



MISSOURI DEPARTMENT OF
**HEALTH &
SENIOR SERVICES**

Community Water Fluoridation Science

Dr. Jennifer Sample,
MD, FAAP, FACMT, FAACT
Pediatrician and
Medical Toxicologist

Dr. Kevin Baumgartner, MD

Assistant Professor of
Emergency Medicine

Gwen Sullentrup, MAT

Unit Chief
Office of Dental Health

The presenters report no relevant financial relationships with commercial interests related to fluoride products, water treatment additives, or fluoridation policy. This presentation was developed independently and reflects current public health practice and regulatory frameworks in Missouri.



Objectives

- Understand children's exposure to fluoride.
- Understand IQ research and neurodevelopmental impact.
- Discuss and clarify National Toxicology Program's report on fluoride.
- Understand dose vs. toxicity.
- Real-world fluoride exposures.
- Clinical perspective on fluoridation.
- Fluoridation in Missouri.
- Population benefits: access and population health.
- Regulatory oversight and compliance.
- Public health position on fluoridation in Missouri.



Section 01

**Dr. Jennifer
Sample**

Children's Exposure

Fluoride is a trace mineral naturally found in small amounts in a variety of foods.



It is most recognized for its role in preventing and reversing dental caries and building strong teeth and bones.



Most fluoride is absorbed in the gut and stored in bones and teeth.



Unabsorbed fluoride is excreted in urine.



Children absorb fluoride more efficiently than adults, as their teeth and bones are rapidly forming.

Human exposure to fluoride; Adequate Intake (AI) 0.05 mg/kg/day ⁽¹⁾		
Fluoride source	Water	Drinking water: maximally 1.5 mg/L Mineral water: must not exceed 5 mg/L; mineral water must be labelled if >1.5 mg/L Median intake by water in the EU: 0.13 mg/day (1.86 µg/kg/day*)⁽¹⁾ Rare, extremely high level: 8.4 mg/day (120 µg/kg/day*)⁽¹⁾ <u>Problematic exposure levels of fluoride in drinking water</u> ≥4 mg/L: increased risk of bone fractures⁽²⁾ ≥10 mg/L: skeletal fluorosis⁽²⁾ >0.1 mg/kg/day: dental fluorosis in children up to 8 years⁽³⁾; suggested 'trade-off' between caries prevention and fluorosis: 0.7 mg/L in drinking water⁽⁴⁾
	Other	<u>Food</u> Tea infusions: 0.34-5.2 mg/L⁽¹⁾ Vegetables, fruit: 0.02-0.2 mg/kg⁽¹⁾ Milk, dairy products: 0.05-0.15 mg/kg⁽¹⁾ Bread, cereals: 0.1-0.29 mg/kg⁽¹⁾ Meat: 0.15-0.29 mg/kg⁽¹⁾ Fish: 0.48-1.91 mg/kg⁽¹⁾ Average intake from food in the EU: 5-28 µg/kg/day ^(1,7,8,9,10) <u>Fluoridated salt</u> (200-250 mg fluoride/kg); 3 g of salt ingestion per day: additional intake of 0.50-0.75 mg/day (7-11 µg/kg/day*)⁽¹⁾ <u>Toothpaste</u>: approximately 1.4 µg/kg/day (adults); 11.5 µg/kg/day (children)⁽¹⁾
		Internal exposure
		<u>Fluoride concentrations in plasma</u> Normal adults: 0.4-2.4 µM (7.6-45 µg/L)⁽³⁾ 1-3 µM (19-57 µg/L)⁽⁵⁾ 1.1 µM (21 µg/L)⁽⁶⁾ Adults consuming drinking water with >8 mg fluoride/L: 10.0 µM (190 µg/L)⁽⁶⁾ <u>Fluoride concentrations in saliva</u> Baseline: 1.7-1.8 µM (32-34 µg/L) After consumption of 5 g fluoridated salt: 5.8-7.9 µM (111-150 µg/L)⁽¹⁾ <u>Fluoride concentrations in breast milk</u> 2.7 µM (52 µg/L) 2.4 µM (46 µg/L)

⁽¹⁾ EFSA, 2013; ⁽²⁾ NRC, 2006; ⁽³⁾ EFSA, 2005; ⁽⁴⁾ Heller et al., 1997; ⁽⁵⁾ Rugg-Gunn et al., 2011; ⁽⁶⁾ Jha et al., 1982; ⁽⁷⁾ AFSSA, 2003; ⁽⁸⁾ Taves, 1983; ⁽⁹⁾ Bergmann, 1994; ⁽¹⁰⁾ EVM, 2001; * adults with 70 kg b.w.

Fluoride

FAST FACTS

Fluoride is a natural substance that is found in rocks, soil, and water. It prevents tooth decay in children and adults.



Fluoride helps keep teeth healthy by:

- Strengthening tooth enamel
- Reversing early tooth decay by replacing and preventing the loss of minerals that make teeth healthy
- Stopping the growth of bacteria that cause cavities



The U.S. Public Health Service recommends 0.7 parts per million of fluoride in drinking water, or about 3 drops of fluoride in a 55-gallon barrel, to prevent tooth decay.



The majority of the U.S. population receives fluoridated water.*

63%



* Decisions about water fluoridation are made at the state or local level.

You can get fluoride by:

- Drinking local tap water that has fluoride in it
- Using fluoride toothpaste/mouth rinse
- Getting varnish/gel at the dentist's office
- Taking a dietary supplement



After adding fluoride to the community water supply, tooth decay decreased in both children and adults, and complete tooth loss in older adults became much less common.



1940s 2014
Tooth Decay
in U.S. Schoolchildren



1960-62 2017-19
Complete Tooth Loss in
U.S. Adults Ages 65-74

In communities where fluoride is no longer added to water supplies, levels of tooth decay have doubled.

Too much fluoride may cause:

- Dental fluorosis, a condition occurring in mild forms in the U.S. which causes white flecks, spots, or lines on the teeth.
- Skeletal fluorosis, an extremely rare condition in the U.S., which causes pain and damage to bones and joints.

Research conducted outside of the U.S. has found a connection between high fluoride levels (more than twice the level recommended in U.S. drinking water) and lower intelligence quotient (IQ) in children.



