 2019; Helte et al., 2021; Lindsay et al., 2023] thyroid and brain function [Iamandii et al., 2023; Grandjean, 2019; Taylor et al., 2025]. Excessive fluoride exposure is particularly hazardous for young children due to the vulnerability of their developing brain [Lanphear, 2015]. In recent years, more and more studies have shown that fluoride exposure can not only damage the bone tissue, but also leads to a series of non-bone injury, including the vascular system, nervous system, reproductive system, urinary system, and so on [Wang et al., 2019; Amini et al., 2011; Ding et al., 2010].

Fluoride absorption, distribution, and excretion

Fluoride is present in the body primarily associated with calcium - for which it has a high affinity - in teeth and bones. Considered essential by some and merely beneficial by others, it is important for the mineralisation of the skeleton and enamel. Fluoride enters the human body primarily through the gastrointestinal tract: in the stomach at pH <3.5 fluoride is absorbed as hydrofluoric acid by simple diffusion with a pH-dependent gradient, with no need for enzymatic reactions.

In the intestine, at alkaline pH, the ionic form is predominant and is absorbed through a pH-independent mechanism. The rate of absorption depends on the type of fluoride compound: the absorption of fluoride in aqueous form as fluoride ions is faster and more complete than that bound to proteins, the form found in foods. About 99% of the body's fluoride is strongly bound to mineralised tissues (mainly bone); about 1% is found in soft tissues, including calcified parts of the pineal gland [Luke et al., 2001]. Absorption results in a rapid increase in plasma concentration, reaching a peak within 20–60 min. Fluoride that is absorbed or released from calcified tissues enters the systemic circulation and is eliminated by the kidneys [Buzalaf and Whitford, 2011]. Infants and young children retain 80–90% of absorbed fluoride [Ekstrand Jet al, 1994] compared with 50% in healthy adults [Buzalaf and Whitford, 2011]. About 99% of the body's fluoride is strongly bound to mineralised tissues (mainly bone); about 1% is found in soft tissues, including calcified parts of the pineal gland [Luke et al., 2001]. Fluoride is mobilised from continuous skeleton remodeling. Fluoride absorption is influenced by pharmacokinetic factors, including blood pH, dietary intake of calcium and other cations, and pregnancy-related renal changes [Buzalaf and Whitford, 2011; Ekstrand et al., 1994; Luke, 2001; Castiblanco-Rubio and Martinez-Mier, 2022]. In pregnancy, urinary fluoride concentrations is found to increase toward the end of gestation [Malin et al., 2023; Till et al., 2018]. Reasons for this trend are unclear but may reflect uptake of fluoride into fetal bone or increased mobilisation of fluoride from maternal bone [Cerklewski, 1997]. In infants, fluoride absorption may be reduced by coagulation of milk in the stomach due to acidity and calcium fluoride formation. Fluoride readily crosses the placenta [Opydo-Szymaczek and Borysewicz-Lewicka, 2007; Uyghurturuk, 2020], penetrates the blood–brain barrier [Ferreira et al., 2020; Forestier et al., 1990] and accumulates in the cerebellum, motor cortex, and hippocampus [Ferreira et al., 2020; Dec et al., 2019]. The rate of diffusion across the placenta depends on plasma concentration: lower concentrations passively diffuse across the placenta, but transportation is attenuated at higher concentrations [Gupta et al., 1993]. Once fluoride reaches the plasma, it is rapidly bound to the skeleton or excreted through the kidneys, with only a small amount of unabsorbed fluoride excreted in the feces. Renal excretion is regulated by urinary flow and pH, which depend on numerous factors, including renal function and a diet rich in acids and water. Urinary fluoride excretion is also influenced by age and circadian rhythm. Fluoride is freely filtered by the glomerulus and then reabsorbed in the tubule. Reduced filtration, as occurs in renal failure, results in reduced fluoride filtration and a consequent increase in plasma concentration, with a potential risk of fluorosis, as reported in some pediatric cases of children with chronic renal failure undergoing dialysis or receiving renal transplants. For all these reasons extreme caution is recommended regarding fluoride supplementation in children with impaired renal function.

