



# **IMPORTANCE OF FLUORIDE AND APPLICATION METHODS**

**Assoc. Prof. Tuğba Bezgin**

Department of Pediatric Dentistry

[cetintugba@yahoo.com](mailto:cetintugba@yahoo.com)

Dental caries is a major dental disease affecting a large population all around the World.

One of the most important discoveries made in terms of improving oral health in the last century was the discovery and use of fluoride as a caries prevention method.



**Fluoride (F) is a natural mineral that can be found in groundwater and in many foods, for example in fish and tea.**

**United States Food and Drug Administration describes fluoride as an essential nutrient (Essential elements are required for normal growth and development of human beings.)**

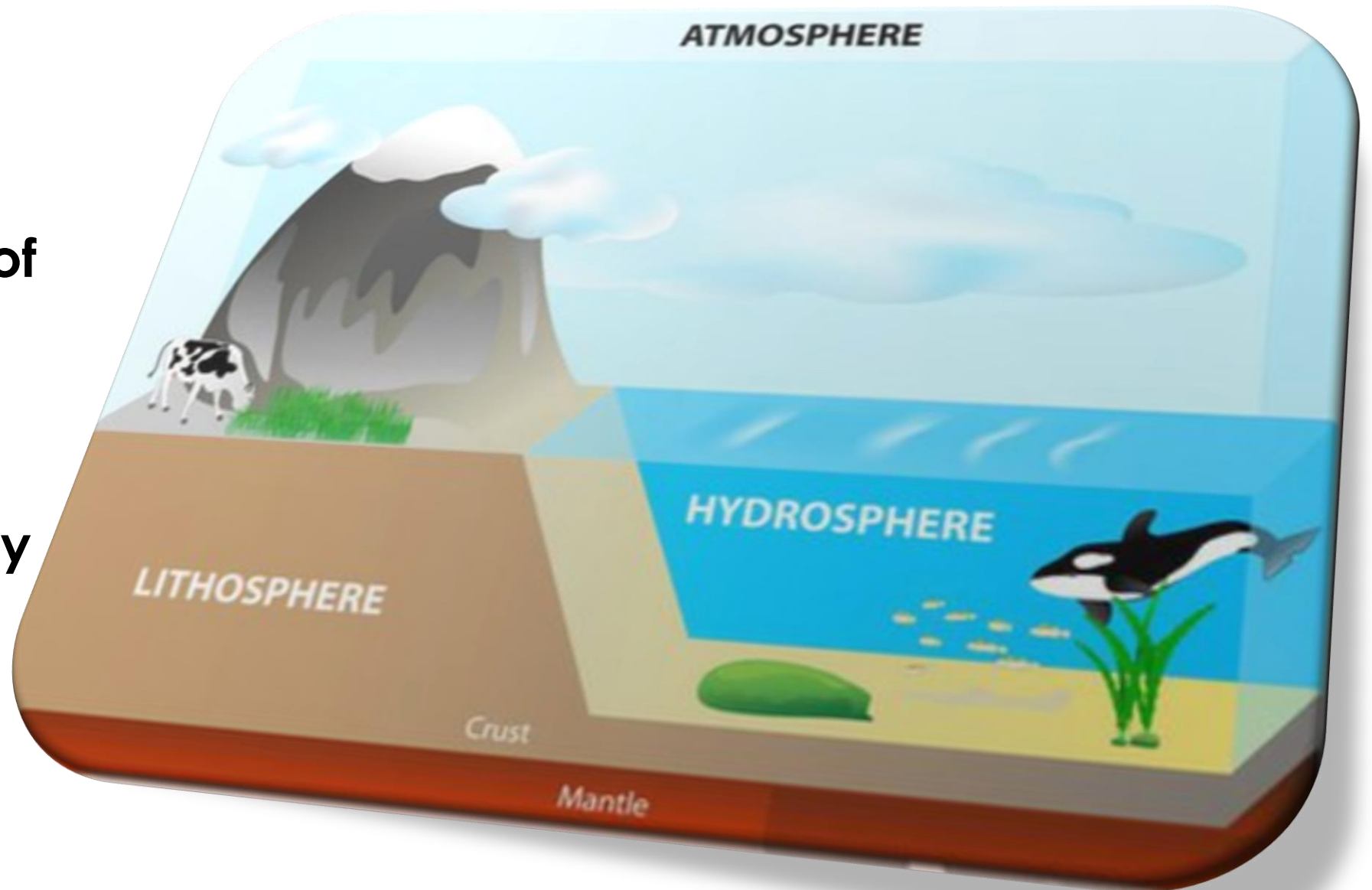






# FLUORIDE IN ENVIRONMENT

**There is a continuous cycle of fluoride in nature and it spreads to the environment by air and water.**



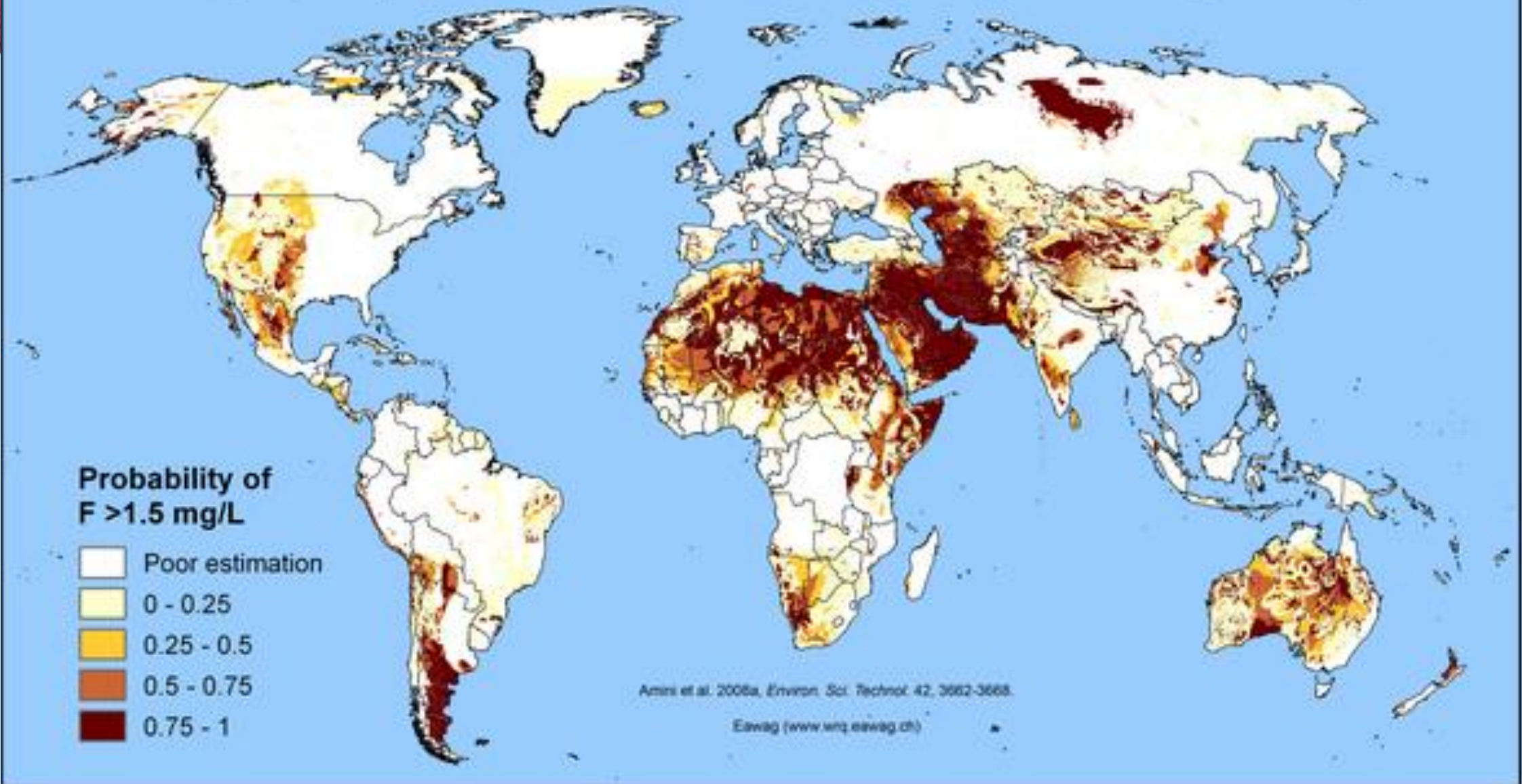


# FLUORIDE IN ENVIRONMENT

1. In Lithosphere: In rock and soil
2. In water: In sea water, lakes and rivers, groundwater
3. In atmosphere
4. In foods: In plants, leafy vegetables, fish, tea