At about age 2 (or sooner if a dentist or doctor suggests it), brush your child's teeth with a tiny amount of fluoride toothpaste.



For children aged 3 to 6, parents should put the toothpaste on the brush. Use only a pea-sized amount of fluoride toothpaste. Encourage your child to spit out the toothpaste rather than swallow it.



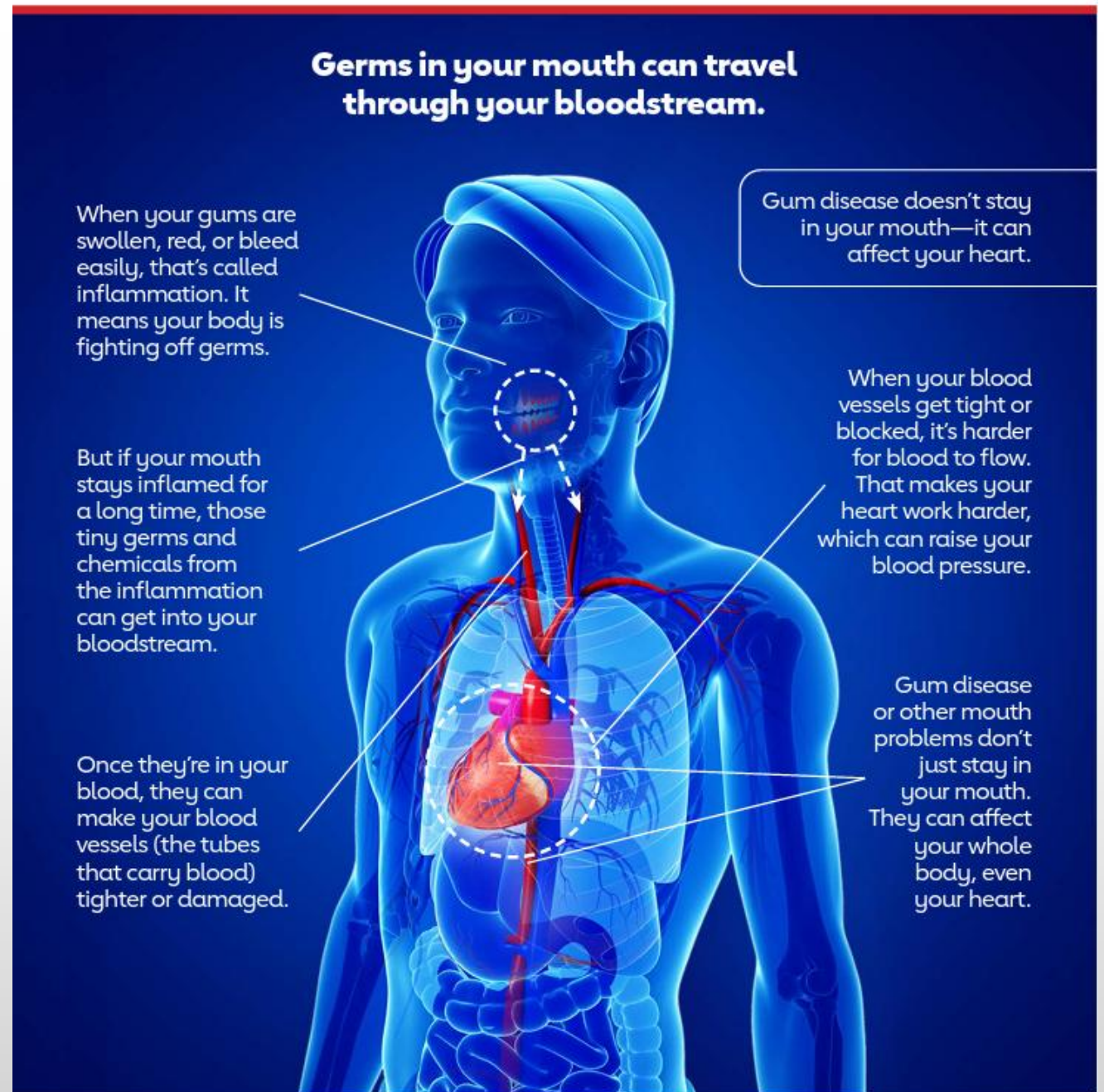
Additional resources

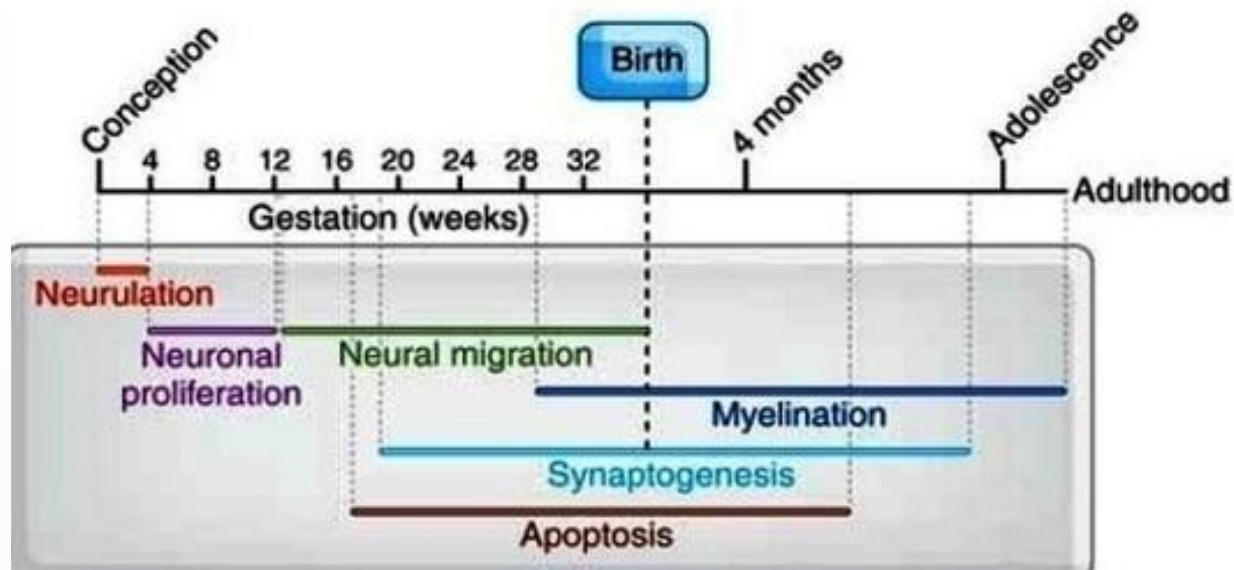


NIH National Institute of Dental and Craniofacial Research

[Ask the Expert: Why is fluoride good for dental health? | National Institute of Dental and Craniofacial Research](#)