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In contrast, fluoride in teeth is mobilised only during remineralisation and demineralisation cycles, resulting in dental caries formation. The main benefits of fluoride are obtained through local administration, on the tooth surface. The benefits of systemic administration during the pre-eruptive phase are less significant: fluoride is incorporated into the developing mineralised structure and increases resistance to acid demineralisation. In the formation of fluorapatite, the hydroxyl ion of hydroxyapatite is replaced by fluorine ion, thus forming fluorapatite.

Risks and benefit of fluoride for the pregnant woman, fetus, and infant

Unfortunately the optimal amount for the body has not yet been unanimously determined and ranges from 1 to 4 mg/day. The main sources of fluoride intake in humans can be divided into: natural and non natural. Natural sources include mainly environmental elements (water, food, air) that convey fluorides to humans. Non natural sources include pharmaceutical fluoridated products that have a topical application such as toothpastes, mouthwashes, varnishes, fluoridated gels, and fluoride pills. Diet (solid foods, drinking water, and mineral water) is the main source of fluoride. The presence of the element in natural drinking water varies depending on the soil from which it is extracted (by law, it must be less than 1.5 mg/liter). Fluoride is found in various foods, reaching significant concentrations in fish and seafood; tea, potatoes (especially potato peel), cereals, beer and spinach are also good sources of fluoride. Concentrations in mineral waters vary widely, tending to be close to zero in the much-touted oligomineralised and minimally mineralised waters, and highest in fluoridated waters, where the element content is higher than 1 mg/l like,for example, in volcanic areas.

Health authorities have promoted community water fluoridation (CWF) to prevent dental caries for more than 75 years. The recommended fluoride concentration in drinking water typically ranges between 0.7 and 1.1 mg/L. However, growing evidence has raised questions about the safety of this public health intervention, particularly for young children who are at risk of excess fluoride intake. The efficacy of topical fluoride in preventing dental caries is strong, whereas contemporary evidence for systemic administration of fluoride is weaker. Furthermore a growing body of evidence has linked systemic fluoride exposure with detrimental effects on teeth, bone strength [Wei et al.,2019; Helte et al., 2021; Lindsay et al., 2023], thyroid and brain function [Iamandii et al., 2023; Grandjean, 2019; Taylor et al., 2025].

Systemic fluoride exposure is associated with detrimental effects on bone strength, thyroid function, and cognitive development.

In literature there are more and more evidences showing that excessive fluoride exposure is not essential for caries prevention, offers little benefit to the fetus and young infant, and is particularly hazardous for young children due to the vulnerability of the developing brain [Lanphear, 2015].

Fluoride toothpastes provide a significant amount, especially to children through ingestion. Young children often swallow toothpaste [Sudrajat et al., 2024]; ingestion of toothpaste by young children is estimated to account for up to 80% of total fluoride intake depending on the age of the child, frequency of brushing, and amount and type of toothpaste used [Petrović et al., 2023; Thornton-Evans et al., 2019]. From the beginning of tooth formation until eruption, fluoride can also cause adverse effects on enamel at various stages of development: the main adverse effect is fluorosis, which occurs after systemic exposure. Fluorosis of primary teeth is less frequent and less apparent than in permanent teeth, where the damage is long-term. Fluorosis is strongly associated with cumulative fluoride intake, and the severity depends on the dose, age of intake, and duration. The main sources of fluoride are: fluoridated water (fluoride concentration and intake), fluoridated toothpaste, fluoride tablets and infant formula, depending on the type of water used. Total fluoride intake in the first 2 years of life predicts the risk of fluorosis of the maxillary central incisors; permanent incisors begin to calcify at 3-4 months and are completely calcified by 4-5 years. After age five, susceptibility to fluorosis of these teeth is low; fluorosis prevention should be undertaken in the first five years of life.

