

Diabetes and Oral Health Water Fluoridation

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Disclosures

- Employee of Delta Dental MI, OH, IN
- Employee of Oakland County Sheriff's Office
- No conflicts of interests

Objectives

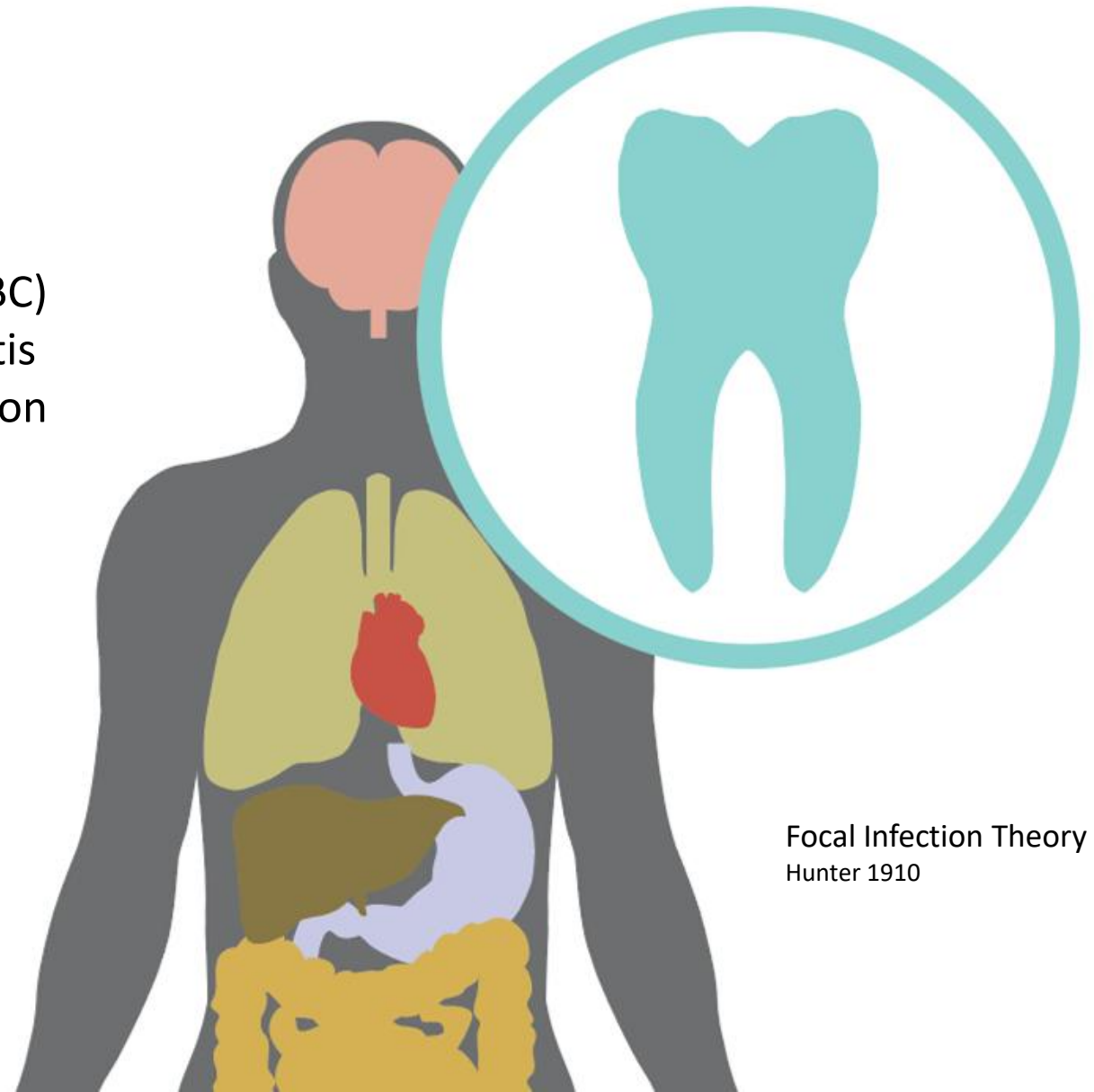
- Review topics related to Diabetes Mellitus
 - Pathophysiology
 - Incidence in the USA
 - The role of chronic inflammation
- The contributing factors of oral disease
- Oral complications of DM
- Can control of oral disease decrease healthcare costs?
- Community water Fluoridation

Would you purchase health insurance that excludes your left foot?



The mouth is attached to the body

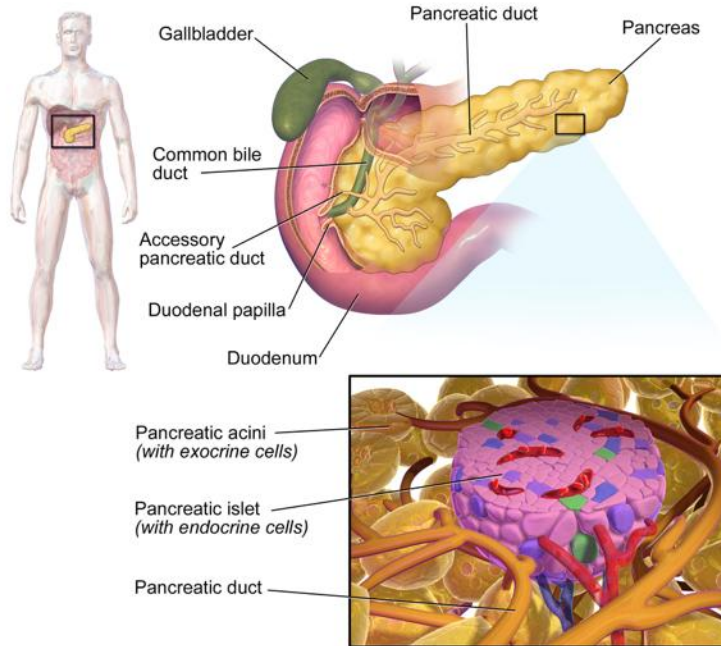
Hippocrates (460 – 370 BC)
Claimed to have cured arthritis
with an extraction



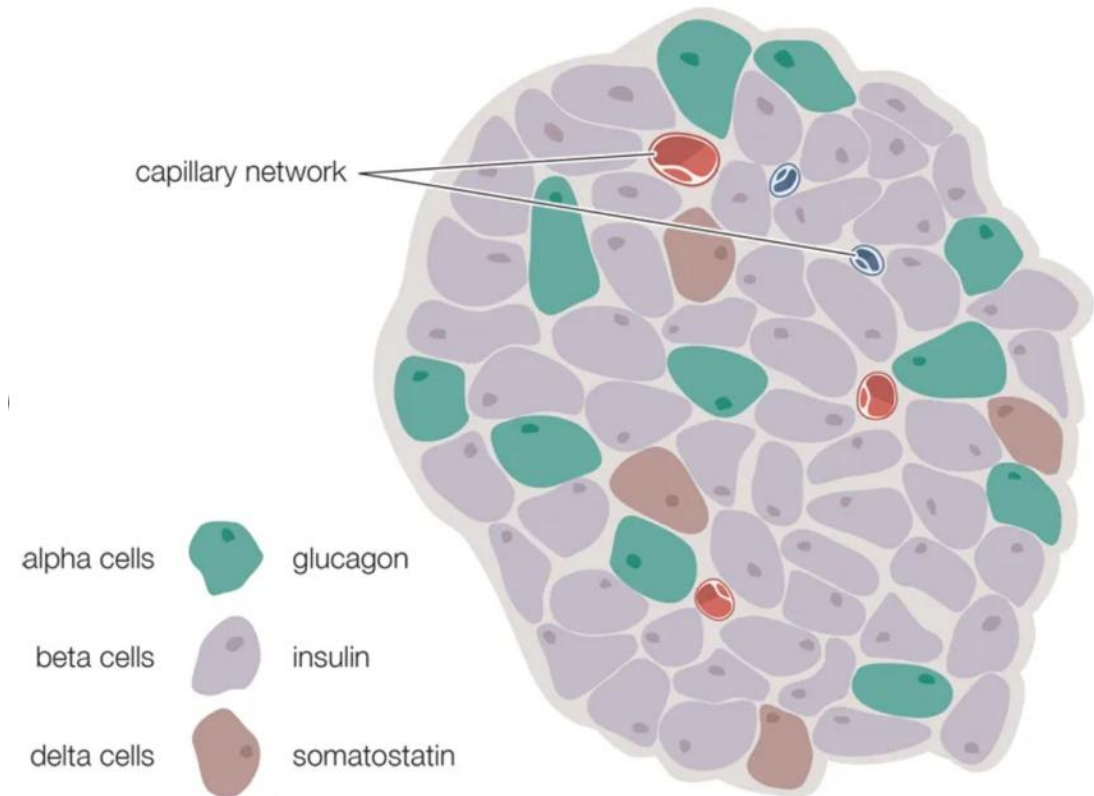
Focal Infection Theory
Hunter 1910

Diabetes mellitus

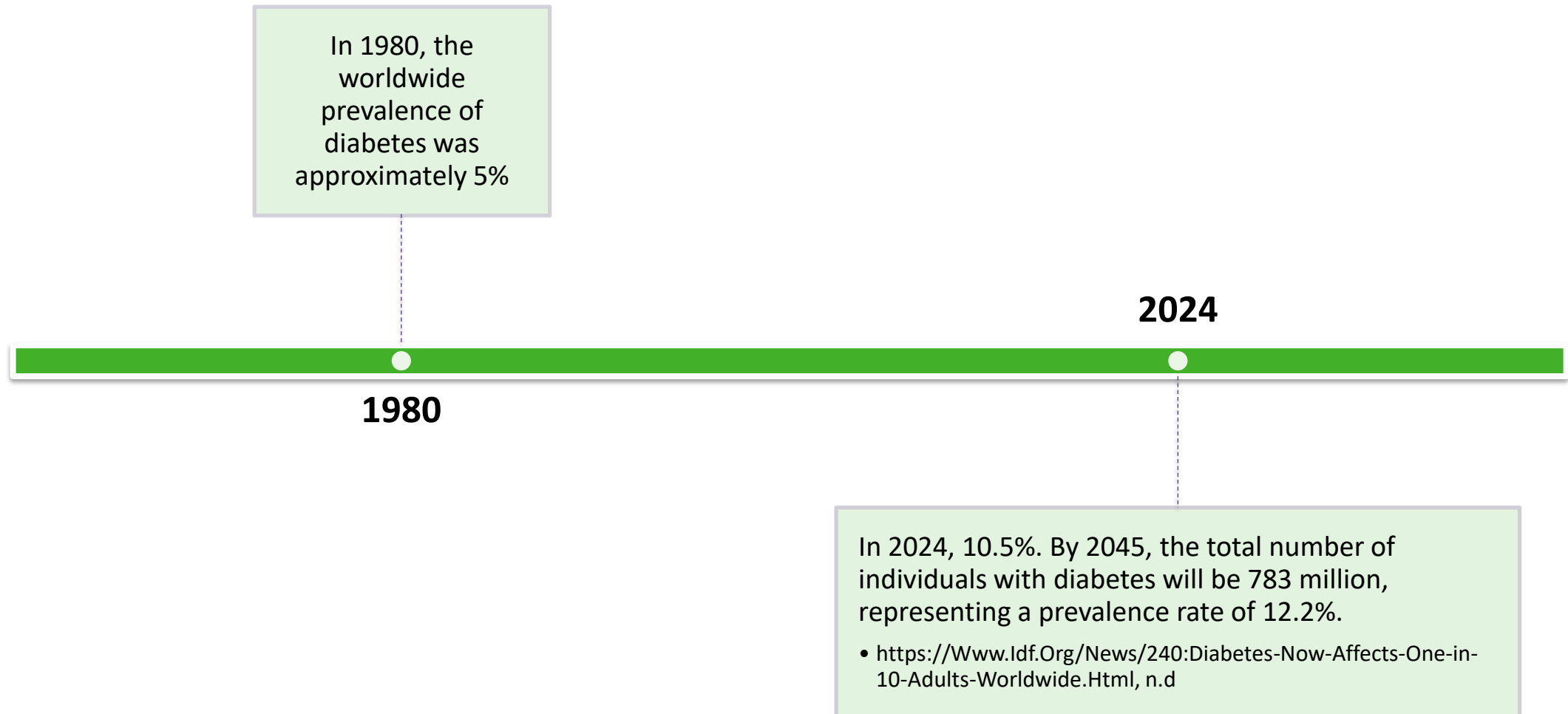
- A metabolic syndrome caused by multiple factors resulting from a deficiency of insulin
- May be absolute due to pancreatic β -cell destruction (type 1) or relative due to an increased resistance of the tissues to insulin (type 2)