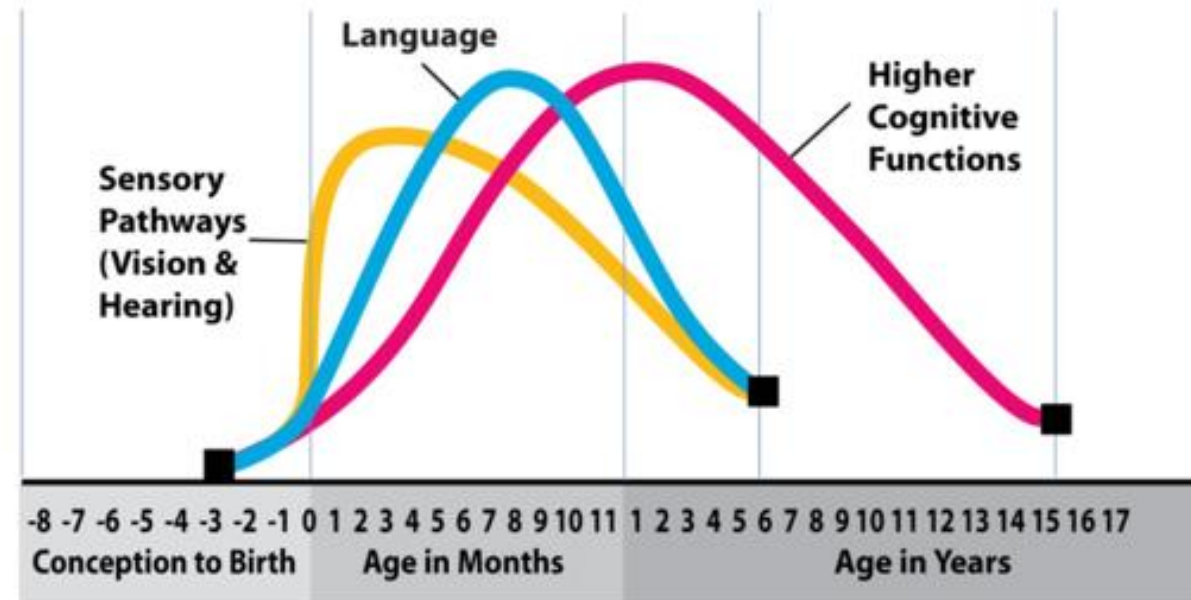
https://www.heart.org/-/media/Files/Health-Topics/Oral-Health/Oral-Heart-Connection.pdf?sc_lang=en





Human Brain Development

Synapse formation is dependent on early experiences



Source: Nelson, C. A. in *Neurons to Neighborhoods* (2000), Shonkoff, J. and Phillips, D. (Eds.)

NTP Findings

NTP monograph concluded, with moderate confidence, that higher levels of fluoride exposure are associated with lower IQ in children.

The NTP review was designed to evaluate total fluoride exposure from all sources and was not designed to evaluate the health effects of fluoridated drinking water alone.

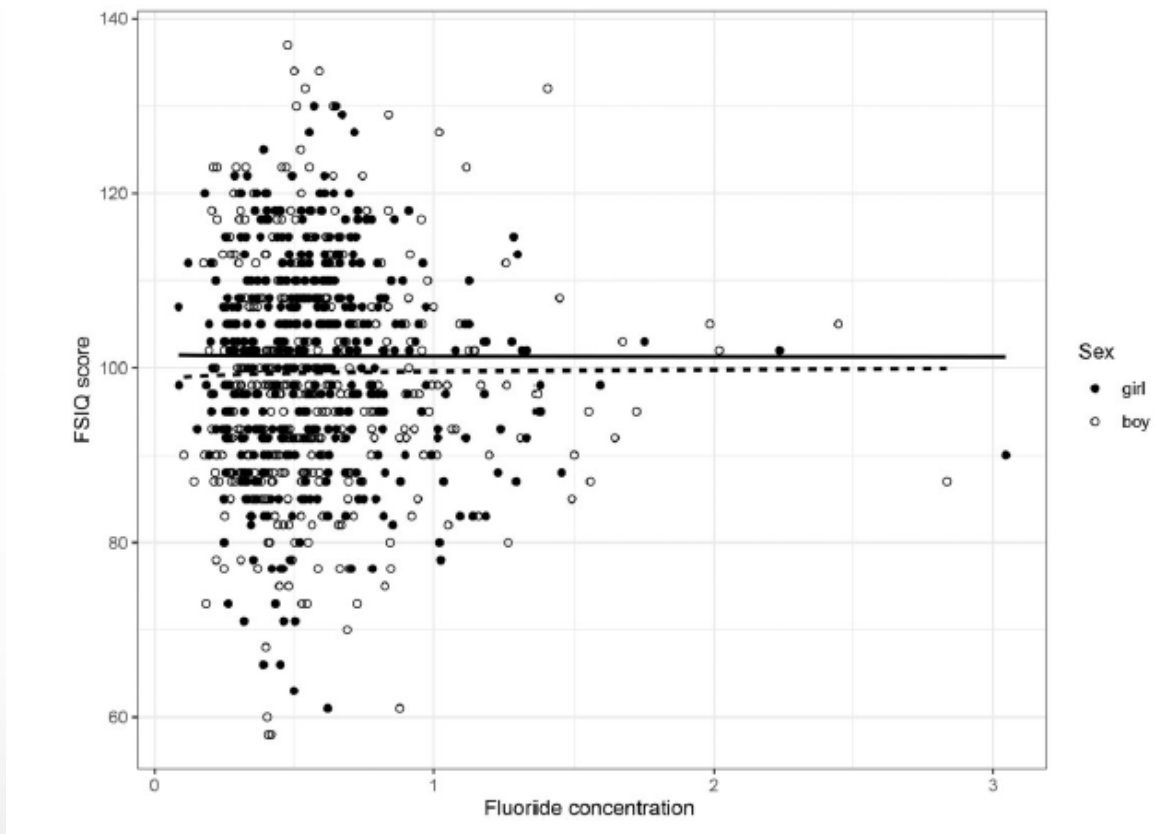
The determination about lower IQs in children was based primarily on epidemiology studies in non-U.S. countries such as Canada, China, India, Iran, Pakistan, and Mexico where some pregnant women, infants, and children received total fluoride exposure amounts higher than 1.5 mg fluoride/L of drinking water.