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Research shows that fluorosis affects more often children who have consumed formula diluted with water in the first few months of life rather than those who have consumed breast milk or cow's milk. The fluoride content in breast milk is approximately 5-20 micrograms/l, which is very low, even when consumed in high quantities by the mother, as little passes from the plasma into breast milk. Breast milk protects against fluorosis thanks to its extremely low fluoride levels [Ekstrand et al.,1981; Esala et al., 1982].

Breast milk contains extremely low concentrations of fluoride, whereas infant formula reconstituted with fluoridated water can contribute to overexposure to fluoride and cause dental fluorosis.

Sugar intake is the most important risk factor for dental caries. Dental caries result when free sugars contained in food or drink are converted by bacteria into acids that demineralise the enamel. The presence of proteins and ions—including fluoride—in the oral environment neutralises these acids and promotes remineralisation, thus preventing the formation of caries. Fluoride exerts anticariogenic action via three mechanisms: slowing demineralisation, promoting remineralisation of enamel by enhancing the precipitation of hydroxyfluorapatite, and inhibiting bacterial metabolism and acid production [Featherstone, 1999]. In the 1940s, fluoride's incorporation into the developing enamel (i.e., pre-eruptively) was thought to make teeth less soluble and more resistant to dental caries.

However, laboratory and epidemiological studies conducted over the past 50 years have shown that fluoride's beneficial effect is predominantly topical, after tooth eruption [Featherstone, 1999; Fejerskov et al., 1981].

Results of a randomised, double-blind trial [Leverett et al., 1997] and a Cochrane review [Takahashi et al., 2017] showed that fluoride supplements taken by pregnant women do not benefit their offspring [Maturo et al., 2011; Leverett et al., 1997]. More recent cohort studies [Singh and Spencer, 2004; Singh et al., 2007] indicated that pre-eruptive fluoride exposure may be beneficial for certain surfaces, particularly pits and fissures of permanent molars, as these areas are highly susceptible to caries and difficult for topical fluorides to reach.

However, the limited data available make it challenging to draw definitive conclusions about the relative contribution of systemic fluoride treatment before teeth erupt. A consensus has now emerged that the primary protective effects of fluoride are topical [Takahashi et al., 2017].

Primary protective effects of fluoride are topical and occur after tooth eruption

Topical fluoride exposure, such as brushing with fluoride toothpaste [Featherstone, 1999; Singh et al., 2004] delivers fluoride to the interface between the tooth surface (enamel) and the oral fluids. Daily use of fluoride toothpaste with 1,000 ppm is shown to be effective for caries prevention in children [Singh et al., 2004]. Hydroxyapatite-based and arginine (i.e., fluoride-free) toothpastes are being investigated as an alternative to fluoride toothpaste [Amaechi et al., 2019; Paszynska et al., 2023]. Systemic fluoride, such as fluoridated drinking water, can also have an anticaries effect through contact with enamel when it enters the oral cavity and when absorbed fluoride is recirculated in saliva [Featherstone, 1999]. Thus its mechanism of action to control caries is through its topical contact with teeth.