Modeled global probability of fluoride concentration in groundwater exceeding the WHO guideline for drinking water of 1.5 mg/L





# FLUORIDE HISTORY





Dr. McKay

Fluoride research had its beginnings in 1901, when a young dental school graduate named Frederick McKay left the East Coast to open a dental practice in Colorado Springs, Colorado. He observed brown stains on the natives' teeth which was named as 'Colorado Brown Stain'. However, caries prevalence was very low.

The reason of this dental anomaly was not understood until 1930s. High levels of water-borne fluoride indeed caused the discoloration of tooth enamel.



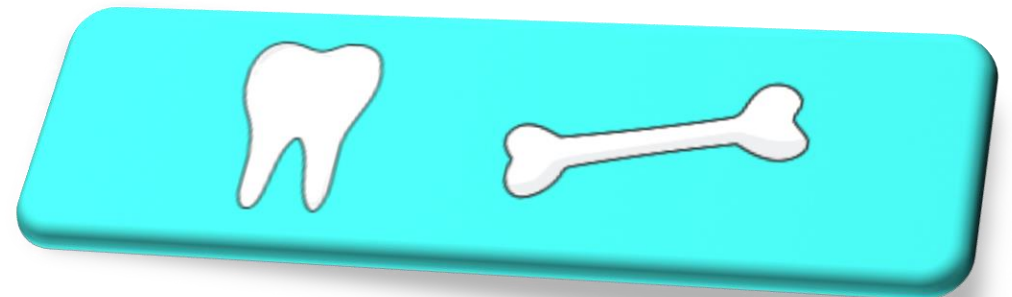


# FLUORIDE METABOLISM

Compared to other tissues in the body, the highest concentrations of fluoride are in teeth and bones due to the high affinity of fluoride for calcium.

Fluoride retention in the bones continues throughout life, but this rate gradually decreases with age. For example, 50% of the fluoride taken in a child can be stored in the bone, while this rate is around 10% in advanced ages.

Fluoride is an important mineral for children especially under 6 years of age.