Pancreatic Tissue

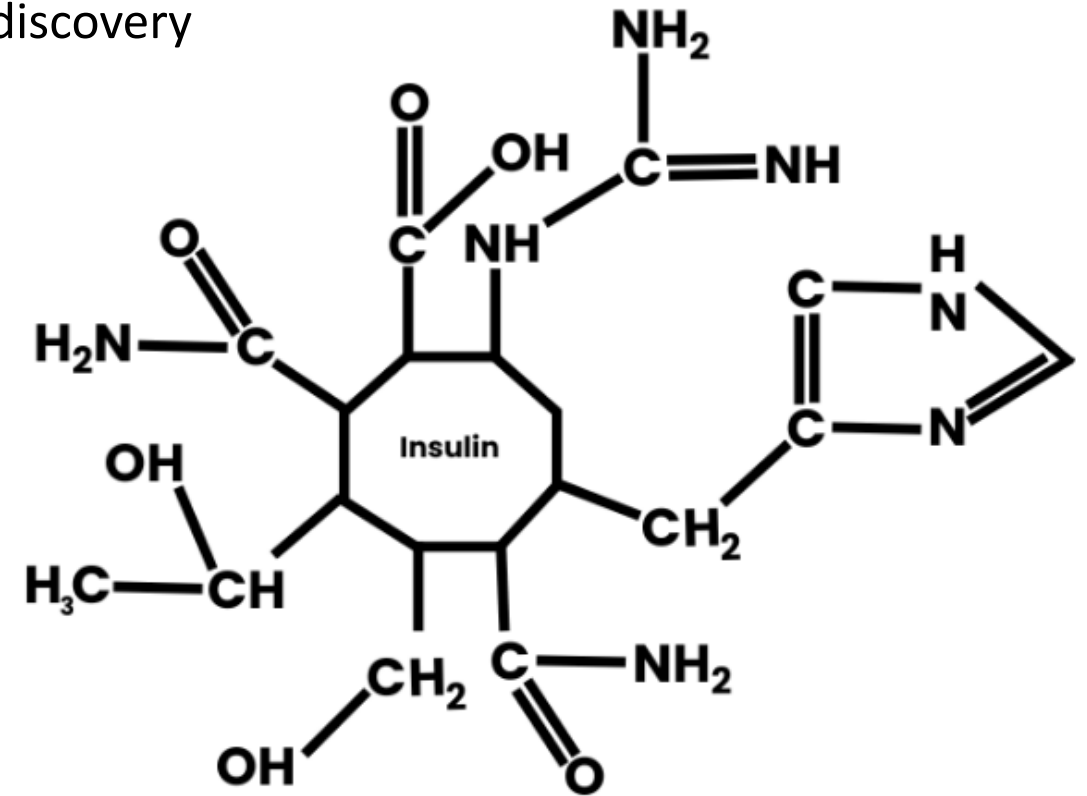


Diabetes: A growing concern



History

- First described in Ebers Papyrus (c. 1550 BC)
- The term diabetes traces back to Demetrius of Apamea (1st century BC).
- 1889, Von Mering and Minkowski are credited with the discovery of diabetes being a pancreatic disease
- 1916, Nicolae Paulescu discovers "pancreine"
- 1921, Banting and Best first isolated insulin
 - Nobel Prize in 1923



Diabetes Types

Type I

Chronic autoimmune disease in which the beta cells in the pancreas are destroyed to create little to no insulin. Accounts for 5% to 10% of all diabetes cases

Type II

Decreased response of target tissues to normal levels of insulin. Accounts for 85% to 90% of diabetes cases. Associated with excess weight, physical inactivity, family history of diabetes, and certain ethnicities

Gestational

Occurs in the second half of a pregnancy, gestational diabetes. Caused by placental hormones and results in insulin deficiency and resistance. Increased risk of developing type 2 diabetes later in life

Pre-diabetes

Blood glucose levels are higher than normal, but not high enough for a formal diagnosis of diabetes. Prediabetes means a person is at increased risk of developing type 2 diabetes

- Specific types of diabetes due to other causes

Data from the National Health and Nutrition Examination Survey

- During 8/21–8/23, diabetes prevalence was 15.8%, diagnosed diabetes was 11.3%, and undiagnosed diabetes was 4.5% in U.S. adults
- Total and diagnosed diabetes prevalence was higher in men (18.0% and 12.9%, respectively) than in women (13.7% and 9.7%, respectively)
- Diagnosed and undiagnosed diabetes prevalence increased with age and weight
- Total and diagnosed diabetes prevalence decreased with increasing educational attainment
- The age-adjusted prevalence of total and diagnosed diabetes increased between 1999–2000 and August 2021–August 2023
- 32.7% teens aged 12–17 has prediabetes, according to the CDC's latest analysis

<https://gis.cdc.gov/grasp/diabetes/diabetesatlas-spotlight.html>

Diabetes

- 29.2% of Americans aged 65 are diabetic! (diagnosed and undiagnosed)
- Annual cost per patient for diabetes is \$9,601.00
- Indirect costs include:
 - Increased absenteeism (\$3.3 billion)
 - Reduced productivity at work (\$26.9 billion), for those not in the labor force (\$2.3 billion)
 - Inability to work as a result of disease-related disability (\$37.5 billion)
 - Lost productive capacity due to early mortality (\$19.9 billion)
- Medical costs and lost work and wages for people with diagnosed diabetes total \$413 billion yearly
- ?

<http://www.diabetes.org/diabetes-basics/statistics/>
<http://cdc.gov/diabetes/php/data-research/index.html>
<https://www.ncbi.nlm.nih.gov/pubmed/29567642>
<http://dactoolkit.org/wp-content/uploads/2018/03/Economic-Costs-of-Diabetes.pdf>
<http://www.diabetes.org/advocacy/news-events/cost-of-diabetes.html>
<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3609540/>
<https://www.cdc.gov/diabetes/diabetesatwork/plan/costs.html>
<https://www.healthdeals.com/blog/save/diabetes-costs/>



The role of chronic inflammation in DM

- 1901, reports on high doses of sodium salicylate led to decreased glycosuria
 - Williamson RT. On the treatment of glycosuria and diabetes mellitus with sodium salicylate. Br Med J. 1901;1:760–2.
 - Reid J, Macdougall AI, Andrews MM. Aspirin and diabetes mellitus. Br Med J. 1957;2:1071–4.
- Hotamisligil et al., 1993, tumor necrosis factor-alpha (TNF-alpha) in obesity and particularly in insulin resistance and diabetes
 - Hotamisligil GS, Shargill NS, Spiegelman BM. Adipose expression of tumor necrosis factor-alpha: direct role in obesity-linked insulin resistance. Science. 1993;259:87–91.
- Fibrinogen, C-reactive protein, interleukin (IL)-6, plasminogen activator inhibitor-1, sialic acid and WBCs, have been shown to be elevated in DM
 - Duncan BB, Schmidt MI, Pankow JS et al. Low-grade systemic inflammation and the development of type 2 diabetes: the atherosclerosis risk in communities' study. Diabetes. 2003;52:1799–805.

**Evidence to
suggest that
inflammation
plays a
significant role
in the
development
of insulin
resistance**

- Chronic, low-grade inflammation is a characteristic feature of obesity and metabolic disorders, including insulin resistance and type 2 diabetes
- Tumor necrosis factor alpha (TNF- α) and interleukin-6 (IL-6), have been shown to impair insulin signaling and glucose uptake in muscle and adipose tissue and to promote hepatic gluconeogenesis and lipolysis

de Luca C, Olefsky JM. Inflammation and insulin resistance. FEBS Lett. 2008; 582(1): 97-105.

**Weinberg Sibony R,
Segev O, Dor S, Raz
I. Overview of
oxidative stress and
inflammation in
diabetes. Journal of
Diabetes. 2024;
16(10):e70014**

- Inflammatory cytokines, stress kinases, and reactive oxygen species (ROS) interfere with insulin signaling pathways, leading to impaired glucose metabolism and organ dysfunction
- Persistent inflammation and heightened OS are implicated in the development of insulin resistance, subsequently fostering hyperglycemia
- Lifestyle interventions, including a balanced diet and exercise, can help reduce chronic inflammation and OS, thereby preventing and controlling T2D
- Anti-inflammatory agents show potential in reducing OS and inflammation. Pioglitazone, metformin, and GLP-1 agonists, may also have anti-inflammatory effects
- Further research, including randomized controlled trials, is needed to evaluate the efficacy of these interventions

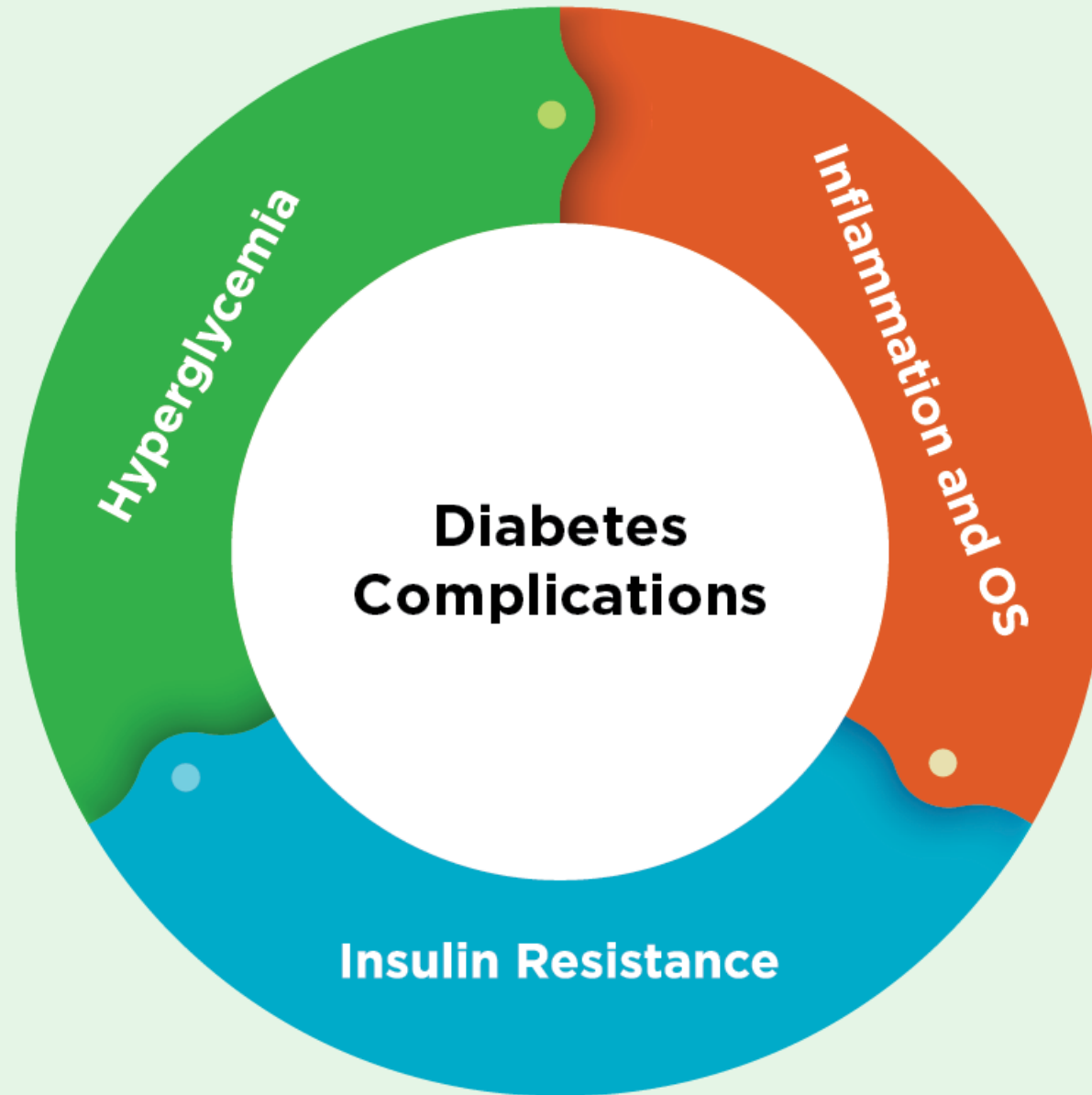
Targeting inflammation to help prevent and control diabetes

- Hypothesis is that obesity stimulates NF- κ B activity and additional stress pathways in adipose tissue, liver, and leukocytes, thereby promoting insulin resistance
- High glucose concentrations induce the production IL-1 β in human pancreatic β cells, may contribute to impaired insulin secretion, decreased cell proliferation, and apoptosis
 - Donath MY, Mandrup-Poulsen T. The use of interleukin-1-receptor antagonists in the treatment of diabetes mellitus. *Nat Clin Pract Endocrinol Metab.* 2008;4:240–1. doi: 10.1038/ncpendmet0783
- Tumor necrosis factor α (TNF- α), a proinflammatory cytokine, was shown to be produced by adipose tissue and to promote insulin resistance
- Weight loss and metformin reduces hsCRP
- Insulin itself can reduce the activity of NF- κ B (short duration)

Goldfine AB, Fonseca V, Shoelson SE. Therapeutic approaches to target inflammation in type 2 diabetes. *Clin Chem.* 2011;57:162–7. doi: 10.1373/clinchem.2010.148833.

However,

- Glucocorticoids and most immunosuppressive drugs lack glucose-lowering efficacy and have many long-term deleterious consequences
- Nonselective (COX) inhibitors (e.g., ibuprofen, naproxen) and the selective COX2 inhibitors (e.g., celecoxib) are ineffective at insulin sensitization and glucose lowering
 - Goldfine AB, Fonseca V, Shoelson SE. Therapeutic approaches to target inflammation in type 2 diabetes. Clin Chem. 2011 Feb;57(2):162-7.