NTP Meta-analysis

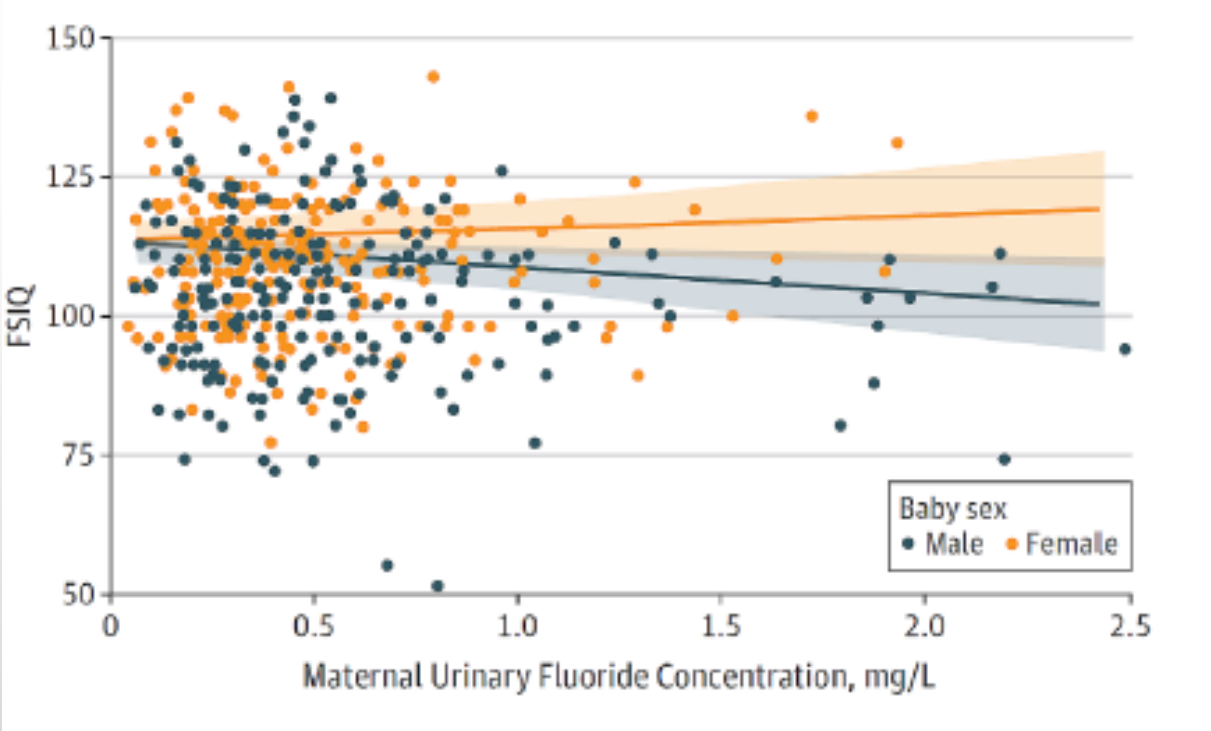
- Total of 74 publications (64 cross-sectional studies and 10 prospective cohort studies). No studies were conducted in the United States.
- 52 studies were rated high risk of bias.
- 59 publications reported IQ scores for group level exposures
- The meta-analysis found a statistically significant association between higher fluoride exposure and lower children's IQ scores.
- The meta-analysis found that for every 1 mg/L increase in urinary fluoride, there is a decrease of 1.63 IQ points in children.

Table 8 Examples of confounding factors that should be considered in epidemiological studies on a possible association between fluoride exposure and intelligence