Given the important role of fluoride in preventing tooth decay, but also the risk of fluorosis, it is very important to know the fluoride content in the diet. This can be complicated because the fluoride content of solid foods or water, and especially in baby foods, is often udeclared. Dental fluorosis is a developmental defect of tooth enamel due to excessive fluoride intake during the pre-eruptive period [Wong et al., 2011]. High fluoride exposure before tooth eruption disrupts the formation of hydroxyapatite crystals (main component of the enamel mineral matrix) causing hypomineralisation of the enamel subsurface. As a result, the tooth enamel is discolored: mild fluorosis appears as thin white lines, moderate fluorosis coalesces into larger white areas, and severe fluorosis covers the entire surface, with or without the presence of brown discoloration and pitting. The severity of dental fluorosis relates to the dose, frequency, and timing of fluoride exposure as well as other individual susceptibility factors O'Hagan-Wong et al., 2022]. The prevalence and severity of dental fluorosis has increased worldwide over the past three decades [Neurath et al., 2019]. The window of susceptibility for dental fluorosis in permanent central incisors, the most aesthetically relevant teeth, is from birth through age 4, but particularly during the first 2 years of life [Evans et al., 1995]. However, overexposure to fluoride during the first 8 years of life can result in fluorosis for the entire permanent dentition [Hong et al., 2006]. Drinking water with fluoride concentrations higher than 1 mg/L contributes to dental fluorosis [Levy and Guha-Chowdhury, 1999], but dental fluorosis is also prevalent among populations living in optimally fluoridated areas [Hung et al., 2023]. Infants fed formula reconstituted with optimally fluoridated water [Levy and Guha-Chowdhury, 1999; Levy et al., 2010] and young children who swallow fluoride toothpaste have increased risk of developing dental fluorosis [Petrović et al., 2023; Levy et al., 1995]. Powdered infant formula mixed with fluoridated water is a significant source of fluoride [Iheozor-Ejiofor et al., 2024]. Soy-based formulas contain higher fluoride levels (2.52 mg/L) compared to milk-based formulas (0.22–0.31 mg/L) prepared with deionized water as soy proteins bind fluoride. In contrast, breast milk has extremely low fluoride levels [Ekstran et al.,1981; Esala et al.,1982] meaning that less fluoride is absorbed from milk-based relative to soy-based formulas.

Discussion

Community water fluoridation (CWF) played a significant role in reducing dental caries and improving oral health when it was first introduced over 75 years ago. Nowadays it is facing growing scrutiny. When fluoride was first introduced, fluoride toothpaste was not available, and it was assumed that fluoride needed to be ingested before teeth eruption to prevent dental caries. It is now established that the beneficial effect of fluoride is topical, occurring almost exclusively after teeth erupt [Featherstone, 1999; Featherstone, 2000; Fejerskov et al., 1981]. Fluoride's topical cariostatic mechanism brings into question the necessity of an entire population ingesting fluoride to prevent dental caries when contemporary evidence shows much smaller preventive benefits than expected [Iheozor-Ejiofor et al., 2024].

It should be emphasized that caries is not a disease due to a lack of fluoride

Some health authorities assert that consuming fluoride during pregnancy and infancy at levels consistent with national fluoridation standards poses no harm. However, recent evidence shows that fluoride is not just affecting teeth, but also potentially impacting thyroid function [Levy et al., 1999] and brain development [Taylor et al., 2024]. Fluoride exposure may negatively affect thyroid function in children and adults [Iamandii et al., 2023]: indeed, while the use of fluoride as a thyroid suppressant dates back to the 1930s [Day and Powell-Jackson, 1972], few studies have examined thyroid functioning in people, particularly pregnant women, living in areas with optimally fluoridated water. Thyroid hormone insufficiency in pregnancy is of particular concern because the developing fetus relies exclusively on maternal thyroid hormone during the first 10–12 weeks of gestation [Morreale de Escobar, 2004]. Hall et al in a study involving 1,105 pregnant women found that a 0.5 mg/L increase in drinking water fluoride concentration was associated with 1.65 greater odds of having primary hypothyroidism [Levy SM et al, 2010]; the odds increased to 3.88 among the women with normal levels of antithyroid peroxidase antibodies who were living at the same residence for at least one year [Hall et al., 2022]. In this cohort, boys born to women with hypothyroidism had lower IQ scores than children whose mothers had normal thyroid function, suggesting that thyroid disruption may be a mechanism underlying developmental neurotoxicity of fluoride. Moreover, the combination of low iodine, an essential nutrient for thyroid hormone synthesis, and high fluoride exposure in pregnancy was associated with lower IQ scores in boys [Goodman et al., 2022]. For all these reasons, more studies examining thyroid disease risk with measures of iodine status and chronic fluoride exposure are needed given that thyroid disorders tend to develop over time and can be exacerbated by low or excess iodine. A large body of evidence supports a consistent, inverse association between fluoride exposure during early brain development and children's IQ [Taylor et al., 2024]. Significant and inverse associations have been reported between maternal urinary fluoride levels and lower child IQ scores among populations living in optimally fluoridated areas. Adding to this evidence, recent bibliography indicates that current exposure levels among pregnant women are too high to protect against neurocognitive effects in children. Based on the current epidemiological literature, thyroid disruption has been proposed as a possible mechanism of fluoride neurotoxicity, but more research is needed to confirm this theory. In the end we can say that need for a margin of safety is strongly required. A growing and consistent body of evidence indicates a link between fluoride intake and reduced child IQ, which is a more consequential outcome than dental fluorosis. At high intake levels, it is not disputed that fluoride poses a hazard to human health. However, evidence has now linked urinary fluoride concentrations below 1.5 mg/L to reduced child IQ. This finding has raised concern because urinary fluoride levels for pregnant women and children can exceed this level depending on the amount of fluoridated water ingested and exposure to other fluoride sources. Urinary fluoride levels represent an aggregate of total fluoride intake, with fluoridated water a significant contributor [Till et al., 2018; Ridell et al., 2021]. These findings underscore the need for current guidelines to have a margin of safety between a hazard level and the community's exposure level.