Affect of diet

Anti-inflammatory Diet

- Healthy fats like omega-3 fatty acids, olive oil, flaxseed oil and canola oil
- Avocados
- Walnuts
- Most fruits and vegetables, like oranges, tomatoes, and leafy greens

Foods that tend to increase inflammation in the body include unhealthy fats, such as:

- Trans-fatty acids
- Vegetable shortening
- Margarine
- Red meat
- Cheese, cream, full-fat dairy



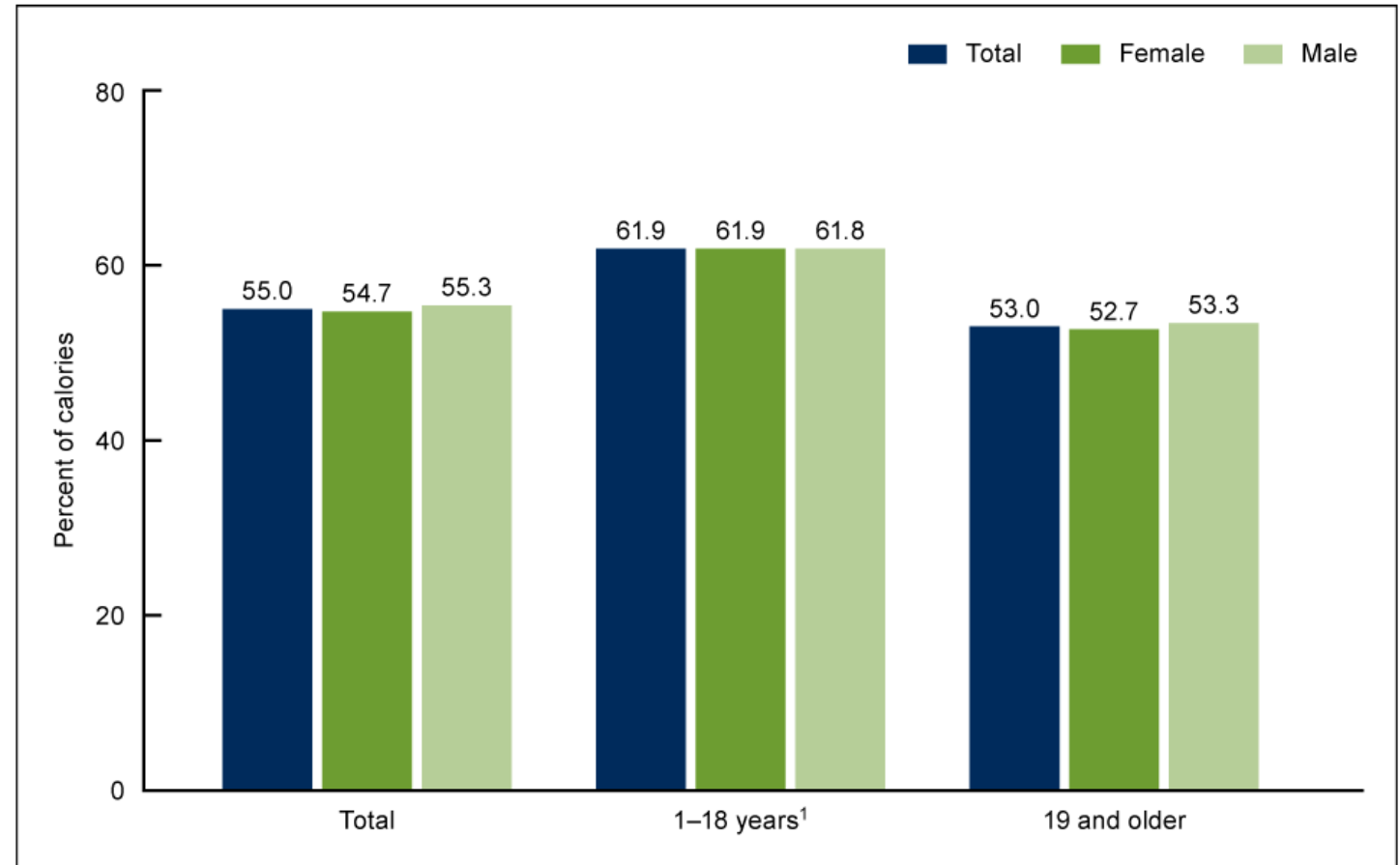
Du S, Sullivan VK,
Fang M, Appel LJ,
Selvin E, Rebholz CM.
Ultra-processed food
consumption and risk
of diabetes: results
from a population-
based prospective
cohort. Diabetologia.
2024 Oct;67(10):
2225-2235

- 15,792 middle-aged adults with representation of men and women, across racial groups, age, and socioeconomic factors of four geographically diverse US communities
- A higher intake of ultra-processed food was associated with a higher risk of incident diabetes, particularly sugar- and artificially sweetened beverages, ultra-processed meats, and sugary snacks
- Interventions reducing ultra-processed food consumption and specific food groups may be an effective strategy for diabetes prevention

Ultra-processed Food Consumption in Youth and Adults: United States, August 2021–August 2023

- During August 2021–August 2023, the mean percentage of total calories consumed from ultra-processed foods among those age 1 year and older was 55.0%
- Youth ages 1–18 years consumed a higher percentage of calories from ultra-processed foods (61.9%) than adults age 19 and older (53.0%)

Figure 1. Mean percentage of total calories from ultra-processed foods consumed by youth and adults, by sex: United States, August 2021–August 2023



¹Significantly different from adults.

NOTE: Ultra-processed food is based on the Nova classification.

SOURCE: National Center for Health Statistics, National Health and Nutrition Examination Survey, August 2021–August 2023.

American advertising



Today's obese / pre-diabetics are tomorrow's diabetics



Glycemic index (GI)

- GI is a ranking of carbohydrates on a scale (0 to 100) based on how quickly they raise blood sugar levels after eating
- High GI foods are absorbed quickly, with a rapid rise in blood sugar, while those with a low GI are absorbed more slowly, resulting in a more gradual rise
- Low GI: (1 to 55)
- Medium GI: (56 to 69)
- High GI: GI (70 and higher)
- Glucose has a GI of 100



Glycemic Load (GL) Wolever and David Jenkins 1981

- GL considers both the GI of a food and the amount of carbohydrates in a typical serving
- It provides a more comprehensive and realistic picture of how a specific food will impact your blood sugar when consumed in a normal portion size
- $GL = (GI \times \text{grams of carbohydrate}) / 100$
- Low GL: 10 or less
- Medium GL: 11-19
- High GL: 20 or more

Food ▼	Glycemic index ◆	Carbohydrate content (g) ◆	Glycemic Load (100 g serving) ◆	Insulin index ◆
Watermelon	72 (high)	5	<4	—
Rice, boiled white, mean of 12 studies	64 – 93 ^[19]	25 ^[19]	16 – 23 ^[20]	40 ± 10 ^[19] – 55 ± 8 ^[17] – 67 ± 15 ^[19]
Potato, mean of 5 studies	50 (low) – 99 ± 25 (high) ^[17]	19	9 – 18 ± 5 ^[18]	85 ± 8 ^[17]
KFC Chicken	145 (high)	11	5.7	—
Corn tortilla	52 (low)	48	25	—
Cherry, fresh	22	48	3 ^[23]	
Carrots, mean of 4 studies	47 (low)	8	<4	—
Cabbage	10 (low)	5.9	<1	—
Banana, Mean of 10 studies	52 (low) – 55 ± 7 (low–medium) ^[17]	20	10 – 11 ± 1 ^[18]	57 ± 4 ^[17]
Baguette, white, plain	95 (high)	50	48	—
Apricot	57	31	4 ^[22]	
Apple	38	47	4 ^[21]	

Even if you read the labels

These do not show up as sugars
can be labeled as “natural sweeteners” and “no added sugars”

Brown Rice Syrup

- GI of 98
- 100% glucose-based
- High insulin response
- Seen in Granola bars, Organic snacks, Plant-based protein bars

Dextrose

- GI of 100
- Chemically identical to glucose
- Strong insulin response
- Seen in Sports drinks, Processed foods, and Candy

The image shows two nutrition labels. The top label is for 'Blueberries' with a serving size of 100g/3.5oz. The bottom label is partially visible and appears to be for rice, with a serving size of 1 cup (160g/5.7oz). Both labels show 'Sugars' as 10g and 10% of the daily value, respectively.

Amount	% Daily Value
Calories 56	
Calories from Fat 3	
Total Fat 0.5 g	1%
Saturated Fat 0 g	0%
Trans Fat 0 g	
Cholesterol 0 mg	0%
Sodium 4 mg	1%
Carbohydrate 14 g	5%
Fiber 2.5 g	10%
Sugars 10 g	

Amount	% Daily Value
Calories 371	
Calories from Fat 14	
Total Fat 2 g	3%
Saturated Fat 0 g	
Trans Fat 0 g	
Cholesterol 0 mg	
Sodium 11 mg	
Carbohydrate 10 g	
Fiber 24 g	
Sugars 10 g	

Maltodextrin

- GI of 105-136 Higher than glucose (100)
- Technically not a sugar, but our body treats it the same as glucose
- Sharp blood sugar and insulin spike
- Seen in Protein powders, “Diet” foods, Salad dressings and sauces
- Sugar-free candies, Sports drinks

Maltose/Barley Malt Syrup/Malt Extract/ Malted Barley

- GI of 105-110 is Higher than glucose
- Quickly absorbed into the bloodstream, spikes insulin to bring down blood sugar levels
- Seen in bagels, pretzels, and crackers
- Beer, breakfast cereals, malted milkshakes



Turbinado

- GI of 65
- “Minimally processed cane sugar”
- Made of mostly sucrose
- Raises blood sugar the same way table sugar does

Cane Syrup

- Mostly sucrose (extracted juice from sugarcane)
- GI of 60-65
- Causes a moderate to high insulin spike
- Seen in baked goods, sauces, and sweetened beverages

Dextrin

- GI of 85-100
- Less broken down than maltodextrin
- Rapidly absorbed into the bloodstream, high insulin spike
- Seen in sports drinks

Fruit juice concentrate

- GI of 40–70
- Mostly glucose + fructose
- Moderate-to-strong insulin spike
- Commonly found in “no added sugar” foods
- Seen in granola bars, fruit snacks, and yogurt

Fruit Nectar

- GI of 50-70
- Moderate to significant insulin spike
- Contains natural fruit sugars + added sugar like HFCS and cane sugar
- Seen in smoothies, mixers, and fruit drinks

Molasses

- GI of 55
- Lower than sucrose, but still causes an insulin spike (moderate)
- Used for baking
- Sweetening sauces and marinades

Agave Syrup/ Agave Nectar

- Lower GI of 15-30
- Contains high levels of fructose (70%)
- High fructose intake leads to insulin resistance
- Seen in “Naturally sweetened” foods
- “Organic” foods, “Diabetic friendly” foods

Maltitol

- GI of 35-52
- Sugar alcohol derived from maltose
- Seen in sugar free chocolate and candy
- Moderate increase in blood sugar and insulin
- Low-carb foods, protein bars

So, what does all this have to do with dentistry?

- Periodontitis is a chronic inflammatory disease
- Odontogenic abscesses are an acute and chronic inflammatory disease
- The oral cavity is connected to the body

Common oral complications of DM

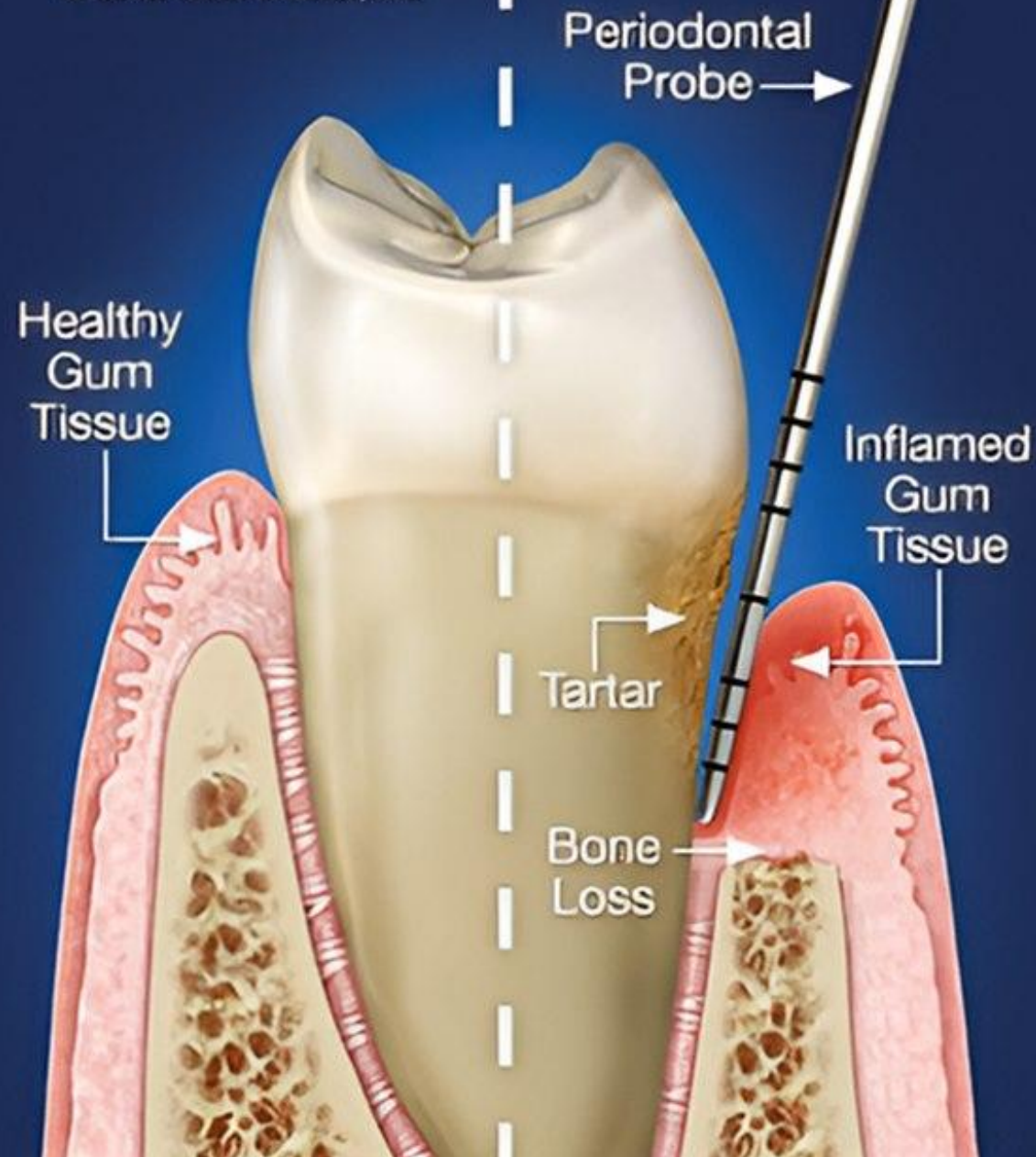
- Gum disease (periodontitis)
- Caries
- Xerostomia
- Oral ulcerations
- Fungal infection (candida albicans)
- Burning mouth / tongue (glossodynia)
- Altered taste (dysgeusia)

Periodontitis

- A chronic inflammatory disease
- Periodontitis is a leading cause of tooth loss
- Poor oral hygiene, diabetes, and smoking are etiologic factors
- Nearly half (42%) of all adults aged 30 years and older have periodontitis. Severe periodontitis affects about 8% of adults



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The Health Risks Of Periodontal Disease

Oral health affects much more than teeth. Many health problems can be aggravated as a result of poor oral hygiene, including:

Stroke

- Research shows that people with severe periodontitis are at twice the risk of suffering a stroke than those with good oral health.

Heart Disease

- Oral bacteria can enter the bloodstream and contribute to clot formation, increasing the risk for heart attacks.
- Inflammation from periodontal disease can also contribute to swelling of the arteries.
- Studies show that people with periodontal disease are almost twice as likely to suffer from coronary artery disease as those without periodontal disease.