-
- Residence, particularly urban versus rural areas
 - Water improvement plants: is fluoride, lead, or arsenic removed from drinking water?
 - Breastfeeding; breastfed children may have higher IQs
 - Confounding by other sources of fluoride (e.g., dental products) than drinking water
 - Background of parents: educational level, socioeconomic status, income, IQ
 - Birth weight; first-born?
 - Intake of iodine
 - Exposure to other chemicals: lead, methylmercury, arsenic, polychlorinated biphenyls
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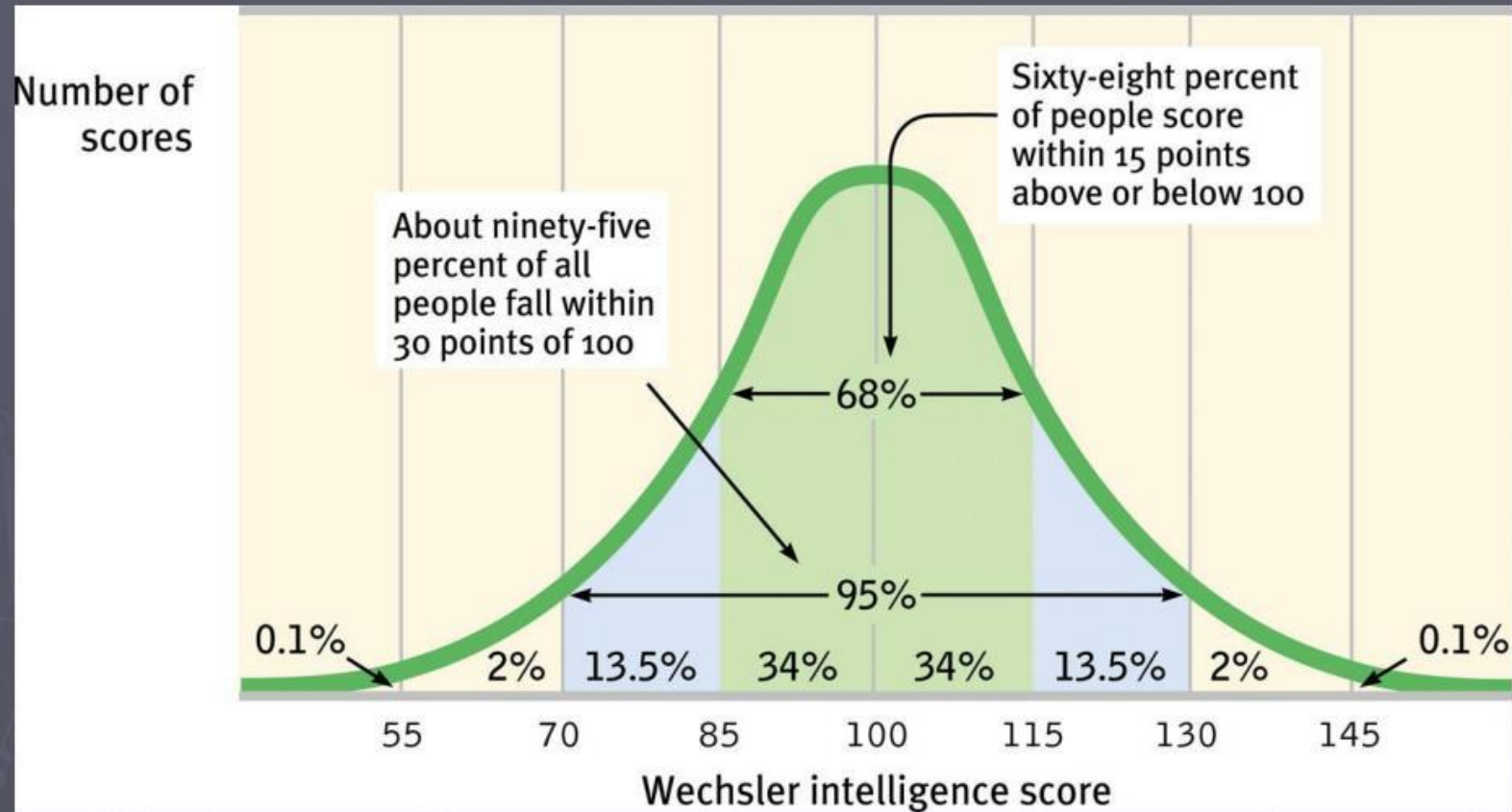


Grandjean et al. European Journal of Public Health. 2023; 34: 143-149



Guth et al. Archives of Toxicology. 2021; 95: 2571-2587

Wechsler Intelligence Score



IQ Research Context

While IQ tests have been a cornerstone of educational and employment assessments, they have been scrutinized for potential biases and limitations.

The use of IQ test is increasingly being reconsidered.

IQ tests may not fully capture the complexity of human intelligence and the role of environmental factors

Shift to terms like “cognitive abilities”