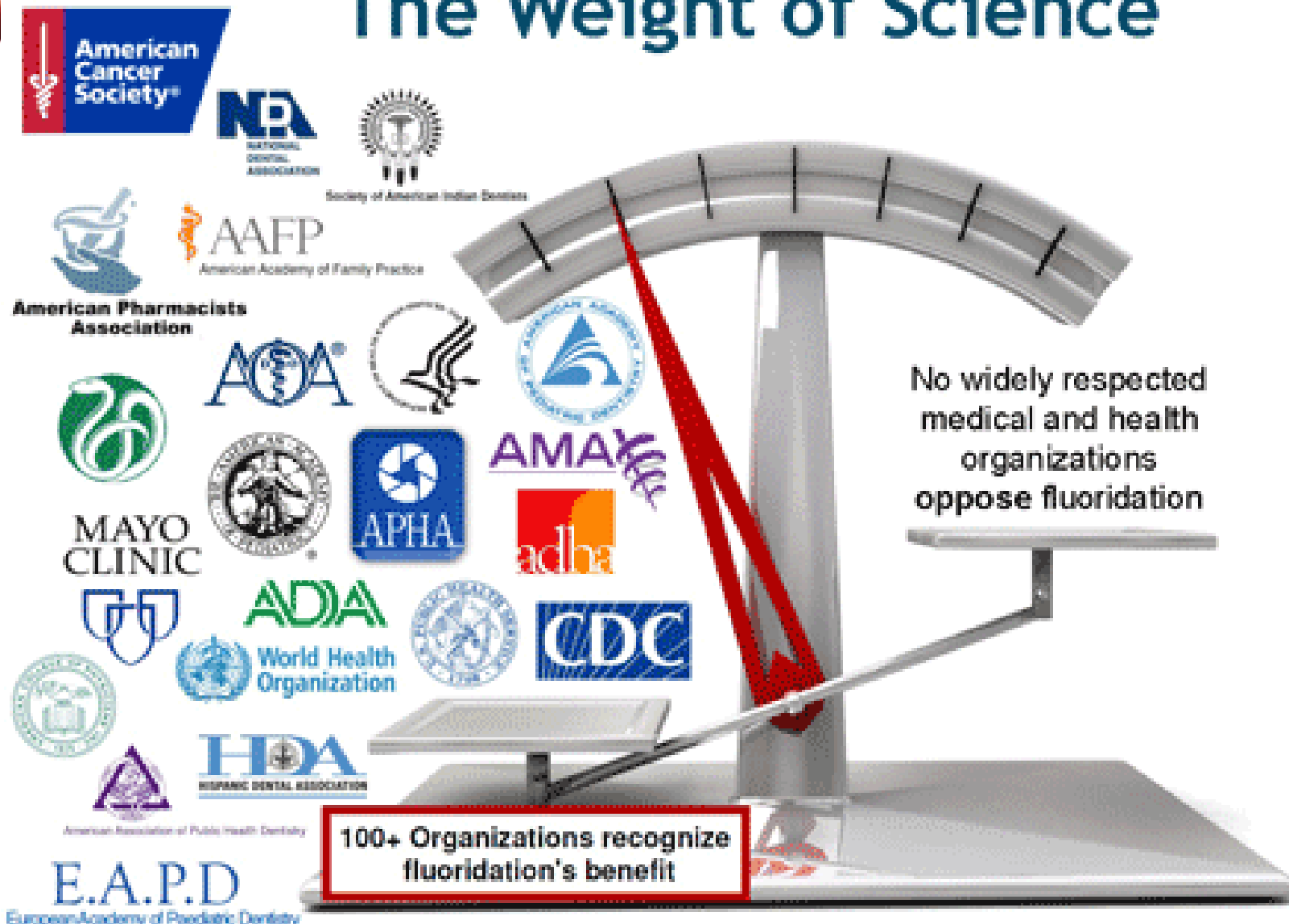


# FLUORIDE CONTROVERSY

The screenshot shows the FluorideAlert.org website. At the top, there is a navigation bar with links for "JOIN US", "DONATE", "Issues", "FAN.tv", "F.A.Q.", "News", and "About FAN". To the right, there are statistics for "NEW VISITORS", "TAKE ACTION", and "RESEARCHERS". A search bar with "Google Custom Search" and social media icons for Facebook and Twitter are also present. Below the navigation bar, a "TRENDING TOPICS" section displays a grid of images from a social media campaign. The images show various people holding signs with messages such as "FLUORIDATION killed my horses", "I'VE FOUGHT FLUORIDATION FOR 34 YEARS TOGETHER LETS END IT NOW!", "KEEP HUMANITY'S MOST IMPORTANT SOURCE OF LIFE AS INTENDED AND FREE OF FLUORIDE", "WATER FLUORIDATION IS AN ENVIRONMENTAL INJUSTICE!", and "WATER SHOULD JUST BE WATER". A large watermark "#FLUORIDELAWSUIT" is overlaid on the images. At the bottom of the grid, the text "FAN LAUNCHES #FLUORIDELAWSUIT SOCIAL MEDIA CAMPAIGN" is displayed.

The screenshot shows the IAOMT (International Academy of Oral Medicine & Toxicology) website. The page title is "Sources of Fluoride Toxicity and Exposure". Below the title is a large image of a person in a white protective suit, mask, and gloves, holding a sign that reads "FLUORIDE IS HAZARDOUS". Below the image, the text reads: "Fluoride is hazardous and can cause toxicity. of human exposure to fluoride have drastically increased since community water fluoridation began in the 1940's, and this means that the potential for cases of fluoride toxicity is also increasing. In water, sources of fluoride now include food, air, soil, pesticides, fertilizers, dental products used at the dental office (some of which are implanted in the human body), pharmaceutical drugs, carpeting, and an array of other consumer items used on a regular basis. Click here to see a of fluoride."

# The Weight of Science





Acute or chronic toxicity is seen if fluorides are taken in excess.

“EVERYTHING IS POISON, THE IMPORTANT  
THING IS THE DOSE.”

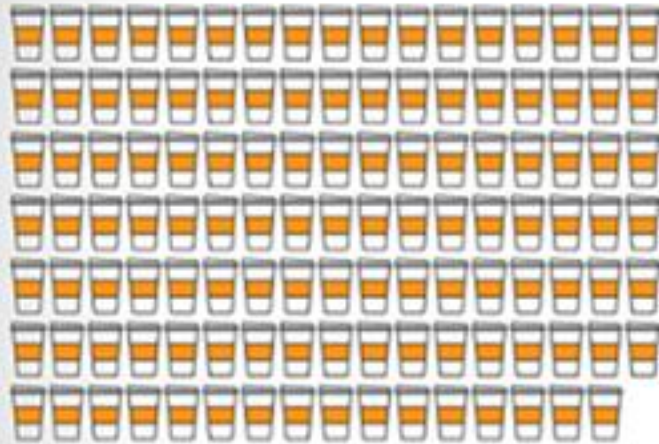
PARACELSUS



# THEORETICAL LETHAL DOSE



**WATER:** 6 liters



**COFFEE:** 118 cups



**ALCOHOL:** 13 shots

## Acute Fluoride toxicity:

**Probable toxic dose:** 5 mg/kg. Gastrointestinal symptoms are seen.

**Lethal dose:** 32-60 mg/kg.  
In children: 16 mg/kg



For a 3-year-old child, about 15 kg weight:

Probable toxic dose:  $15 \times 5 = 75 \text{ mg F intake}$

Lethal dose:  $15 \times 16 = 240 \text{ mg F intake}$

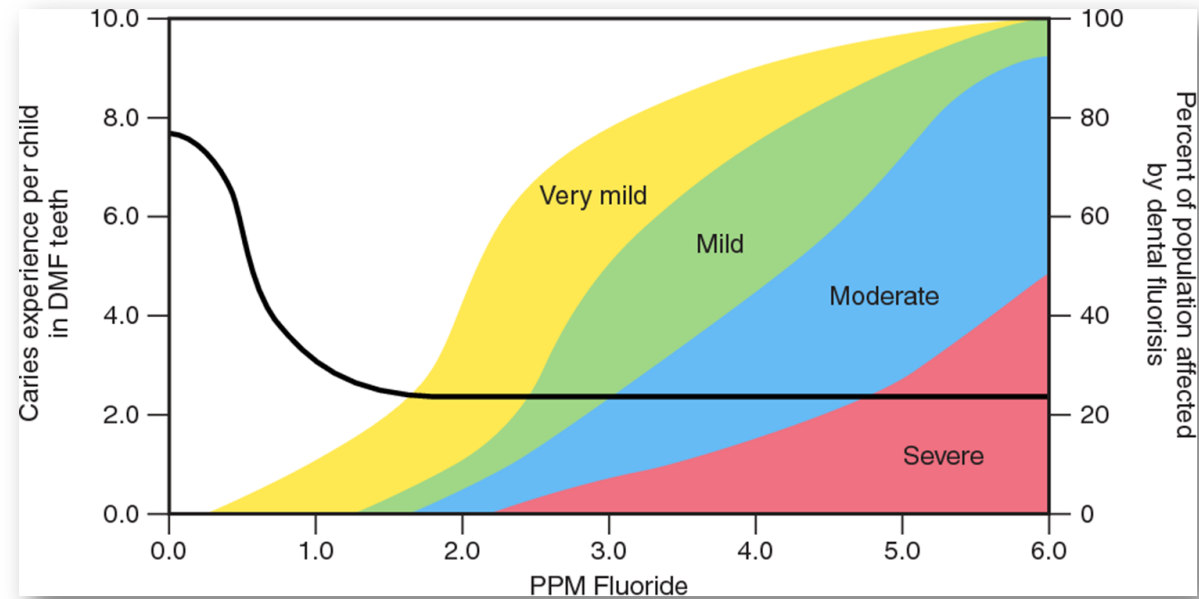


<b>Material</b>	<b>F concentration (ppm F)</b>	<b>Single application</b>	<b>F intake in single applicaiton (mg F)</b>
<b>Varnish (5% NaF)</b>	<b>22600</b>	<b>0.5 ml</b>	<b>11</b>
<b>APF gel</b>	<b>12300</b>	<b>5 ml</b>	<b>62</b>
<b>Mouthwash</b>	<b>900</b>	<b>10 ml</b>	<b>9</b>
<b>Mouthwash</b>	<b>225</b>	<b>10 ml</b>	<b>2.3</b>
<b>Toothpaste</b>	<b>1450</b>	<b>0.6 g</b>	<b>0.9</b>
<b>Toothpaste</b>	<b>1000</b>	<b>0.4 g</b>	<b>0.4</b>
<b>Toothpaste</b>	<b>500</b>	<b>0.4 g</b>	<b>0.2</b>



# **CHRONIC FLUORIDE TOXICITY**

Fluorosis develops as a result of long-term exposure to high concentrations of fluoride. Concentrations of 1.5 mg/kg and above in drinking water pose a risk of **dental fluorosis**. Total daily fluoride intake should be 0.05-0.07 mg F/kg for dental health.







Mild



Severe

Different levels of fluorosis can be seen depending on the concentration.

# SKELETAL FLUOROSIS







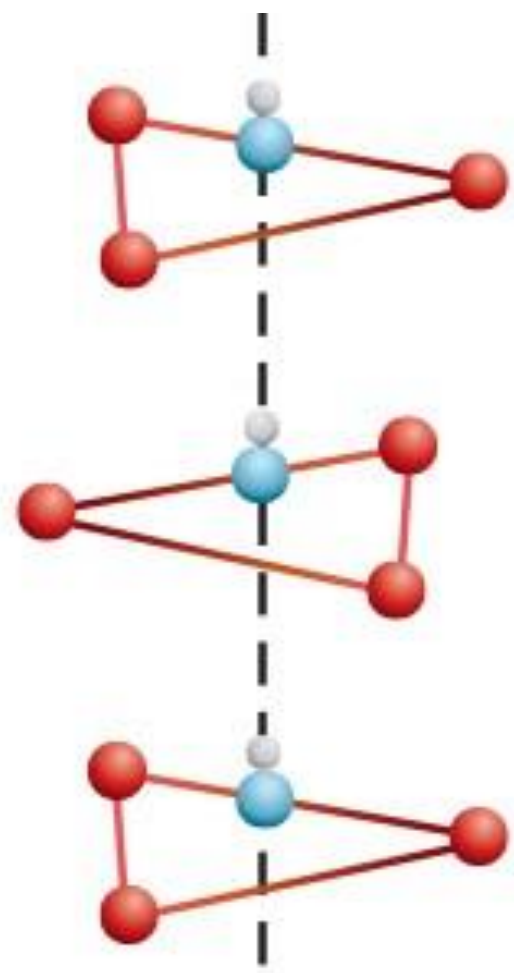
Occurs in areas with drinking water at a concentration **above 10 mg/L F**. Severe bone deformations can be seen.