Osteopenia

- Periodontitis has been linked to bone loss as well as tooth loss.
- Studies show that women with periodontal bacteria in their mouths are more likely to have bone loss in the oral cavity, which can lead to tooth loss if not treated.

Diabetes

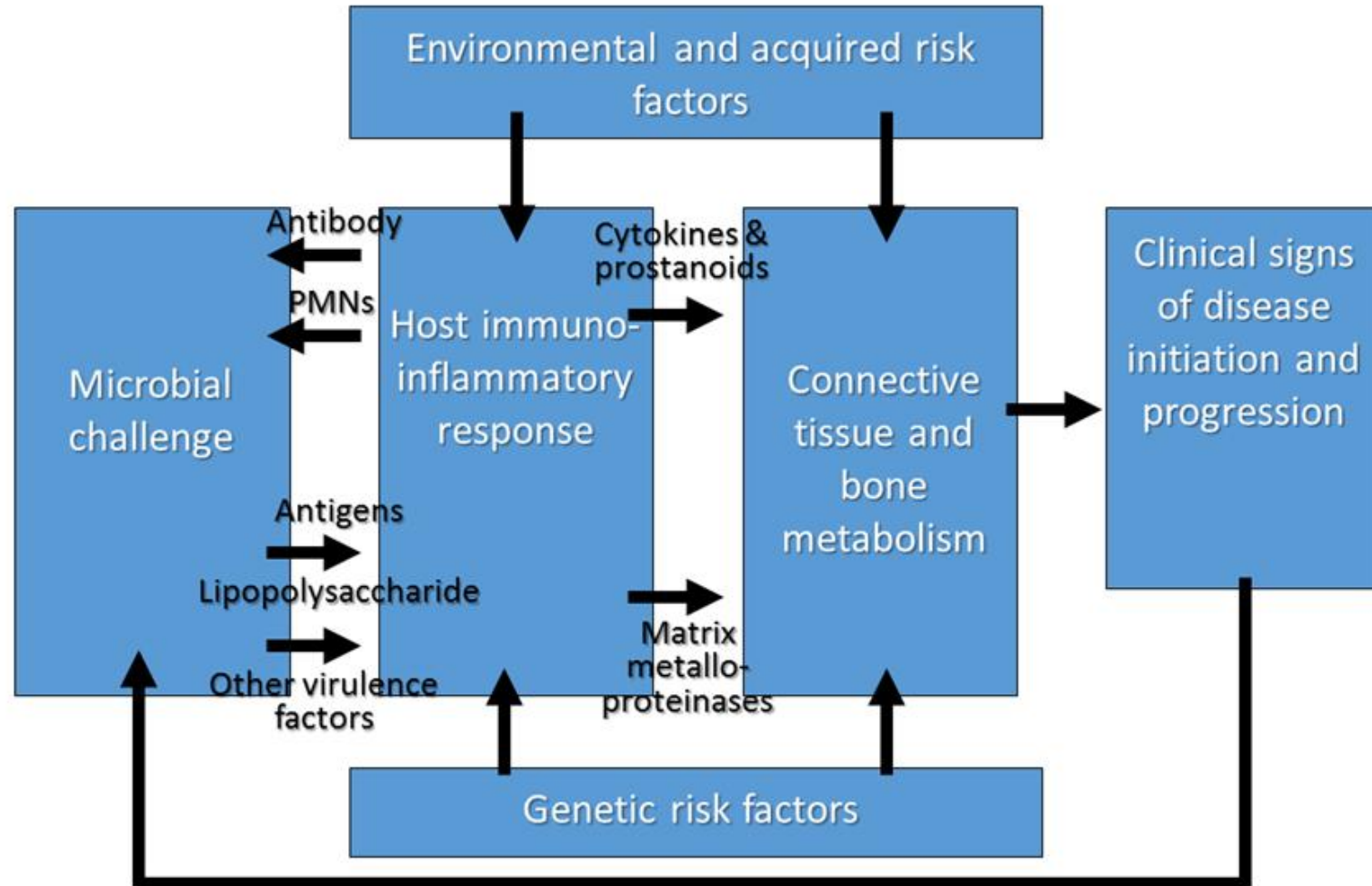
- Periodontal disease can negatively affect blood glucose control, contributing to the development of diabetes.
- Research also shows that periodontal disease can have an adverse effect on metabolism, affecting insulin production, which can lead to pre-diabetes.
- Diabetic smokers have a 20 time greater chance of tooth loss.
- Respiratory Infections
- Oral bacteria can be aspirated into the lungs to cause pneumonia, especially in people with periodontal disease.

Prenatal Issues

- Periodontal disease has been linked to low birth weight and preterm labor.
- 50 percent of pregnant women experience "pregnancy gingivitis." This results from frequent snacking, especially on sugary foods, and can cause periodontal disease.

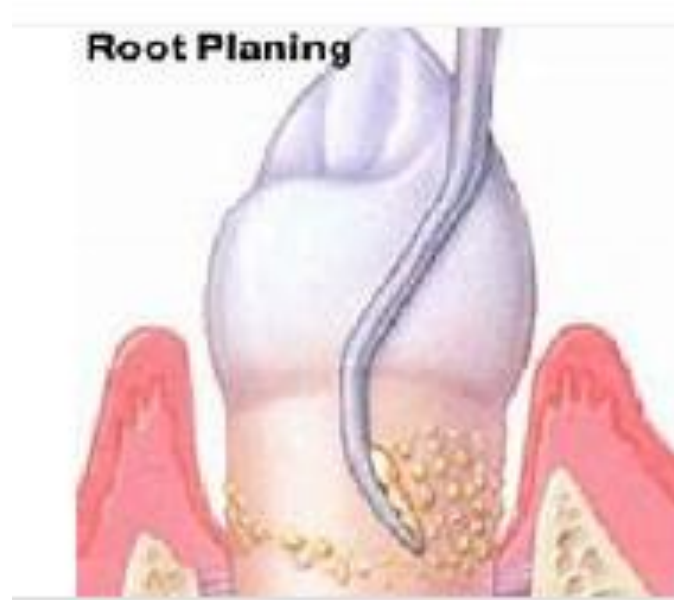
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Pathophysiology of periodontitis

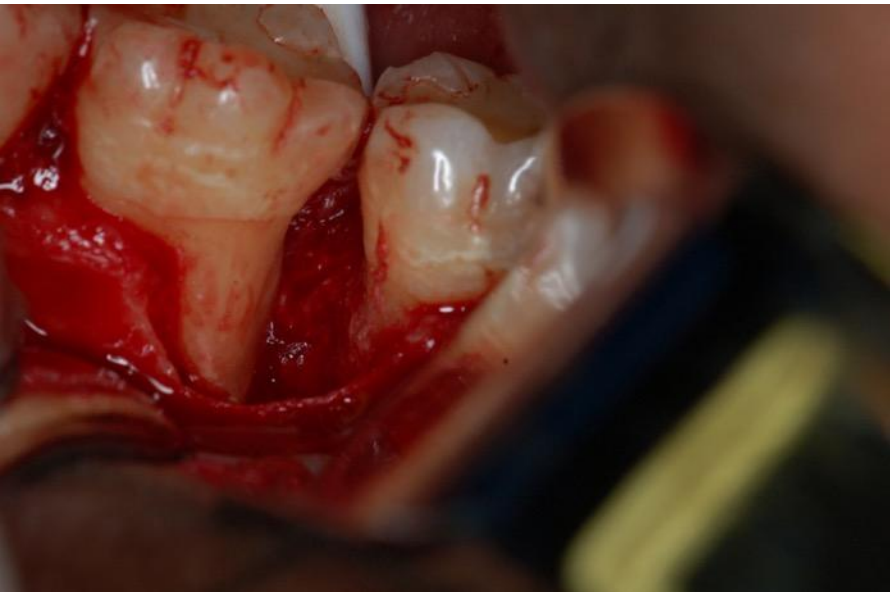
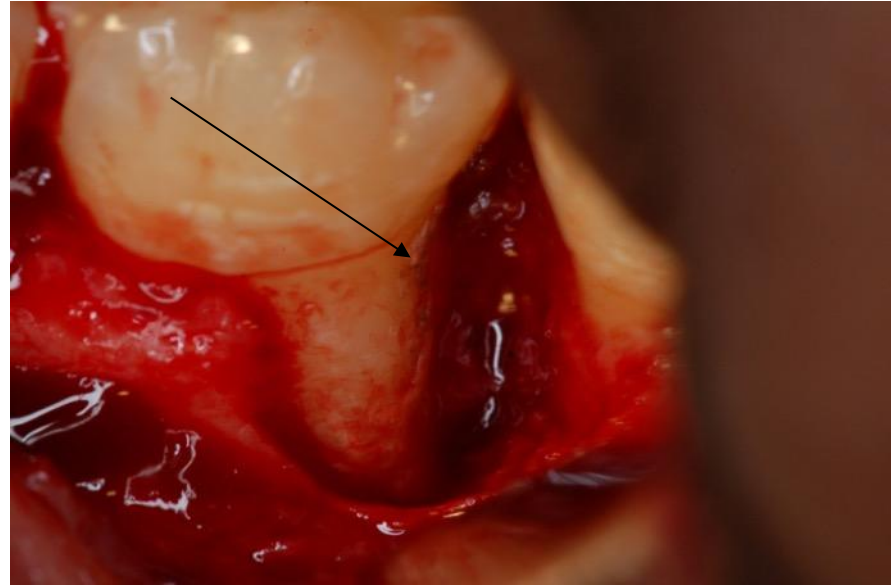
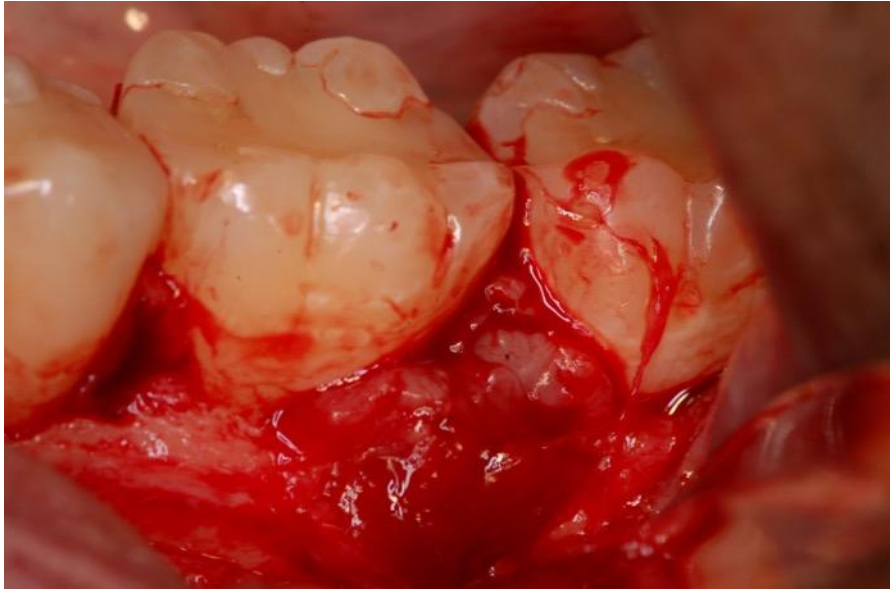


Treatments

- Scaling and root planning (Deep cleaning)
- Surgical therapy



Periodontal regeneration



Periodontal regeneration

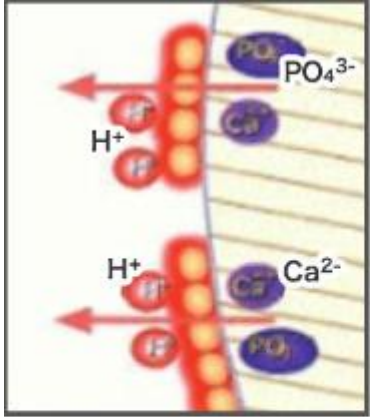


Periodontitis

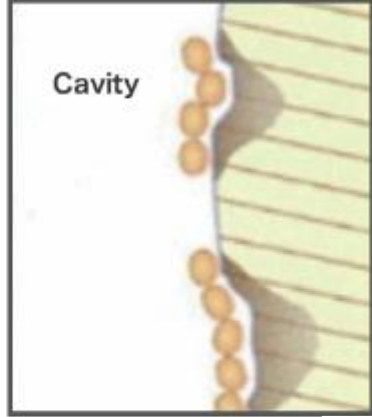
- Because periodontitis is associated with diabetes, screening in a dental setting and referral to primary care is a prudent step to improve the diagnosis of prediabetes and diabetes



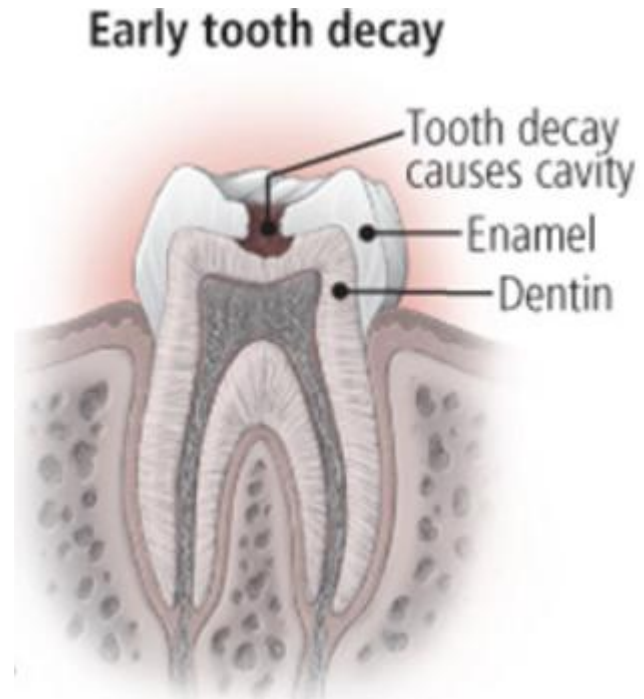
Cavity (caries)



Decalcification due to acid produced by cariogenic bacteria



Cavity formation



Treatment

- Fillings
- Crowns
- Root Canal Treatment
- Extraction
- Replacement with bridges or dental implants



Xerostomia

Dryness of the mouth due to a change in the composition or amount of saliva

- Xerostomia results in a higher caries rate
 - Xerostomia affects 34% – 51% of patients
 - 50% of persons aged older than 75 years of age have root caries affecting at least one tooth
 - Cost of a 1 surface filling \$80.00 - \$130.00
 - Cost of a crown is over \$1,200.00
-
- <https://www.ada.org/en/member-center/oral-health-topics/xerostomia>
 - Cicmil S, Mladenović I, Krunic J, Ivanović D, Stojanović N. Oral Alterations in Diabetes Mellitus. Balk J Dent Med. 2018;22:7–14.
 - <https://www.ada.org/en/member-center/oral-health-topics/aging-and-dental-health>

Xerostomia

- Avoid sugar-sweetened beverages
- Use of saliva-stimulating products
 - Sugarless sour candies
 - Biotene (glucose oxidase, lactoferrin, lactoperoxidase)
 - Salagen (Pilocarpine) Tabs 5mg TID or QID

Oral ulcerations and type II diabetes

- Prevalence of oral lesions was 78.4%
- Traumatic ulcers (16.4%)
- Actinic cheilitis (12.7%)
- The lips (35.3%) and tongue (23.5%) were the most common locations

Silva MF, Barbosa KG, Pereira JV, Bento PM, Godoy GP, Gomes DQ. Prevalence of oral mucosal lesions among patients with diabetes mellitus types 1 and 2. An Bras Dermatol. 2015 Jan-Feb;90(1):49-53.