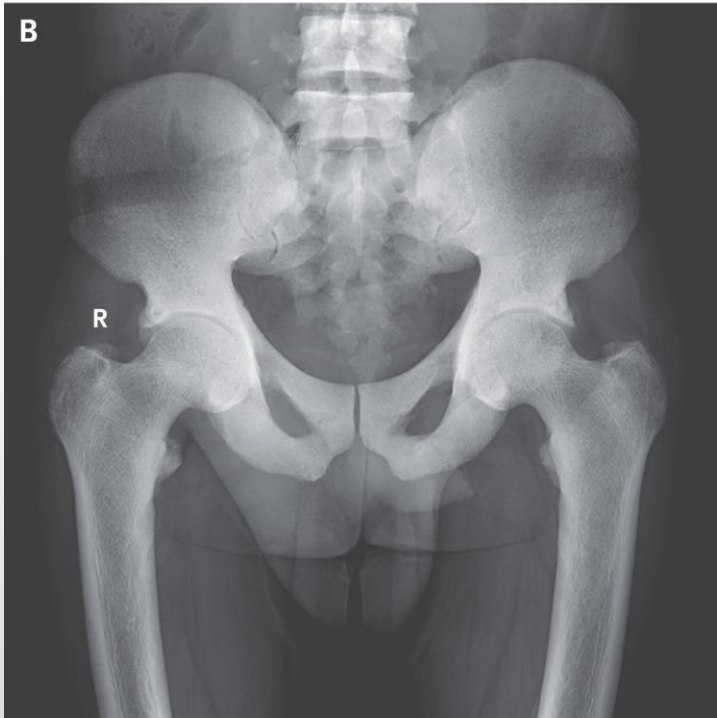
Section 02

**Dr. Kevin
Baumgartner**

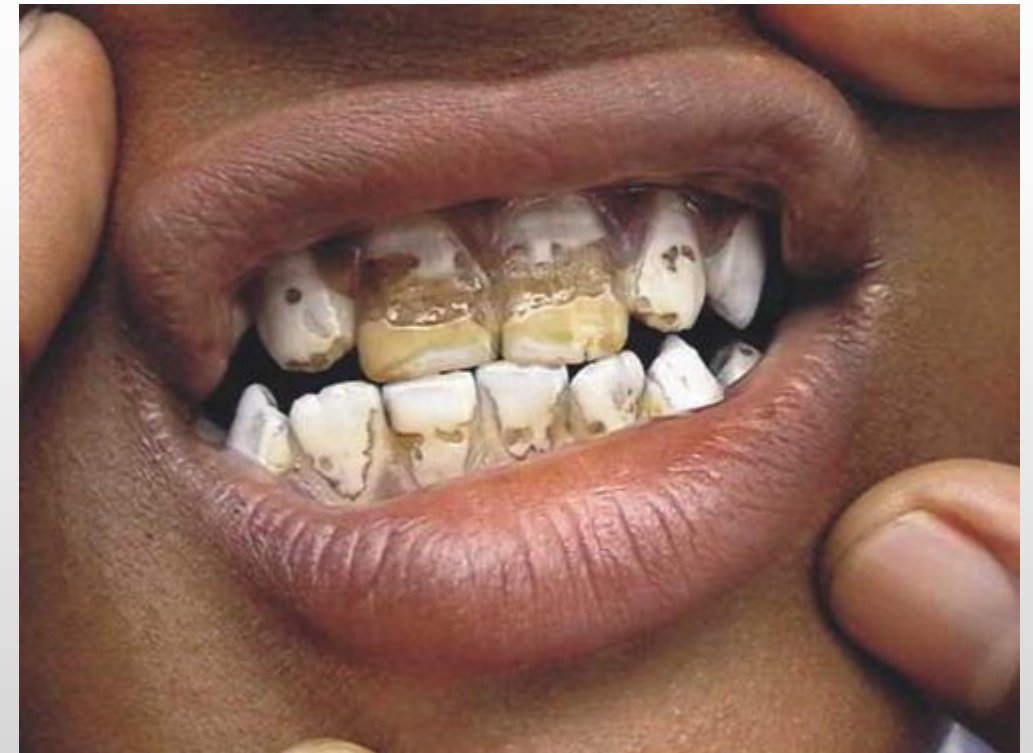


“All things are poison,
and nothing is
without poison; the
dosage alone makes
it so a thing is not a
poison.”

- Paracelsus (1493-1541)



Nayak B, Roy MM, Chakraborti D. Dental fluorosis. *Clin Toxicol.* 2009;47(4):355



Meena L & Gupta R. Skeletal fluorosis. *N Engl J Med* 2021;385(16):1510.

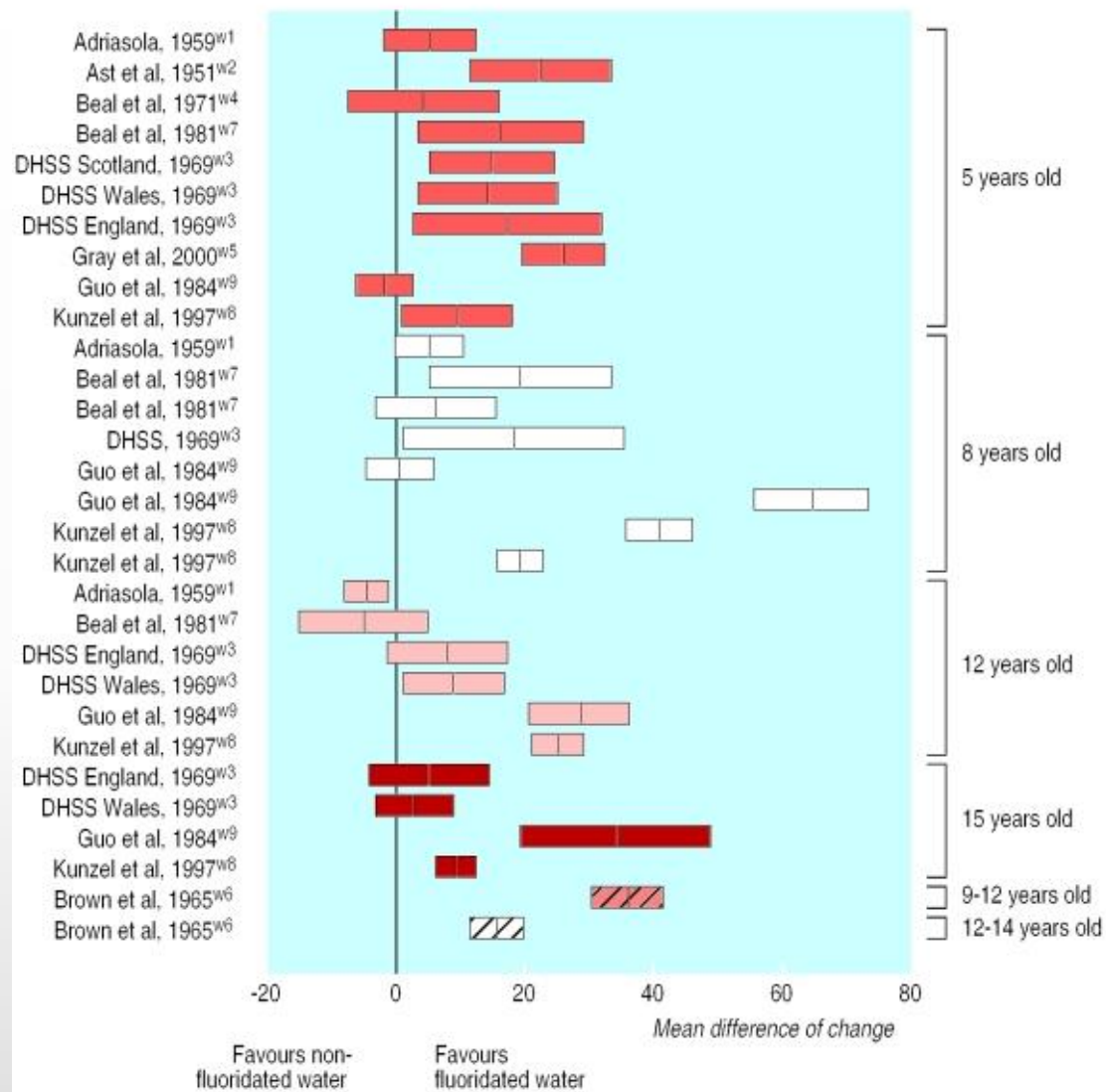


Figure 1. Change in proportion (%) of children without caries.