# ANTI-CARIOGENIC MECHANISMS OF FLUORIDE

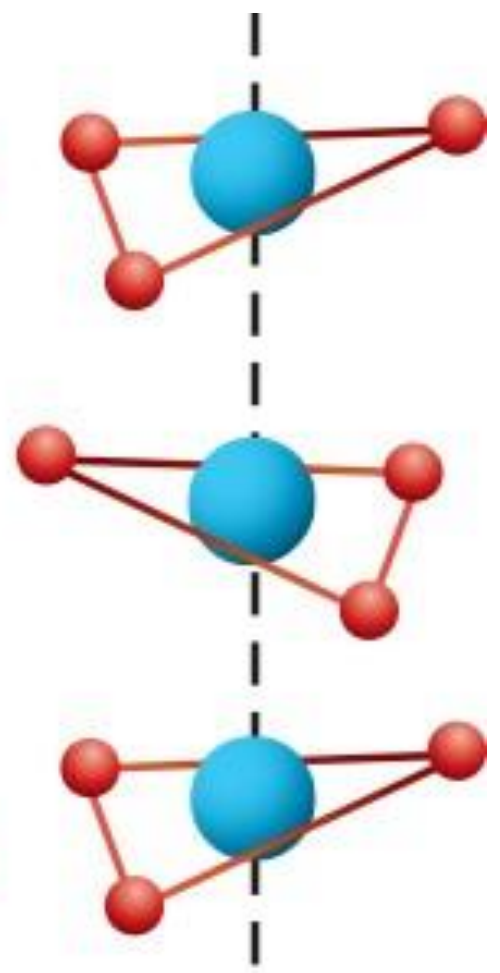




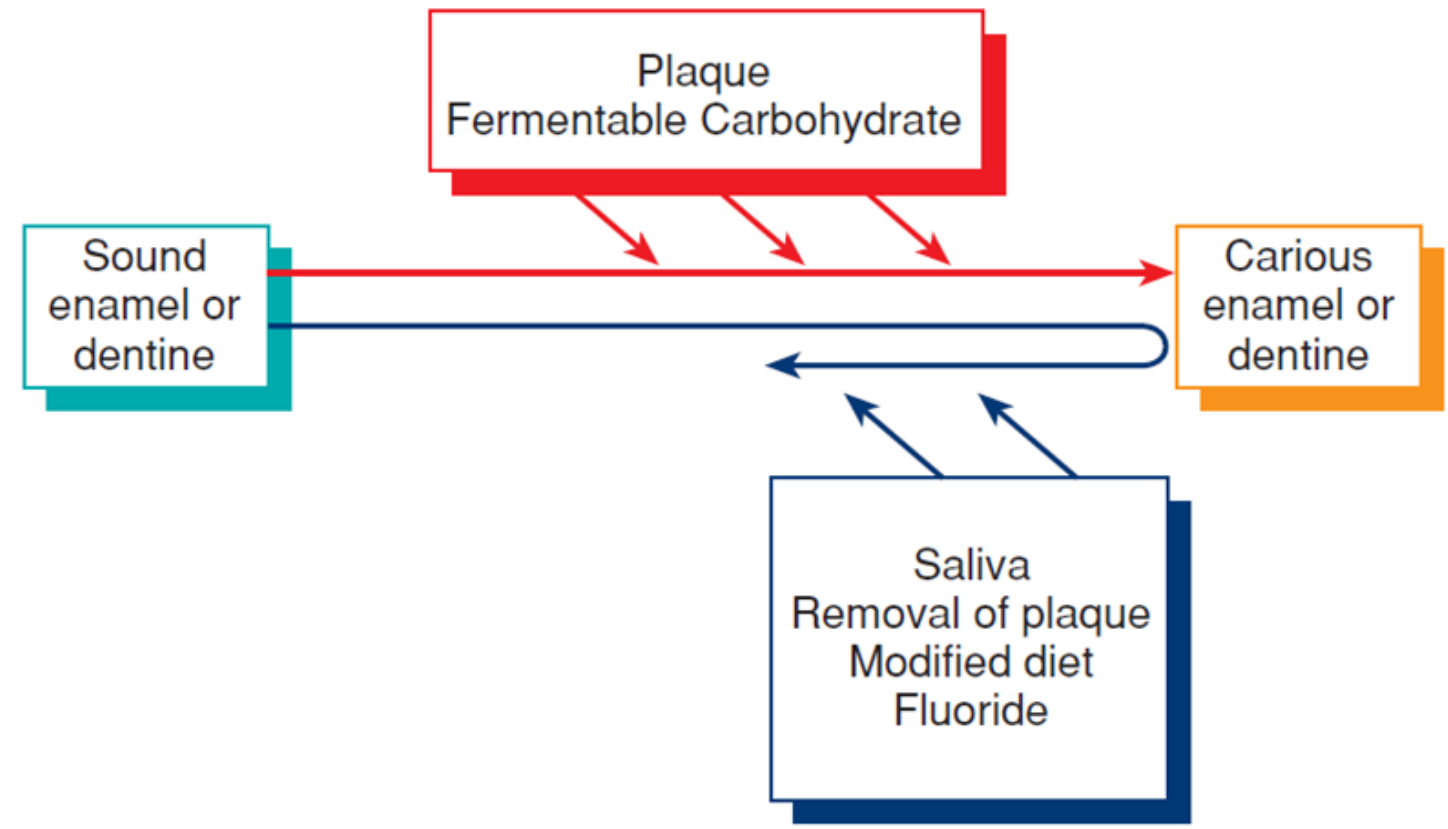
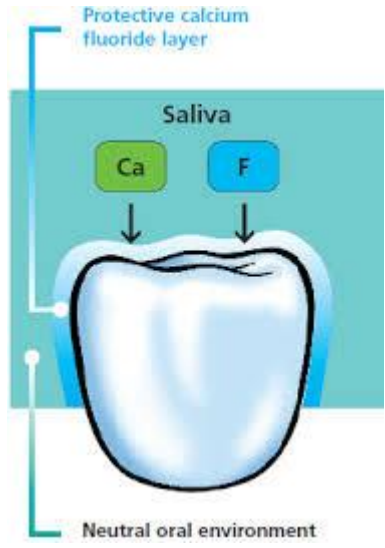
-  Oxygen
-  Calcium
-  Fluoride
-  Hydrogen



Hydroxyapatite



Fluorapatite



Fluoride also prevents tooth decay by affecting the activity of cariogenic bacteria.







# SYSTEMIC AND TOPICAL FLUORIDE APPLICATIONS


# SYSTEMIC FLUORIDE APPLICATIONS

Systemic fluoride application is made in the form of fluoridation of drinking water, salt, milk or the use of fluoride supplements (tablets and drops). Systemic applications other than fluoride supplements are community-based procedures, and are should be designed by evaluating the social, political, environmental, economic and educational situation of the society.

# WATER FLUORIDATION








It is the most common type of systemic fluoride applications.

It is recognized by WHO as an effective public health method for the prevention of dental caries.