Candida Albicans (Thrush)



Candida Albicans infection

- First described in 1838 by pediatrician Dr. Francois Veilleux
- Candida is part of the normal oral microflora
- The condition is generally obtained secondary to immune suppression
- Forms:
 - Chronic erythematous candidiasis
 - Angular cheilitis
 - Median rhomboid glossitis
 - Linear gingival erythema
- Treated with anti-fungal medications(Nystatin, Diflucan)



Image Courtesy of M. McGinnis
Copyright © 2000 Doctorfungus Corporation

Burning mouth/tongue syndrome

(Idiopathic burning sensation in the mouth)

- First, remove all known causes (candida albicans, iatrogenic, idiopathic)
- Magic Mouth rinse (Maalox, Benadryl, Nystatin)
- Decadron (dexamethasone) Elixir 0.5mg/5ml
- Klonopin (clonazepam) 0.5 – 2.0 mg Tabs/wafers 0.5 – 4.0mg per day
- Elavil (amitriptyline) 50mg before bed

Altered taste (Dysgeusia)

- Taste disorders like ageusia (taste loss), hypogeusia (decrease in taste), and dysgeusia (abnormal taste) form an important but neglected part of the presentation of DM
- Possibly related to the xerostomia
- Specific cause for taste sense alteration is not known
 - Neuropathy involving taste nerve tracts and microangiopathy involving taste buds?



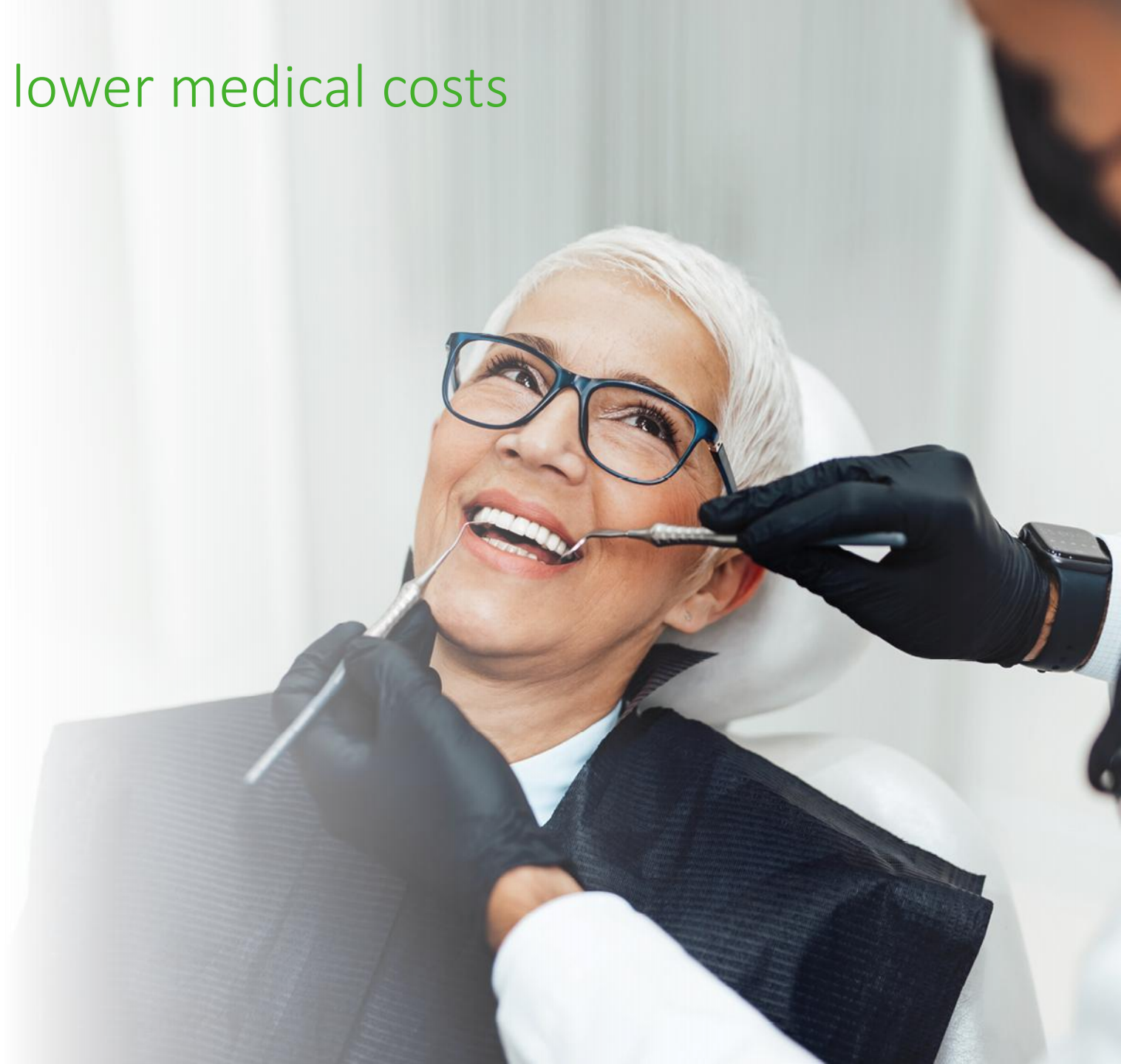
Bhandare NN, Keny MS, Nevrekar RP, Bhandare PN. Diabetic Tongue - Could it be a Diagnostic Criterion? J Family Med Prim Care. 2014 Jul;3(3):290-1.

Le Floch JP, Le Lievre G, Sadoun J, Perlemuter L, Peynegre R, Hazard J. Taste impairment and related factors in type I diabetes mellitus. Diabetes Care. 1989;12:173-8.

Bajaj S, Prasad S, Gupta A, Singh VB. Oral manifestations in type-2 diabetes and related complications. Indian J Endocrinol Metab. 2012;16:777-9.

Perros P, MacFarlane TW, Counsell C, Frier BM. Altered taste sensation in newly-diagnosed NIDDM. Diabetes Care. 1996;19:768-70

Improving oral health yields lower medical costs



Is there evidence that periodontitis increases medical costs?

Aetna/Columbia

- Diabetes = \$0.27 pmpm
- Coronary artery disease = \$0.37 pmpm
- Stroke = \$0.44 pmpm

Albert DA, et al. An examination of periodontal treatment and pmpm medical costs in an insured population. BMC Health Services Research, 2006.

**University of
Michigan/
Delta Dental**

**2,000-member group—
gum disease/diabetes**

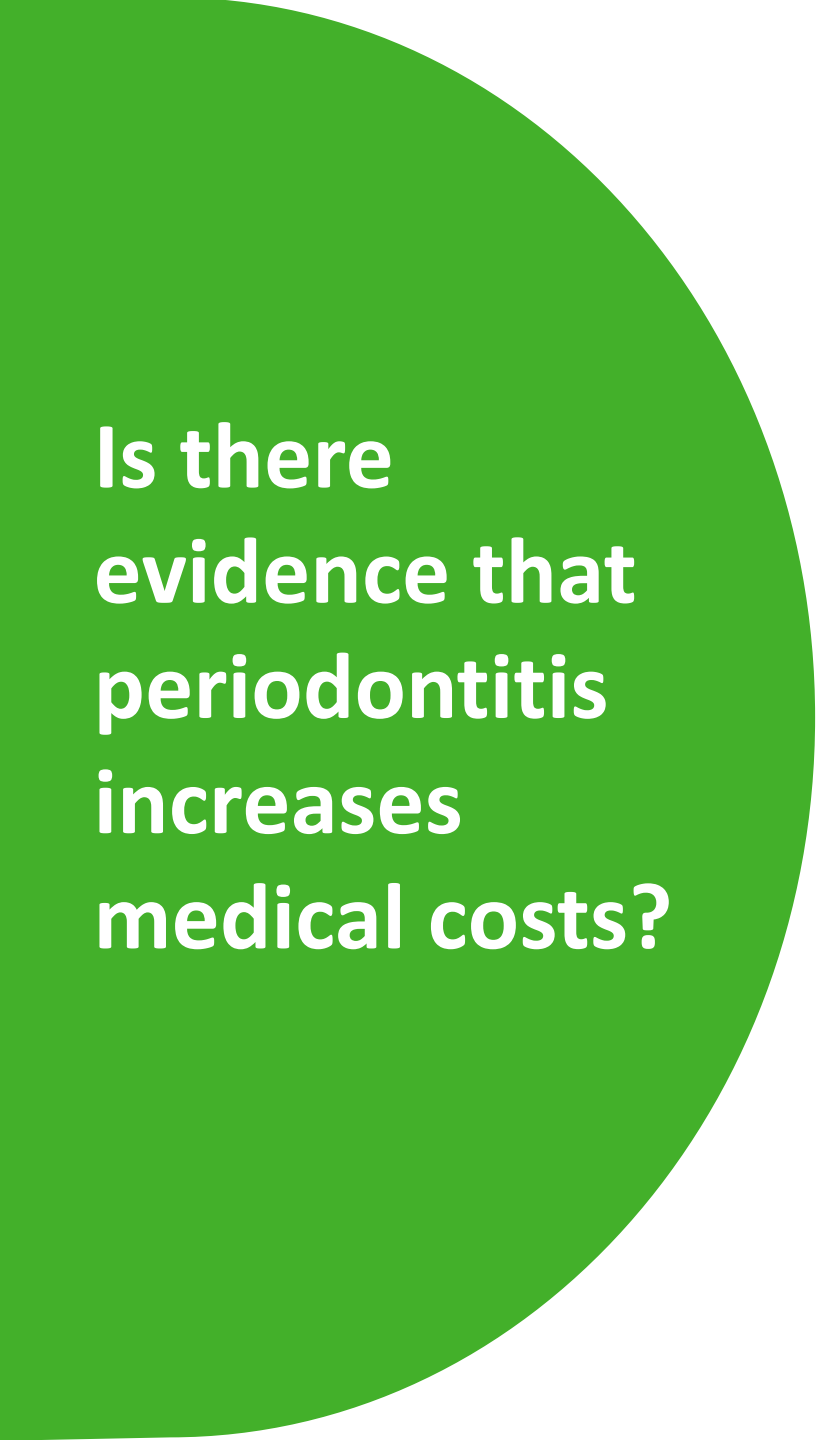
**Medical and
pharmaceutical costs**

- Two cleanings per year—19% reduction
- More than two cleanings per year—28% reduction

Is there
evidence that
periodontitis
increases
medical costs?