Given that fluoride offers little benefit to the fetus and young infant, community-wide administration of systemic fluoride may pose an unfavorable risk–benefit ratio for the pregnant woman, fetus, and infant.

Sources of fluoride intake must be monitored. The prevalence and severity of dental fluorosis has steadily increased [Neurath et al., 2019; Dye et al., 2007] suggesting that excess fluoride exposure during tooth enamel formation has been occurring over the past few decades.With over two-thirds of children and adolescents having dental fluorosis, it is critical to monitore fluoride intake from dietary and nondietary sources in young children.To reduce the risk of dental fluorosis among formula-fed infants [Levy et al., 1999], the American Academy of Pediatrics [Clark et al., 2020] and the American Dental Association recommend using fluoride-free water or water with low fluoride levels for reconstituting infant formula. Since tap water is most commonly used for formula preparation, caregivers living in areas with fluoridated tap water may feel pressured to seek alternative water sources to minimise the risk of dental fluorosis. The traditional division into systemic or topical fluoridation is no longer valid today. In both children and adults, the caries-preventing effects of fluorides are essentially topical, while systemic administration for this purpose has minimal effects. It has been demonstrated that fluoride enrichment during the enamel formation phase has very little effect on the demineralisation and remineralisation processes of the enamel surface of the erupting tooth [Featherstone, 1999]. In fact, fluoride found in solution block the demineralisation of the crystalline surface, while simultaneously promoting remineralisation of the crystalline surface and inhibiting bacterial activity. Systemic forms of application such as fluoridation of drinking water, salt, or tablets have an essentially post-eruptive effect, that is topical in the mouth. In patients at high risk of caries, measures such as fluoridation of drinking water or salt are nevertheless useful as they work independently of the patient's cooperation. Fluoride tablets are effective if sucked, especially for teeth already present in the oral cavity, but this type of fluoride prophylaxis yields poor results in at-risk patients who are uncooperative [Klimek et al.,1982]. Naturally, before prescribing fluoride tablets, it is always necessary to carry out a thorough anamnestic investigation to avoid the risk of overdose. The fluoride content in drinking water can be requested from municipal authorities. Furthermore, evaluating the percentage of fluoride present in mineral waters used to prepare children's meals is very important. It has been shown that systemic fluoridation before teeth erupt does not reduce the incidence of tooth decay compared to administration after teeth eruption [Buzalaf, 2018]. In children under 6 years old, toothpastes containing 500 ppm fluoride should preferably be used. However, these toothpastes should only be used after the expulsion reflex appears, which usually occurs around the age of three: in fact, fluoride toothpastes should be spat out and not swallowed to avoid the risk of overdose. For the same reason, never give fluoride tablets in addition to fluoride toothpastes; on the other hand fluoride varnishes are recommended in an outpatient setting to target early lesions.