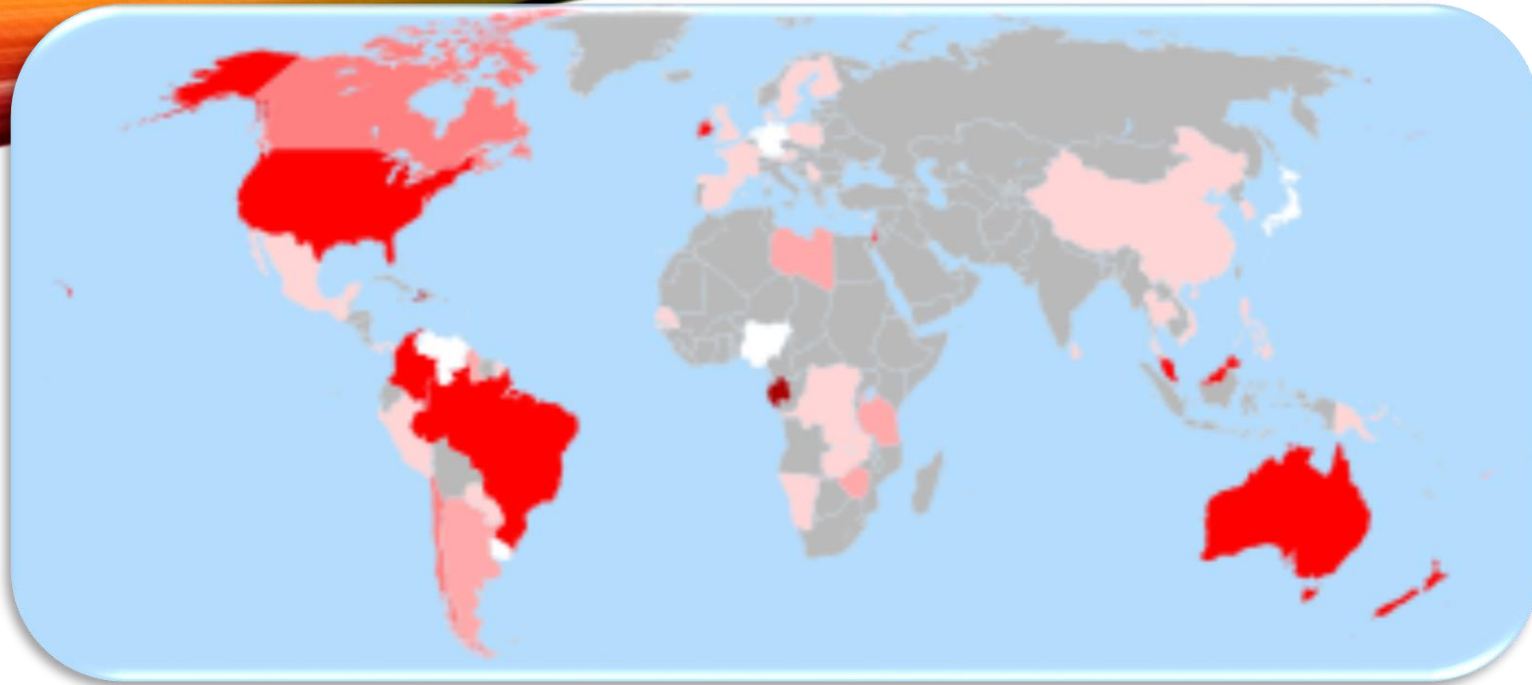
Fluoridation of drinking water is the most convenient and cost-effective method of distributing fluoride to all members of a community.

It ensures that fluoride is distributed fairly to the whole community. It affects all social groups and age groups equally.

Its most important advantage is that a large number of people benefit and the consumption is regular.



1 mg fluoride concentration in 1 liter of drinking water (1ppm) has been defined as the optimal fluoride concentration that provides maximum caries reduction without causing dental fluorosis. It has been reported that drinking water should contain 0.7-1.2 ppm fluoride depending on the daily average maximum air temperature. Since individuals living in warmer climates drink more tap water, a lower fluoride concentration is found to be suitable for these communities.



Fluoridation of drinking water was first started in 1945 and 1946 in the USA and Canada and it was investigated epidemiologically for a long period.

Currently, drinking water is artificially fluoridated in 25 countries around the world and covers approximately 380 million people. Approximately 3% of the population in Western Europe (mainly in the UK, Ireland and Spain), and more than 70% of the population in the USA and Australia, consumes fluoridated drinking water.



Fluoridation of waters reduces caries inequality between poor and non-poor children. Researches on the fluoridation of community water have shown that the decrease due to fluoridation in childhood dental caries is 18-40%.



Adults also benefit from water fluoridation. In older adults, gingival recession usually occurs and the root surfaces of the teeth are exposed. Unlike crowns of teeth, root surfaces are more susceptible to caries. These root caries can cause extreme sensitivity in patients. The prevalence of root caries decreases in elder patients where water is fluoridated.



It is an intervention at a social level, it does not require adaptation of individuals. These interventions are more effective than individual and clinical level interventions. However, concerns have also arisen regarding the ethics of such collective intervention.



# SALT FLUORIDATION







It has been proposed as an option for communities where it is not possible to fluoridate drinking water technically and financially.

Its concentration is adjusted to 250-300 mg F (250-300 ppm) in 1 kg of salt.

It was first applied in Switzerland in the 1950s. It is available in more than 30 countries today. It is estimated that 40-280 million people mainly use fluoridated salt in European, South American and Central American countries.

Unlike the fluoridation of water, it is possible for the consumer to choose.



## **There are some drawbacks about this method:**

- Lack of complete control regarding consumption (Salt consumption varies considerably between individuals).
- Salt consumption is low in the first years of life when fluoride is most needed
- Due to the connection of excessive salt consumption with hypertension, it is recommended to reduce consumption today.

# **MILK FLUORIDATION**



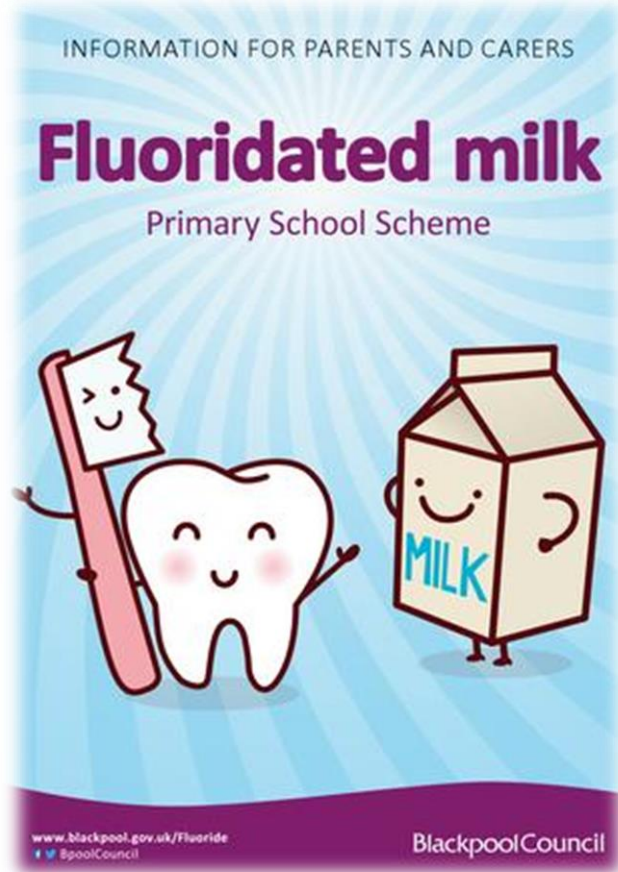


Distribution of fluoridated milk to preschool and school-age children in areas where water and salt are not fluoridated is a cost-effective method.