Cigna/Penn

- Stroke = \$10,000/year less
- Diabetes = \$1,418/year less

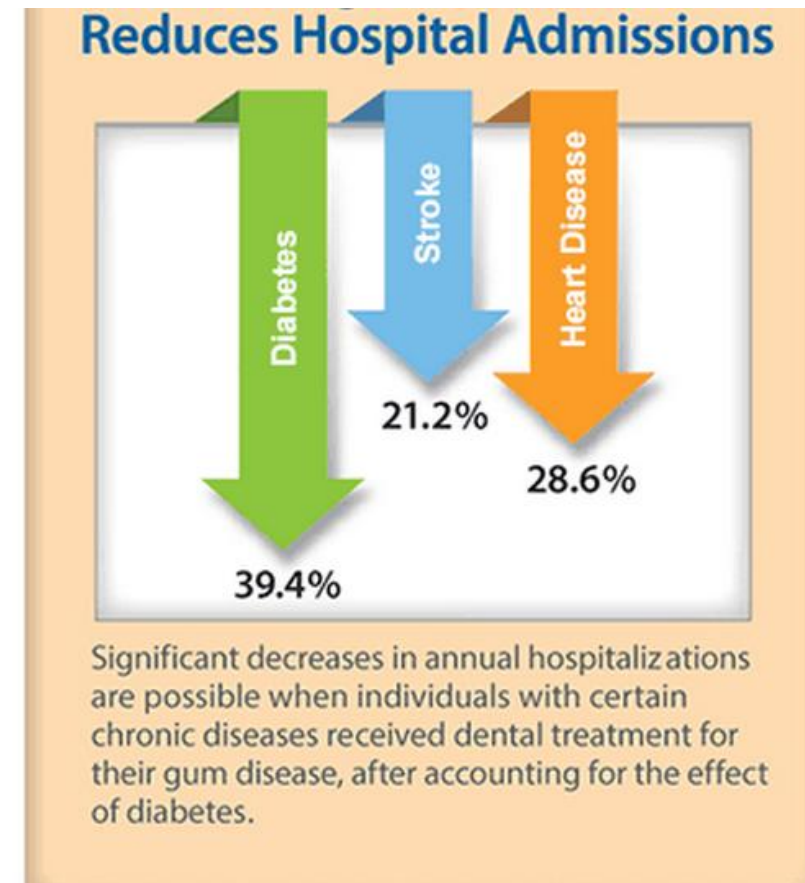
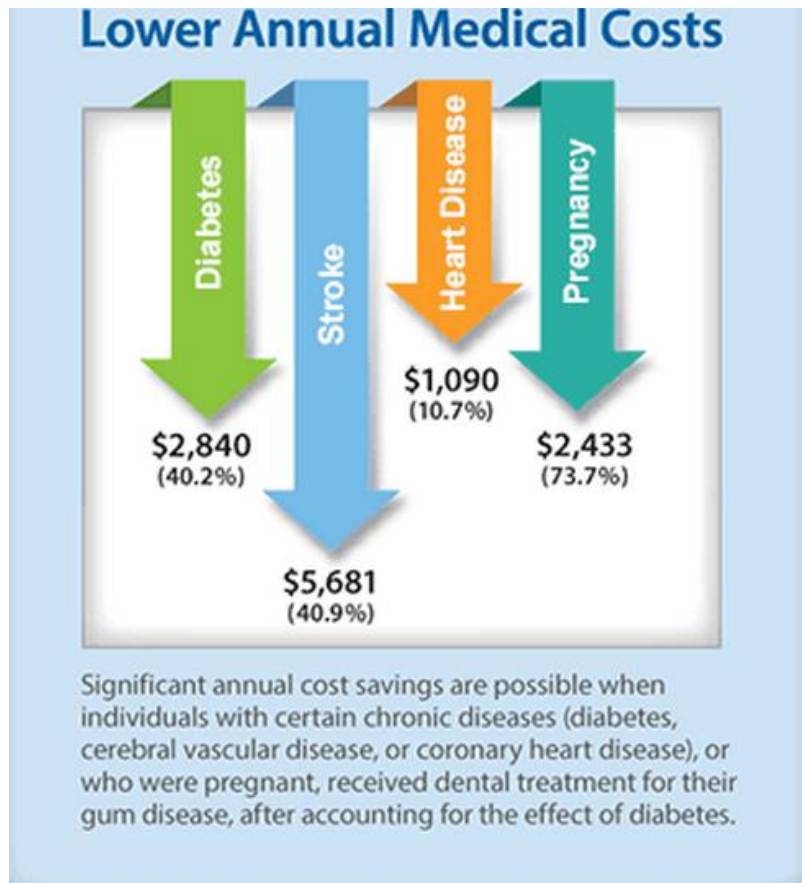


Is there
evidence that
periodontitis
increases
medical costs?

University of Michigan/BCBS

- Overall, medical and pharmacy costs lowered by 10% in the treatment group
- 19% reduction in diabetes-related medical costs

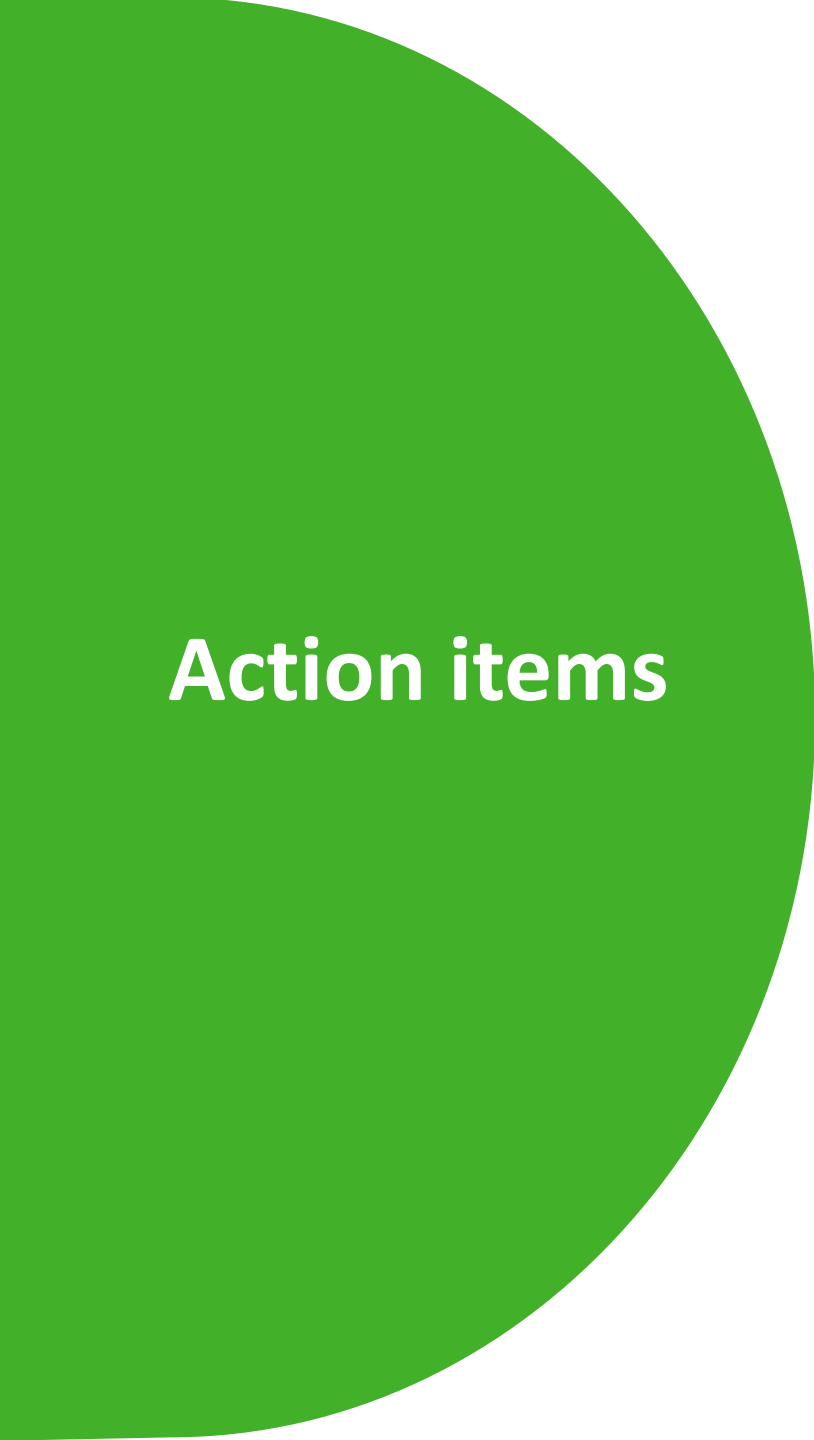
Can treatment of gum disease reduce medical costs?



**Periodontal
treatment
associated with
decreased diabetes
mellitus–related
treatment costs:
An analysis of
dental and medical
claims data**

An analysis of commercial insurance and Medicaid databases found a 12% and 14% decrease, respectively, in overall health care costs for people with diabetes who had received periodontal treatment, compared with people who didn't receive treatment.

Periodontal treatment associated with decreased diabetes mellitus–related treatment costs An analysis of dental and medical claims data Madhuli Thakkar-Samtani, BDS, MPH Lisa J. Heaton, PhD Abigail L. Kelly, MS Shelly Dionne Taylor, DMD, MPH Linda Vidone, DMD Eric P. Tranby, PhD JADA VOLUME 154, ISSUE 4, P283-292.E1, APRIL 2023



Action items

Prediabetes and type 2 diabetes can be prevented with lifestyle changes

- Weight control
- Sugar intake (frequency and volume)
- Active lifestyle (exercise)

Recognition of dental cofactors



Summary

- Inflammation is a consideration in DM
- The mouth is connected to the body
- Systemic disease affects the mouth and vice versa
- Prevention through lifestyle changes is less expensive than treatment
- Oral health is a vital component of overall health

Fluoride
Should it be
added to our
water?



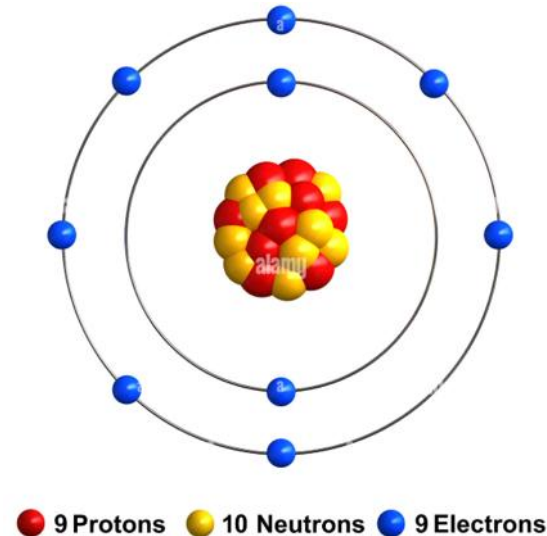


1901 -1931

-
- Dr. Fredrick McKay investigated the cause of Colorado Brown Stain
 - City residents did not have the stain
 - Stained teeth were resistant to decay
 - Population of Bauxite, Arkansas also had the brown stain
 - Photospectrographic analysis showed the water contained high amounts of Fluoride

What is fluoride?

- Monatomic anion of fluorine, a naturally occurring element
- Ferdinand Moissan, a French chemist, isolated fluorine in 1886.
- 13th most abundant element on earth (CaF)
- Fluoride in a negatively charged ion, therefore reacts with calcium in the teeth and bones
- Found in the ocean, ground water, plants
- Sodium hexafluorosilicate added to drinking water



January 25, 1945



- Grand Rapids became the first city in the world to fluoridate its drinking water
- Muskegon was the control group
- 15-year project, researchers monitored the rate of tooth decay among Grand Rapids' almost 30,000 schoolchildren
- The caries rate among Grand Rapids children born after fluoride was added to the water supply dropped more than 65 percent
- 1951, Muskegon withdraws from the fluoridation trial and begins fluoridating its water

1962

Federal drinking water standards are updated, now including fluoride guidelines with recommended and maximum levels.

The standards incorporate a sliding scale to account for higher water consumption in warmer weather, adjusting fluoride levels accordingly.

The optimal fluoride concentration ranges from 0.7 ppm to 1.2 ppm, contingent on the local climate.

Legislative changes

Safe Drinking Water Act (SDWA)

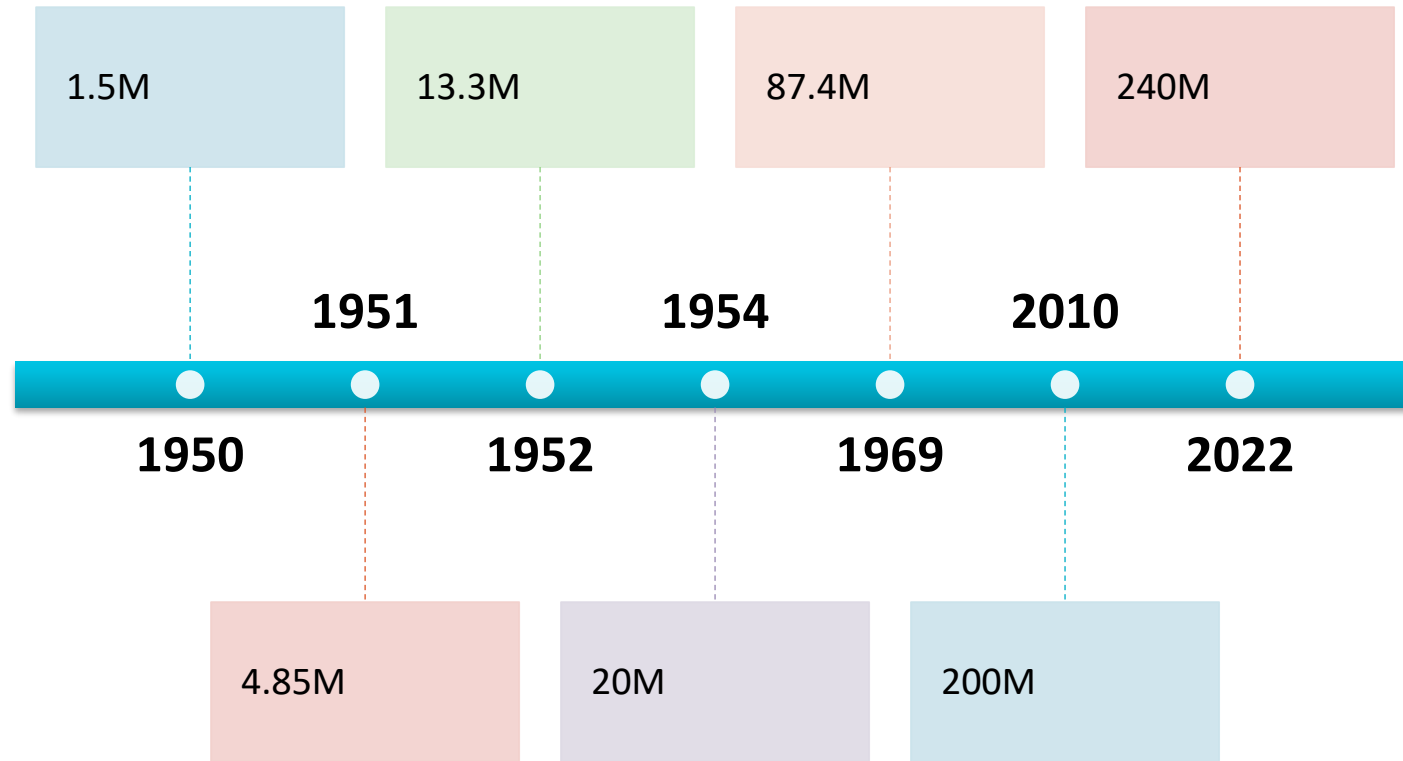
- EPA can't mandate adding substances for health benefits, only requiring additives necessary for safe water.
- SDWA designates drinking water fluoridation as a state, not federal, responsibility.

1974

1978

The U.S. Surgeon General moves the National Fluoridation Program to the Centers for Disease Control (CDC).