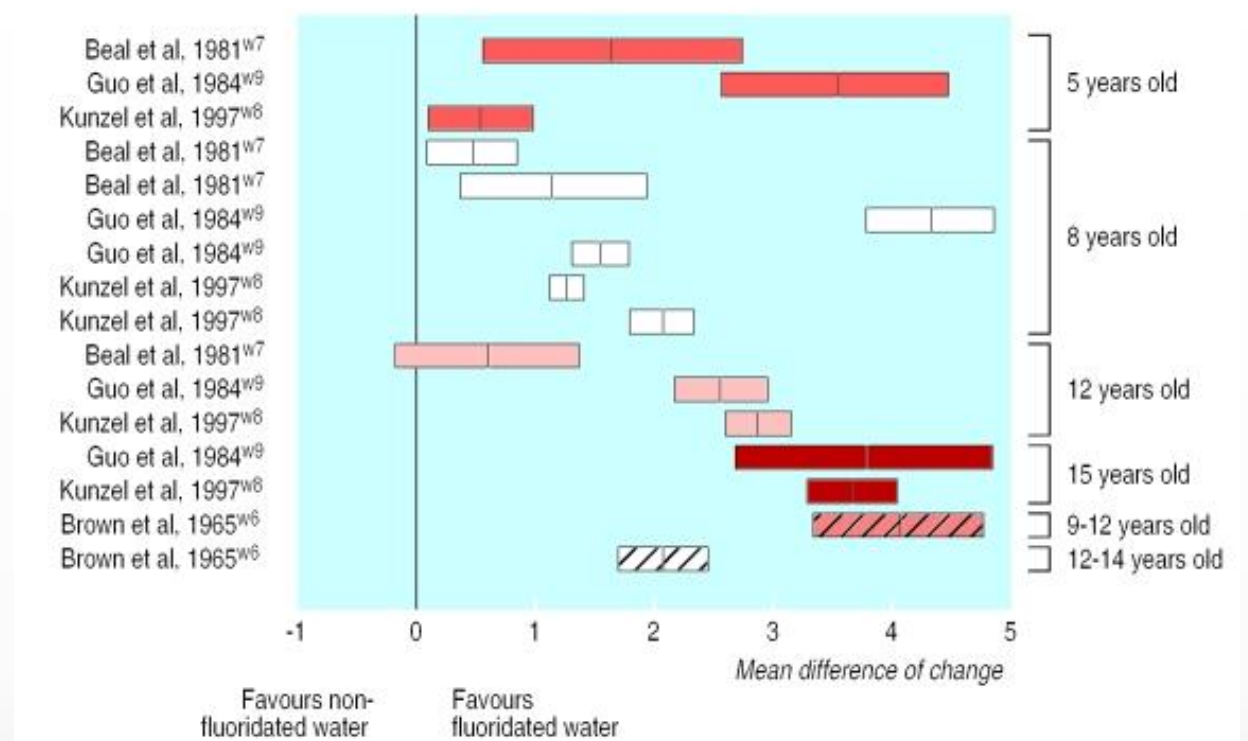


Figure 2. Change in decayed, missing, and filled teeth
McDonagh MS et al. Systematic review of water fluoridation. *BMJ*. 2000;321(7265):855-859

4.0 mg/L



EPA primary maximum
contaminant level

2.0 mg/L



EPA secondary maximum
contaminant level

1.5 mg/L



WHO
maximum
guideline value

0.70 mg/L



**Community Water
Fluoridation target**

Table 2. Pooled Changes in Standardized Mean Differences (SMDs) From the Linear Model From the Dose-Response Mean-Effects Meta-Analyses Using Group-Level Measures of Fluoride Exposure

Fluoride exposure, mg/L	Studies, No.	Effect estimates, No. ^a	Children, No.	Parameter estimates ^b	
				β (95% CI)	<i>P</i> value
Water fluoride, all studies					
All data	31	41	12 487	−0.15 (−0.20 to −0.11)	<.001
<4	23	29	9554	−0.22 (−0.27 to −0.17)	<.001
<2	8	10	3682	−0.18 (−0.40 to 0.03)	.10
<1.5	7	7	2832	0.05 (−0.36 to 0.45)	.82
Water fluoride, low risk-of-bias studies					
All data	7	12	5066	−0.21 (−0.33 to −0.09)	.001
<4	7	10	4962	−0.23 (−0.34 to −0.11)	<.001
<2	4	5	1632	−0.33 (−0.53 to −0.13)	.001
<1.5	3	3	879	−0.32 (−0.91 to 0.26)	.28

From **Table 2**. Taylor KW et al. Fluoride Exposure and Children's IQ Scores: A Systematic Review and Meta-Analysis. *JAMA Pediatr.* 2025;179(3):298-292. Emphasis added.

We need **high-quality direct evidence**:

- From the **United States**
- Distinguishing between **naturally occurring fluoride** and **community water fluoridation**
- Appropriately adjusting for **known confounders**
- Measuring both **water fluoride** and **urinary fluoride**
- Assessing **other sources of fluoride**
- Considering both **risks and benefits**