> In children younger than 6 years of age
> •
> Detect the anamnesis before carrying out fluoride supplements
> •
> Use toothpastes with reduced fluorine content (500ppm).
> •
> Do not administer fluoride tablets in addition to flourine toothpaste
> •
> Apply in a reduced and targeted way preparations with a high concentration of fluorine

In children older than 6 and particularly after the eruption of the first permanent molars, an adult toothpaste containing 1000 to 1,500 ppm fluoride (0.1-0.15%) can be used. Furthermore, to support post-eruptive maturation of the enamel, weekly applications of fluoride gel with toothbrushes are recommended. Varnishes and fluids are indicated for outpatient topical applications to fissures, pits, single approximal spaces and initial lesions. In adults, gels, fluids and mouthwashes can be used depending on the level of risk [Axelsson et al., 2004].

> In children older than 6 and especially after eruption of permanent molars, toothpastes for adults containing 1000 to 1500 ppm fluoride should be used

Conclusion

Fluoride-based prevention of dental caries is a cost-effective approach, that has been implemented since 1940’s. It includes systemic and topical administrations, through community-based or individual programs. Today, people use numerous fluoride-containing products, such as toothpaste, that offer targeted and highly effective protection against dental caries without the need to ingest fluoride [Walsh et al., 2019].

> It has been shown that systemic fluoridation before teeth erupt does not reduce the incidence of tooth decay compared to administration after teeth eruption

While some countries continue to endorse community-wide fluoridation, its risk and benefits have come under scrutiny in recent years, driven by a growing body of evidence. The benefits of systemic fluorides must be counterbalanced against the potential for adverse health impacts, particularly in vulnerable populations. Public health policies have a profound effect on the health of the population and must be based on prudent judgement of current scientific evidence [Meyer et al., 2024]. In the end, it has been demonstrated that therapeutically effective amounts of fluoride can be achieved with topical application, therefore any form of supplementation should be performed as a topical measure. From these considerations, it emerges that the fluoride content of common toothpaste is sufficient as basic fluoridation program for most patients. In patients at higher risk of caries, a more intensive (temporary) topical application of fluoride may be useful. This can be achieved with the supplemental administration of fluoride mouthwashes, gels or fluoride varnishes.

> •
> Fluorine content of common toothpaste is sufficient as basic fluorization for most patients.
> •
> In patients at higher risk of caries, additional topical applications of fluoride mouthwashes, gels or fluoride varnishes can be useful.

To safeguard the developing child, pregnant women and caregivers can take steps to minimise fluoride intake while maintaining the topical benefits of fluoride, for example, avoiding foods and beverages (e.g., black tea) with high fluoride when pregnant and supervising young children to minimise inadvertent swallowing of fluoride toothpaste. Reducing fluoride intake during pregnancy would not disadvantage the fetus because fluoride’s benefits are minimal until teeth erupt [Featherstone et al., 1999]. Pregnancy is a time of increased susceptibility to periodontal disease and caries due to physiological disruptions and changes in behavior [Wei et al.,2019; Gupta et al., 1993]. Prevention of oral health problems requires maintenance of good oral health, which can be achieved by regular brushing twice a day and flossing daily [Meyer et al.,2024]. Ingestion of fluoride is not required for caries prevention. However, as time passed, the landscape of dentistry and public health has evolved: in other words there is a need to educate the public and health care professionals working with pregnant women and caregivers on the safe use of fluoride.

> Open issues
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> Fluorine content in foods and beverages often unreported
> •
> Lack of evidence-based recommendations on optimal intake levels
> •
> Identification of biomarkers capable of estimating fluoride status in the body

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