The first article on the fluoridation of milk was published in 1953 by Eugen Ziegler, a Swiss pediatrician.

It has been shown that it contributes to the reduction of caries in both milk and permanent teeth by applying it to children in school programs.





It is attractive to use milk as a carrier to provide fluoride in community oral health programs because milk already occupies an important place in children's diets.

The amount of fluoride added is decided by the age of the child and the total amount of fluoride taken from other sources. It is set at 0.5mg daily for younger children and 1.0 mg for older children.

# FLUORIDE SUPPLEMENTS






Fluoride supplements are available in tablet, pastille or drop form.

The use of supplements requires a high degree of patient cooperation.

In the years when it was accepted that the anti-caries effects of fluorides were essentially systemic, it was started to be used to benefit from the caries-preventing effect in communities living in regions where water is not optimally fluoridated.



As a result of increasing data on the prevalence of fluoride intake and dental fluorosis, the prescribed supplement dose for those under 6 years of age has been significantly reduced.


According to the fluoride supplement dosage schedule recommended for those under the age of 16, which was accepted in 1994 by the American Dental Association (ADA), the American Academy of Pediatric Dentistry (AAPD) and the American Academy of Pediatrics (AAP); fluoride supplements should not be used in infants younger than 6 months and children living in areas where the fluoride concentration in their water is more than 0.6 ppm.

When adjusting the dosage of fluoride supplements, consideration should be given to the age of the child, the fluoride content of the drinking water, and the fluoride ingested from other sources (eg/ toothpaste or mouthwash).



Considering that teeth began to develop before birth, before 1969, fluoride supplements were also recommended for pregnant women in order to provide prenatal effect. Although fluoride crosses the placenta, there is insufficient evidence that fluoride taken during pregnancy will reduce the prevalence of caries in the child and is no longer recommended.






Today, it is known that the topical effect of fluoride plays a more important role than the systemic effect in the prevention of caries. The effect of fluoride supplements is both systemic and topical.

Local or topical effect is possible either by touching the tooth before swallowing or by reaching saliva through the circulation.


To enhance the topical effect of fluoride, tablets and pastilles should be chewed or sucked for 1-2 minutes before swallowing.



# **TOPICAL APPLICATION METHODS OF FLUORIDES**

- 
- The importance of **topical fluoride** use has increased in recent years with the understanding of the effect of fluoride in the oral cavity at a certain concentration in the period after tooth eruption, reducing the demineralization of enamel and preventing early caries lesions.





Topical applications can be done with low concentration fluoride-containing toothpastes and mouthwashes that the individual can apply at home or with gels and varnishes containing high concentrations of fluoride applied professionally by dentists.

Low concentration products are applied frequently (eg/Toothpastes should be used twice a day), high concentration products are applied infrequently(eg/Fluoride varnishes are applied every 6-12 months).

Individual methods at home are sufficient for individuals with low caries activity.

The child's age, caries risk and total fluoride intake should be taken into account when programming topical fluoride applications to the child.

Individual methods at home are sufficient for individuals with low caries activity.





# **INDIVIDUALLY APPLIED TOPICAL FLUORIDES**

# FLUORIDE TOOTH PASTES







Fluoride toothpastes, which have been used as caries prevention method since 1955, are the most common topical fluoride applications.

Almost 95% of the toothpastes on the market in industrialized countries today are fluoridated.

With regular use of fluoride toothpaste, the fluoride concentration in saliva and plaque increases. Thus, caries is prevented.



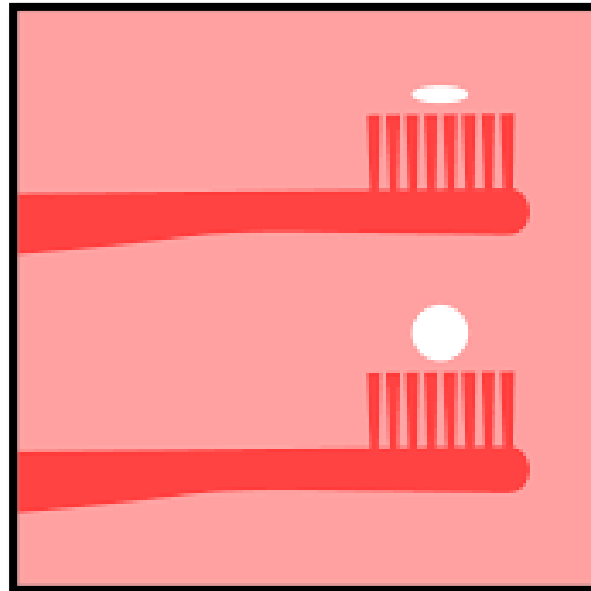
The fluoride concentration in adult toothpastes is between 1000-1500 ppm (1450 ppm in Turkey).

Child toothpastes contain 500-1000 ppm. Since children under the age of 6 can swallow toothpaste, it is more appropriate for them to use this dosage. After 6 years of age, they can use adult toothpaste.

The amount of toothpaste under 2 years of age should be a thin smear (as much as a rice) in children, however in children between the ages of 2-6, it should be up to a pea.

<2-year-old children

<2-year-old children





Toothbrushing should be started with the eruption of the first primary tooth.



Teeth should be brushed twice a day; once before going to bed at night and the other can be any time of the day (preferably after breakfast).

Brushing twice a day is a sensible social model. It is suitable for most people's daily routines.



It is also advantageous if the fluoride toothpaste is in more contact with the teeth during brushing. For this purpose, brushing for 2 minutes is effective.



There are also fluoride-free toothpastes on the market. However, they have no caries prevention effect.