Section 01

Gwen

Sullentrup

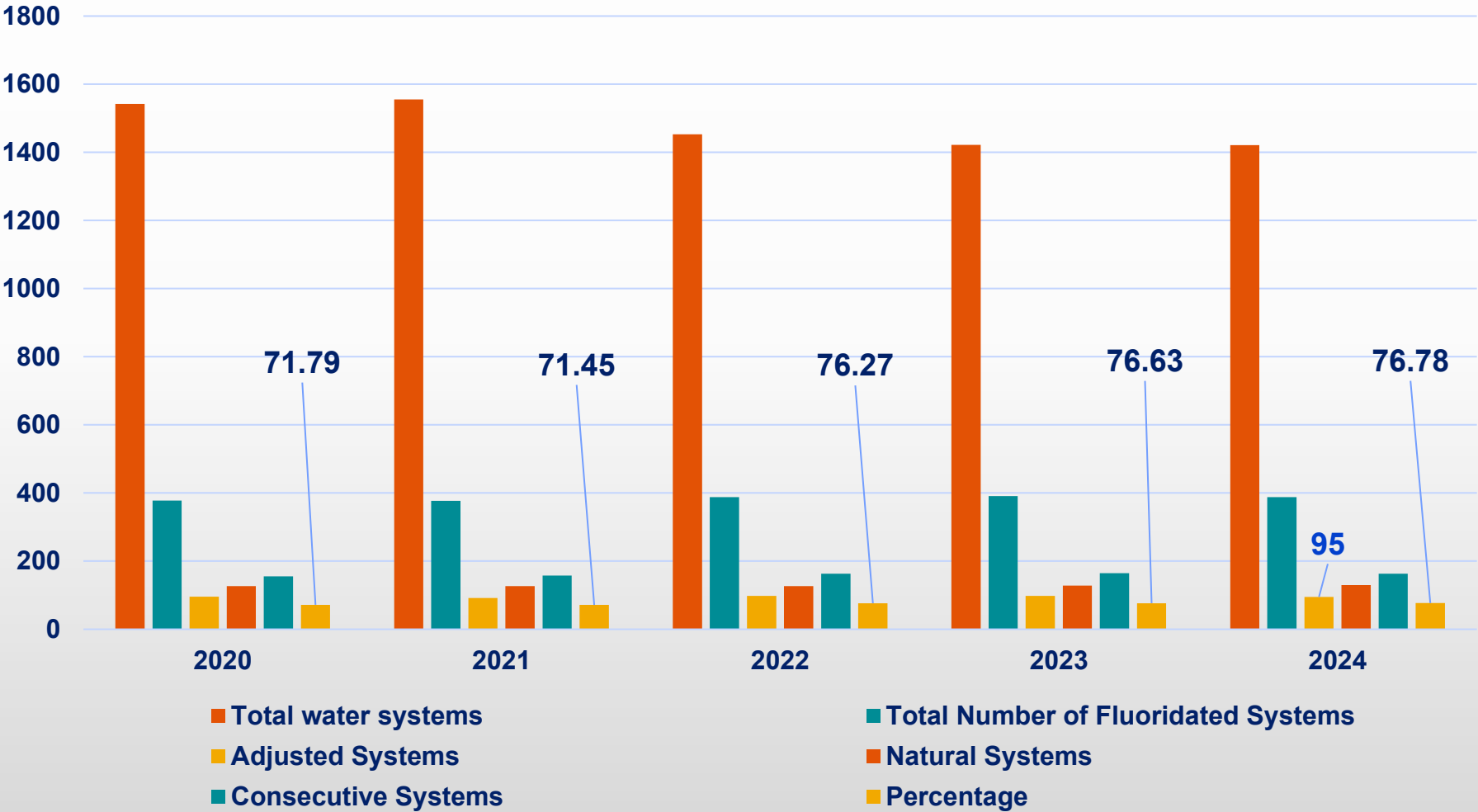
Missouri Fluoridation Snapshot

- Optimal level: 0.7 mg/L
- EPA Maximum Contaminant Level: 4.0 mg/L
- EPA Secondary Maximum Contaminant Level: 2.0 mg/L
- 76.8% (4 million) of Missouri's population receive fluoridated water
- 388 public water systems have fluoridated water at 0.6 mg/L or higher
 - 95 systems adjust the level of fluoride in the water supply to the optimal level of 0.7 mg/L
 - 163 systems purchase water from one of the 95 adjusted systems
 - 130 systems have background levels of fluoride at 0.6 mg/L or higher, naturally occurring
 - 49 systems range between 0.6-1.0 mg/L naturally
 - 44 systems range between 1.01-1.5 mg/L naturally
 - 28 systems range between 1.51-2.0 mg/L naturally
 - 8 systems range between 2.01-2.5 mg/L naturally
 - 3 systems range between 3.14-3.81 mg/L naturally

Missouri systems operate **well below federal safety thresholds.**

Fluoridation in Missouri

Percentage of Population Served by Fluoridated Water Systems



Population-Level Benefits

20-40 percent reduction in tooth decay in children

Benefits extend to adults and older adults

Reduces severity of decay, not just incidence

Especially protective in communities with limited access to care

Decreases costly emergency department dental visits

Impact: Benefits are greatest among lower-income populations.

Access and Barriers

Nearly 1 in 3 Missourians live in a Dental Health Professional Shortage Area

Rural and underserved populations experience higher untreated decay

Fluoridation reaches people who:

Do not see a dentist regularly

Lack dental insurance or ability to pay

Face transportation and other social barriers

Water fluoridation functions as background prevention infrastructure.

Regulatory Oversight Framework

U.S. Environmental Protection Agency: sets Maximum Contaminant Level and enforces Safe Drinking Water Act



Centers for Disease Control and Prevention: recommends optimal level (0.7 mg/L)



Missouri Department of Natural Resources: monitors water systems



Missouri Department of Health and Senior Services: provides evidenced-based education, technical assistance, and reporting



Multiple layers of oversight exist.

Monitoring and Compliance in Missouri

Daily operator testing

Required reporting to Department of Natural Resources

Annual Consumer Confidence Reports (April of each year)

Corrective action protocols in place if levels deviate or exceed EPA requirements

Missouri compliance rates are on the rise from 28.2% (2020) to 63.5% (2024)

Real-world fluoride exposure in Missouri public water systems remains tightly controlled.

Risk vs. Population Health Benefit

Magnitude of benefit

Magnitude of risk

Exposure distribution

Disparity reduction impact

Feasibility of alternative interventions

At 0.7 mg/L, evidence continues to support net population benefit.

What happens if fluoridation stops?

Evidence from communities that discontinued fluoridation shows:

Increase in decay rates

Higher treatment costs

Greater impact on low-income families

Increased Medicaid expenditures

Prevention infrastructure is *difficult and costly to rebuild once removed.*

Study of Costs of Fluoridation Stopping

Table 1. Impact of Ending Community Water Fluoridation on the Number of Medicaid Enrolled Children Receiving Dental Treatment for Cavities and Cost to Medicaid in 5 States

	1-Year Impact		3-Year Impact	
	Number of Children with Extractions and/or Restorations	Estimated Cost to Medicaid	Number of Children with Extractions and/or Restorations	Estimated Cost to Medicaid
Kentucky	7,788	\$1,949,194	25,235	\$6,315,389
Oklahoma	7,248	\$2,037,673	22,396	\$6,296,409
Louisiana	5,293	\$1,692,208	15,562	\$4,975,090
Florida	17,732	\$2,173,182	52,131	\$6,389,154
Missouri	5,424	\$4,905,204	17,248	\$15,598,550

<https://carequest.org/how-ending-water-fluoridation-would-affect-children-and-state-medicaid-costs/>

Missouri Public Health Position



Continue monitoring emerging research and confer with subject matter experts



Maintain regulatory compliance



Support informed provider communication



Ensure transparency in reporting



Missouri's approach: evidenced-based, regulated, monitored.

Key Takeaways

Missouri fluoridation levels are below EPA safety limits



Population-level benefits are well established



Regulatory oversight is multi-layered



Ongoing research review does not equal evidence of harm at optimal levels



Clear, balanced messaging matters.



MISSOURI DEPARTMENT OF
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QUESTIONS?