USA population on fluoridated water



Facts

- “One of 10 great public health achievements of the 20th century”
 - Tom Frieden, MD, MPH, CDC 2016
- Fluoride adverse affects begin at levels above 1.5 ppm
- The efficacy of fluoridated water has dropped from 65% to 25% due to:
 - Improved oral hygiene
 - Sealants
 - Fluoridated toothpaste (1955)
 - Increased utilization of dental services due to dental benefits
 - Dental awareness (bottle mouth syndrome, in-between meal snacks)

76 Years of research has shown water fluoridation reduces cavities in children

- Community Preventive Services Task Force. Dental caries (cavities): community water fluoridation. The Community Guide. Accessed January 30, 2024. <https://thecommunityguide.org/findings/dental-caries-cavities-community-water-fluoridation.html>
- https://ec.europa.eu/health/scientific_committees/opinions_layman/fluoridation/en/l-3/5.htm#0
Retrieved 2024
- Iheozor-Ejiofor Z, Worthington HV, Walsh T, O'Malley L, Clarkson JE, Macey R, et al. (June 2015). "Water fluoridation for the prevention of dental caries". The Cochrane Database of Systematic Reviews.
- Parnell C, Whelton H, O'Mullane D (September 2009). "Water fluoridation". European Archives of Paediatric Dentistry. 10 (3): 141–148.
- Kohn WG, Maas WR, Malvitz DM, Presson SM, Shaddix KK; Centers for Disease Control and Prevention (U.S.); National Center for Chronic Disease Prevention and Health Promotion (U.S.). Division of Oral Health. Recommendations for using fluoride to prevent and control dental caries in the United States. MMWR Recomm Rep. 2001;50(RR-14):1–30.

The upper limit of fluoride intake from all sources is 0.10 mg/kg/day for infants and children to 8 years old.
For adults, the upper limit is 10 mg/day regardless of weight.

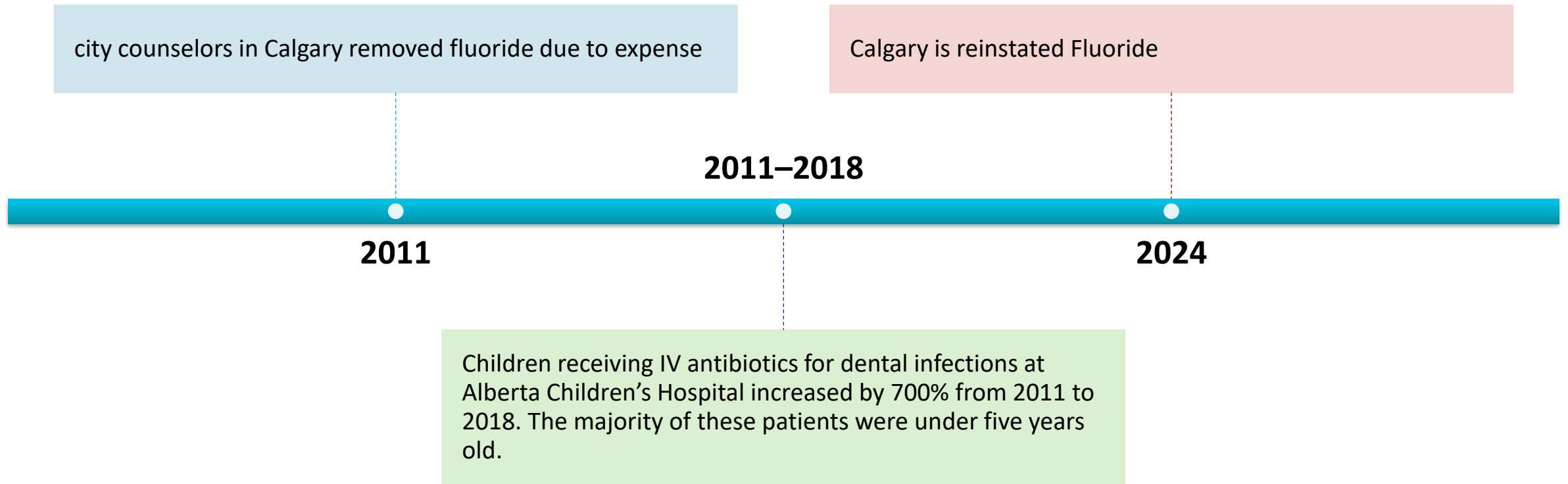
Food/Drink	Fluoride (mg per 1000g/ppm)	Portion	Fluoride (mg per portion)
Black tea (brewed)	3.73	1 cup, 240 g (8 fl oz)	0.884
Raisins, seedless	2.34	small box, 43 g (1.5 oz)	0.101
Table wine	1.53	Bottle, 750 mL (26 imp fl oz)	1.150
Municipal tap-water, (Fluoridated)	0.81	Recommended daily intake, 3 litres (0.79 US gal)	2.433
Baked potatoes, Russet	0.45	Medium potato, 140 g (0.31 lb)	0.078
Lamb	0.32	Chop, 170 g (6.0 oz)	0.054
Carrots	0.03	1 large carrot, 72 g (2.5 oz)	0.002

U.S. Dept. of Agriculture
LD50 = 5 – 10 gm

What do other countries do?

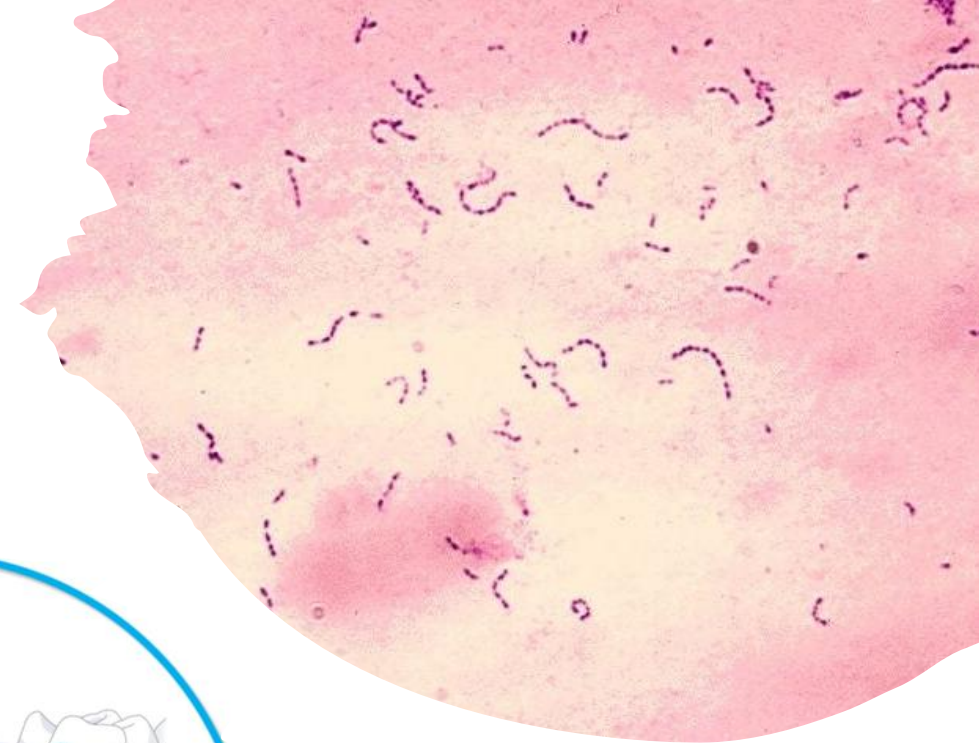
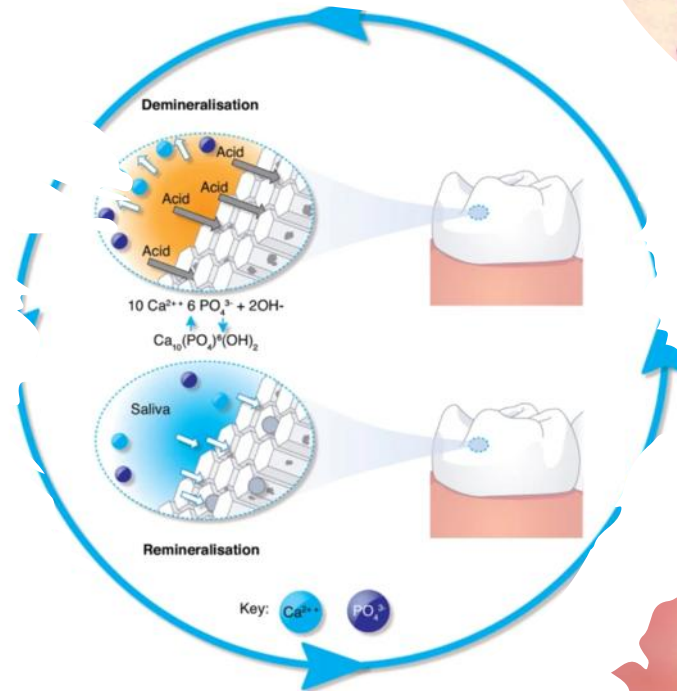
- 25 countries have supplemental water fluoridation
 - Ireland, New Zealand, Australia, Brunei, Chile, Brazil, Malaysia, New Zealand, Parts of the UK, Hong Kong and Singapore
 - Certain parts of Canada (Moosejaw, Windsor and Saskatchewan) (Windsor saw a 50% increase in caries when they stopped)
- UK fluoridates milk
- Italy dispenses fluoride tablets
- Switzerland (parts), Venezuela and Mexico fluoridates salt
- 28 countries have water that is naturally fluoridated
 - Many countries do not use fluoride since their water is naturally 0.8ppm

Calgary, Canada had seen enough



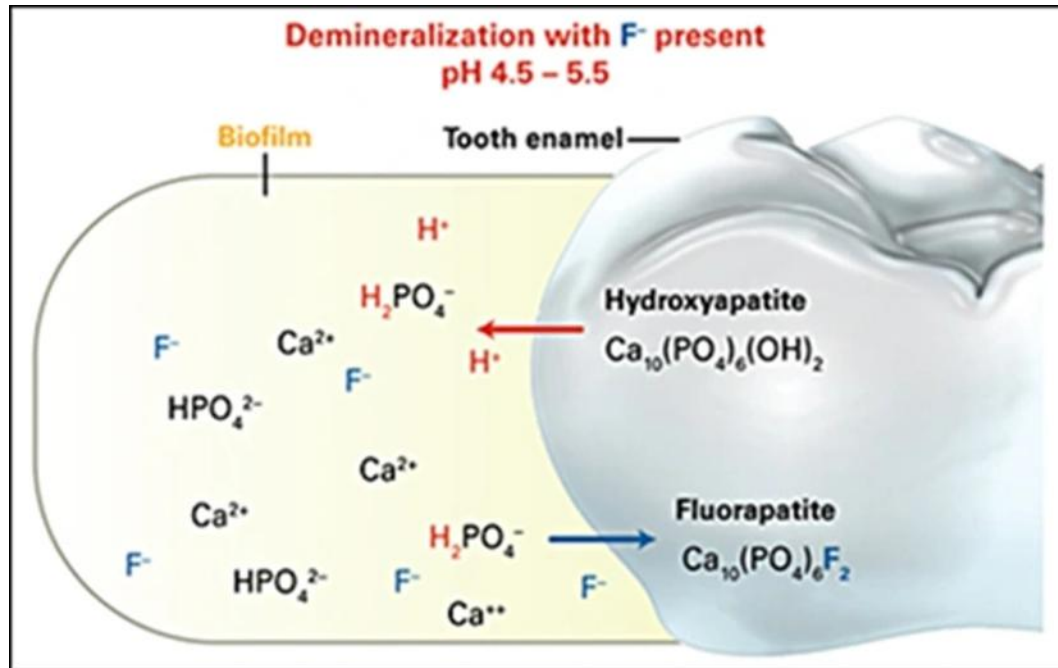
What is the cause of dental caries (cavities)?

- In 1924, J. Clarke isolated *Streptococcus mutans* from carious lesions
- *S. mutans* converts sugar to Lactic acid
- Lactic acid breaks down enamel by removing the hydroxyl groups that bind the Ca and P ions in enamel
- The enamel matrix breaks down, thus creating a hole or “cavity”



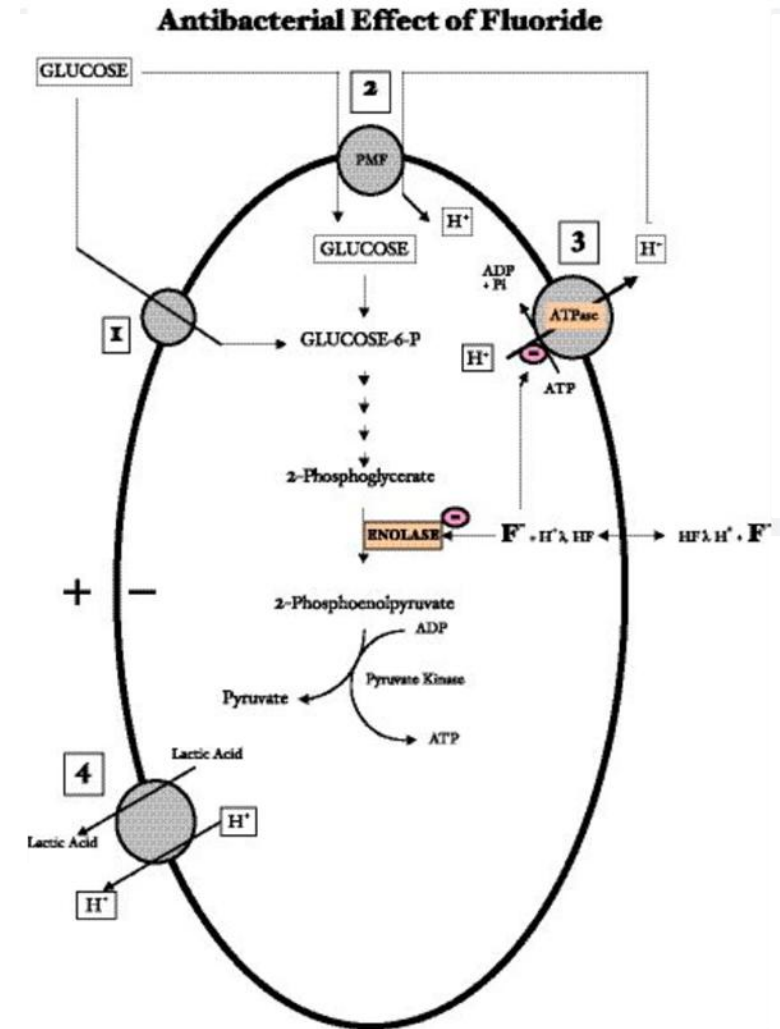
How does fluoride prevent dental caries?