# FLUORIDED MOUTHWASHES







Fluoride mouthwashes are concentrated solutions for daily or weekly use.

It was used frequently in school-based programs in countries with a high prevalence of caries in the 1970s and 1980s.

Nowadays, mouthwashes are recommended in addition to toothpaste for individuals with high and moderate caries activity. It is recommended for individuals older than 6 years due to the risk of swallowing.



# **PROFESSIONALLY APPLIED FLUORIDE COMPOUNDS**

Topical applications with high fluoride concentrations that can only be applied by dentists create a calcium-fluoride-like material on the enamel surface and protects teeth against caries. Its protective effects last 6-12 months depending on the individual's risk of caries.



# FLUORIDE GELS





1.23% Acidulated phosphate fluoride (APF)

It contains 12.300 ppm fluoride per application.





Gels are applied for 1-4 minutes with ready foam spoons.





# FLUORIDE VARNISHES





5% sodium fluoride (22600 ppm F).



0.9% difluorosilane





Fluoride varnish is the safest professional topical fluoride method.

It is the only safe topical fluoride method that can be applied under 6 years of age (especially 0-3 years).

With fluoride varnish applications, dental caries is reduced by 43% in permanent teeth and 37% in primary teeth.





**THANKS**

## REFERENCES

1. Inadequate or excess fluoride: A major public health concern. World Health Organisation, 2010. [[https://www.who.int/ipcs/assessment/public\\_health/fluoride/en/](https://www.who.int/ipcs/assessment/public_health/fluoride/en/)]
2. Guidelines for Drinking-Water Quality. Pp:370-373. 4th. Ed. World Health Organization. 2011. [[https://www.who.int/water\\_sanitation\\_health/publications/dwq-guidelines-4/en/](https://www.who.int/water_sanitation_health/publications/dwq-guidelines-4/en/)]
3. Recommendations for using fluoride to prevent and control dental caries in the United States. Centers for Disease Control and Prevention. MMWR Recomm Rep. 2001. 17;50(RR-14):1-42.
4. Effects of Fluoride on Teeth. In: Fluoride in Drinking water. A Scientific Review of EPA's Standards. Committee on Fluoride in Drinking Water Board on Environmental Studies and Toxicology Division on Earth and Life Studies. The National Academies Press, Washington, 2006.
5. Marwah N. Textbook of Pediatric Dentistry. Pp: 328-351. 3rd ed. Jaypee Brothers Medical Publishers, 2014.
6. Tinanoff N. Use of fluoride. In: Early childhood oral health. Berg JH, Slayton RL (eds.) Pp:104-119. 2nd. Ed., Wiley Blackwell, 2016.
7. Duggal M, Cameron A, Toumba J. Paediatric dentistry at a glance. 1st. Ed. Pp:28-33. Wiley-Blackwell, 2012.
8. Blinkhorn A, Mekertichian K. Fluoride and dental health. In: Handbook of Pediatric Dentistry. Cameron AC, Widmer RP (eds). 4th. Ed. Mosby, Elsevier, 2013.
9. Koch G, Poulsen S. Pediatric Dentistry: A Clinical Approach 2nd Ed. Pp: 99-103. Wiley-Blackwell, 2009.
10. Beltran ED, Burt BA. The pre- and posteruptive effects of fluoride in the caries decline. J Public Health Dent. 1988 ;48(4):233-40.
11. Pollick H. The Role of Fluoride in the Prevention of Tooth Decay. Pediatr Clin North Am. 2018;65(5):923-940.
12. Marthaler TM, Petersen PE. Salt fluoridation--an alternative in automatic prevention of dental caries. Int Dent J. 2005;55(6):351-8.
13. Pollick HF. Salt fluoridation: a review. J Calif Dent Assoc. 2013;41(6):395-7, 400-4. Review.
14. Bánóczy J, Rugg-Gunn A, Woodward M. Milk fluoridation for the prevention of dental caries. Acta Med Acad. 2013;42(2):156-67 Review.
15. Tubert-Jeannin S, Auclair C, Amsallem E, Tramini P, Gerbaud L, Ruffieux C, Schulte AG, Koch MJ, Rège-Walther M, Ismail A. Fluoride supplements (tablets, drops, lozenges or chewing gums) for preventing dental caries in children. Cochrane Database Syst Rev. 2011 Dec 7;(12):CD007592.
16. Marinho VC, Chong LY, Worthington HV, Walsh T. Fluoride mouthrinses for preventing dental caries in children and adolescents. Cochrane Database Syst Rev. 2016 Jul 29;7:CD002284.
17. Marinho VC, Worthington HV, Walsh T, Chong LY. Fluoride gels for preventing dental caries in children and adolescents. Cochrane Database Syst Rev. 2015 Jun 15;(6):CD002280.
18. Chu CH, Lo EC. A review of sodium fluoride varnish. Gen Dent. 2006;54(4):247-53.
19. Marinho VC, Worthington HV, Walsh T, Clarkson JE. Fluoride varnishes for preventing dental caries in children and adolescents. Cochrane Database Syst Rev. 2013 Jul 11;(7):CD002279.
20. Use of Silver Diamine Fluoride For Dental Caries Management in Children And Adolescents, Including Those With Special Health Care Needs. American Academy of Pediatric Dentistry. Oral Health Policies & Recommendations, 2017.
21. Chairside Guide: Silver Diamine Fluoride in The Management Of Dental Caries Lesions. American Academy of Pediatric Dentistry Oral Health Policies & Recommendations, 2018.
22. Policy on The Use of Silver Diamine Fluoride For Pediatric Dental Patients. American Academy of Pediatric Dentistry. Oral Health Policies & Recommendations, 2018.
23. Rajendra A, Veitz-Keenan A, Oliveira BH, Ruff RR, Wong MCM, Innes NPT, Radford J, Seifo N, Niederman R. Topical silver diamine fluoride for managing dental caries in children and adults. Cochrane Database of Systematic Reviews 2017, Issue 7. Art. No.: CD012718.
24. Freeze RA, Lehr JH. The fluoride wars : how a modest public health measure became America's longest running political melodrama. Pp: 356-364. John Wiley & Sons, Inc. 2009.
25. Chi DL. Parent Refusal of Topical Fluoride for Their Children: Clinical Strategies and Future Research Priorities to Improve Evidence-Based Pediatric Dental Practice. Dent Clin North Am. 2017;61(3):607-617.