1. Incorporates into enamel as tooth is formed, more resistant to acid



How does fluoride prevent dental caries?

2. Interferes with *S. mutans* ability to form acid
3. Topical antimicrobial by inhibition of glycolysis



Adverse effects of fluoride



Fluorosis



Long bone, vertebral fracture (Skeletal Fluorosis)



Cognitive impairment (Lower IQ)

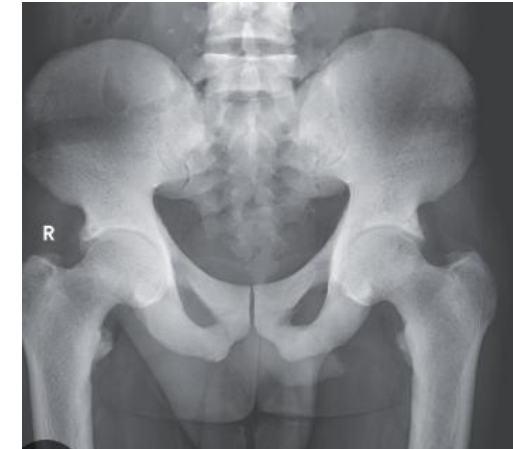
Fluorosis



Skeletal fluorosis

- As fluoride accumulates in the bones it begins to negatively alter processes of bone formation and resorption- affecting the entire skeleton. Gradually bones become weaker and more brittle, while joints increase in pain and stiffness due to skeletal changes.

Skeletal Fluorosis Stages	Fluoride Concentration (mgF/kg)	Symptoms and Signs
Pre-Skeletal	<3500	Symptoms can start at this phase, without an increase in bone mass (arthritis of spine, hands and fingers)
Pre-Clinical Stage	3,500 to 5000	Increase in bone mass, generally no symptoms but stages 1 and 2 symptoms may start to emerge.
Stage 1	6,000 to 7000	Infrequent pain, stiffness of joints, osteosclerosis of pelvis and vertebral column.
Stage 2	7,500 to 9,000	Chronic joint pain, arthritis symptoms, sight calcification of ligaments, and osteosclerosis of cancellous bones.
Stage 3	8,400	Crippling skeletal fluorosis; mobility is significantly affected due to excessive calcification in joints, ligaments and vertebral bodies.



Do the math:

170lbs = 77.1kg

$77.1 \times 3,500 = 269,850 \text{ mg}$

$269,850 / 2.43 = 111,049 \text{ gal of water}$

$111,049 / 365 = 304 \text{ years}$

Cognitive impairment (lower IQ)

- Brain development begins in the third gestational week and is more susceptible to injury by toxins than the mature brain
 - High fluoride exposure might be associated with negative cognitive outcomes in children. However, more longitudinal studies with high methodological quality are needed on this topic
 - Negative association between fluoride exposure and cognitive outcomes appears to be stronger at high levels of fluoride exposure (≥ 2 mg/l) compared to lower levels (< 2 mg/l)
 - Scientific basis for its adverse non-dental health outcomes is contradictory and inconclusive
-
- Gopu BP, Azevedo LB, Duckworth RM, Subramanian MKP, John S, Zohoori FV. The Relationship between Fluoride Exposure and Cognitive Outcomes from Gestation to Adulthood-A Systematic Review. Int J Environ Res Public Health. 2022 Dec 20;20(1):22. doi: 10.3390/ijerph20010022. PMID: 36612346; PMCID: PMC9819484.

Concerns with previous literature reviews

- Child cognitive development is complex, influenced by several physiological and environmental factors
- Poverty, nutritional deficiencies, and inadequate learning opportunities are confounding factors
- Inconsistent reporting across different studies using various assessment tools and units
- No studies considered iodine deficiency, which represents the greatest single cause of brain damage globally. It was associated with a global loss of 10–15 IQ points at a population level

Other diseases

- No evidence in the scientific literature linking community water fluoridation with any potential adverse health effects or systemic disorders such as:
 - Cancer
 - Downs syndrome
 - Heart disease
 - Osteoporosis and bone fracture
 - Immune disorders
 - Low intelligence
 - Renal disorders
 - Alzheimer disease
 - Allergic reactions

Opposition started in the 1940s

Conspiracy theorists claimed that fluoridation was a communist plot to undermine American public health

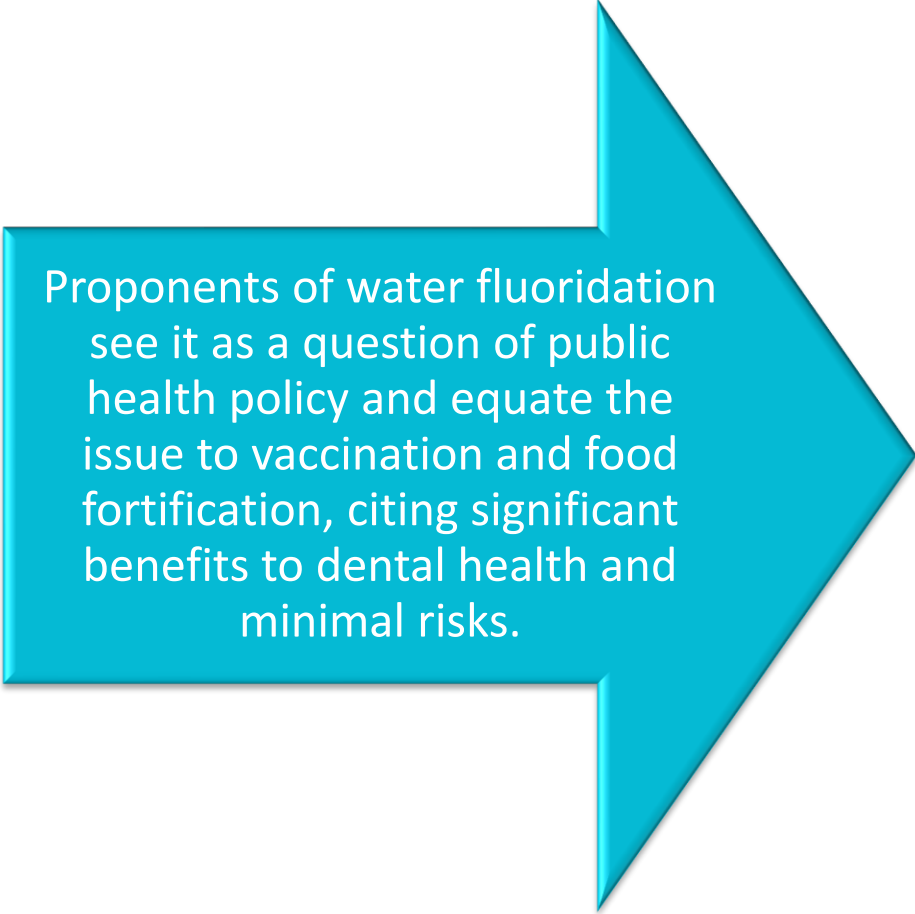
Support

- European Academy of Pediatric Dentistry
- National Dental Associations of:
 - USA, Canada, Australia, Israel
- U.S. Surgeon General
- American Public Health Association
- Royal Commission on the National Health Service
- Australian Medical Association
- New Zealand Medical Association
- Health Canada
- World Health Organization
- FDI World Dental Federation
- National Institute of Health (NIH)
- American Association of Pediatrics and Pediatric Dentistry

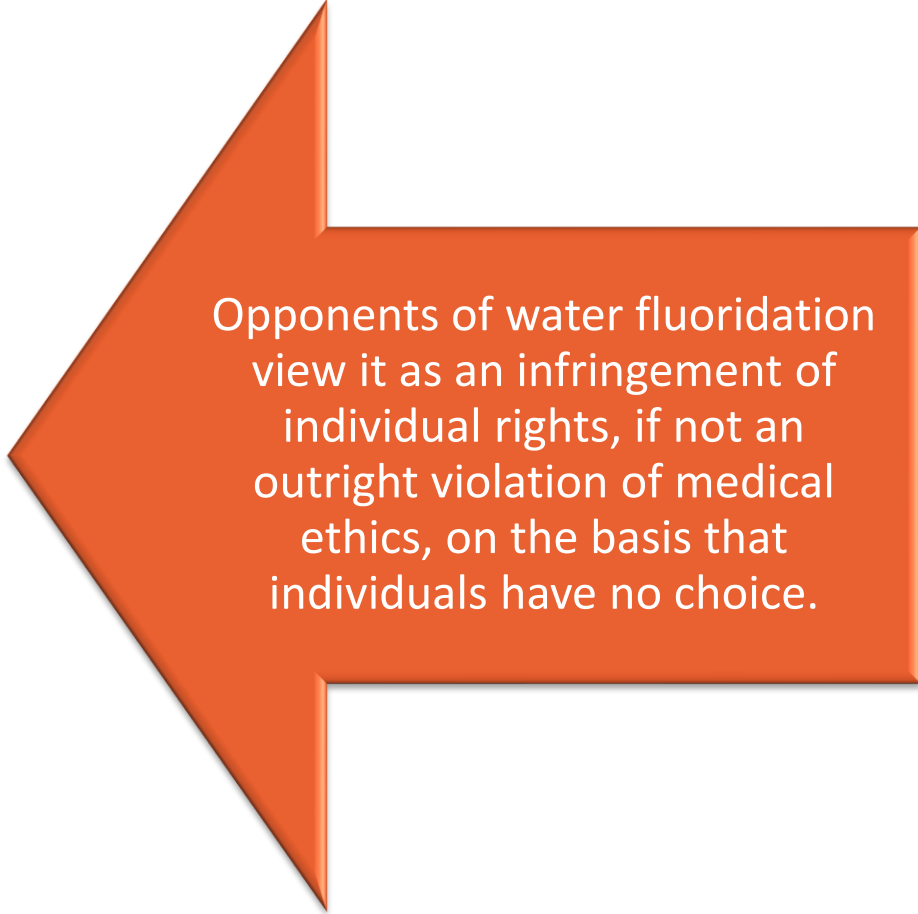
Opposed

- Christian Scientists
- Environmentalists
- Libertarians
- John Birch Society
- Green parties in the UK and New Zealand

The fluoride controversy



Proponents of water fluoridation see it as a question of public health policy and equate the issue to vaccination and food fortification, citing significant benefits to dental health and minimal risks.



Opponents of water fluoridation view it as an infringement of individual rights, if not an outright violation of medical ethics, on the basis that individuals have no choice.



National Toxicology Program

U.S. Department of Health and Human Services

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Fluoride Exposure: Neurodevelopment and Cognition

Fluoride exposure: Neurodevelopment and cognition

August 2024

- Robert Kennedy Jr. aims to remove fluoride from public water sources
- Kennedy claims fluoride is associated with arthritis, bone fractures, bone cancer, IQ loss, neurodevelopmental disorders and thyroid disease, but did not cite any evidence or studies
- Lawmakers in Arkansas filed legislation to repeal a state law requiring fluoride in drinking water
- Utah, FL bans Fluoridated water
- OH has a bill pending to eliminate Fluoride

<https://ntp.niehs.nih.gov/whatwestudy/assessments/noncancer/completed/fluoride>

Concerns with the publication

- Flawed analysis. Did not explore the effect of fluoride exposure according to age group and exposure level
- A cross-sectional study captures a population at a single point in time and hence is not capable of establishing cause and effect
- Not peer reviewed
- Relied on urinary fluoride to assess long term exposure
- Fluoride exposures more than double (≥ 1.5 mg/L) community water fluoridation (0.7 mg/L). Studies were done in Iran, Pakistan and Canada (naturally high F levels in ground water)
- The fluoride concentrations of drinking water were used as a proxy of fluoride exposure, and the fluoride intake from other sources was not considered. The main sources of fluoride exposure in children are diet and unintentional ingestion of fluoridated toothpaste

Association between low fluoride exposure and children's intelligence: a meta-analysis relevant to community water fluoridation, Jayanth V. Kumar, Mark E. Moss, Honghu Liu, Susan Fisher-Owens, Public Health, Volume 219, Pages 73-84,2023

A previous meta-analysis and the National Toxicology Program database that included a search of multiple databases and the authors' search of PubMed, Google Scholar, and Mendeley provided the data. Performed three meta-analyses to synthesize the effects using the random effects models.

Results

- Regression analysis by standardizing absolute mean IQ scores from lower fluoride areas did not show a relationship between F concentration and IQ scores

Conclusions

- These meta-analyses show that fluoride exposure relevant to community water fluoridation is not associated with lower IQ scores in children. However, the reported association observed at higher fluoride levels in endemic areas requires further investigation

Would you ingest this?

- This compound is responsible for over 3500 deaths per year (USA)
 - >10 fatalities per day
- ¼ liter causes death within 4 – 6 minutes depending upon age
- Found on 71% of earth's surface
- Contains Bisphenol A (BPA), Per- and polyfluoroalkyl substances (PFAS)

Everything in the right amount

- A little is good
- Necessary for life
- Too much, you drown
- The wrong kind, you become ill



What will happen if we remove fluoride?

- Dental costs will increase \$45.9B over the next 5 years
- 7.5% increase in caries (25.4M new decayed teeth)
- Low-income individuals will be disproportionately affected





So, should we fluoridate our water?

- Fluoride has been well studied for 76 years; however, science mandates to always look at new evidence
- Evaluate the science, not the science fiction
- Fluoride in the proper amount is efficacious, safe and cost-effective
- Take health advice from healthcare professionals, not politicians
- Caries will increase without Fluoridated water
- The libertarians have a good point
- Has anyone proposed legislation to increase Medicaid Dental benefits for the increase in caries?
- In life, “there are no solutions, only trade-offs.”

— T. Sowell



**Thank you
for listening**

Questions?