Washington State Department of HEALTH

FLUORIDE NEUROTOXICITY REVIEW

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Toxicologist

About Me

- Background in PFAS (analytical chemistry, fate, transport)
- Toxicologist for WA DOH
  - Fish consumption and human health risks
  - Site evaluation
  - Assigned Fluoride in 2023
- Parent of teeth falling out age kids
- Prior to being assigned fluoride - I did not think about fluoride.

Fluoride

- Naturally occurring mineral
- Present in drinking water, food, and consumer products
- Widely promoted for oral health benefits
  - Community water fluoridation, fluoridated toothpaste, fluoride varnishes
- In Washington drinking water:
  - Do not require water fluoridation, community-by-community decision.
  - "Where fluoridation is practiced, the optimal fluoride concentration is 0.7 mg/L." (State Board of Health)
  - EPA Maximum Contaminant Level (MCL) 4 mg/L (caps natural F^-) (DOH, ODW)

Fluoride – Benefits

- We will not be talking about benefits in any detail
- Demonstrated benefit to oral health
  - Reduces cavities
  - Reduces dental procedures
- Demonstrated benefit to public health
  - Increases oral health outcomes at population level
  - Reduces lost learning/work time

Fluoride - Hazards

- Skeletal fluorosis
  - 4 mg/L in drinking water
  - Primary MCL
- Dental fluorosis
  - 2 mg/L in drinking water
  - Secondary MCL
- Neurotoxicity
  - NTP - Total fluoride expressed as 1.5 mg/L drinking water

Photo: Wang et al 2012

Photo: Fejerskov 2019

Recent Tox History

- 2006 National Research Council
  - Reports association between high levels of fluoride in drinking water and adverse neurological effects in humans
- 2016 NTP Review of Animal Studies
  - Reports low to moderate confidence fluoride impacts learning and memory
- 2024 (AUG) Fluoride Monograph:
  - Moderate confidence, that higher estimated fluoride exposures (e.g., >1.5 mg/L in drinking water) are consistently associated with lower IQ in children

Recent Tox History

- 2024 (SEPT) Food and Water Watch v EPA:
  - "… community water fluoridation at 0.7 mg/L presents an unreasonable risk of injury to health under Amended TSCA and that the EPA is thus obliged to take regulatory action"
- 2025 (JAN) Taylor et. al. meta analysis
  - Removed section from the NTP report and authors
  - Approximately 1 IQ pt per 1 mg/L increased maternal urinary fluoride
- 2025 (JUL) European Food Safety Authority
  - Reasonable confidence an association with neurodevelopmental outcomes may occur above 1.5 mg/L in drinking water.
- 2025 (AUG) WA DOH Report of the Fluoride Science Review Panel
  - Provided summary report and recommendations to SBOH

NTP Monograph

National Toxicology Program Fluoride Monograph

- National Toxicology Program (NTP)
  - Began in 2016/2017
  - Evolved through the review process to become a state of the science review (August 2024)
  - Moderate confidence, that higher estimated fluoride exposures (e.g., >1.5 mg/L in drinking water) are consistently associated with lower IQ in children

The NTP Monograph: IQ Association

Monograph (1989 – May 2020)

19 low risk of bias studies

- None from the U.S. (2 Canada)
- 18 showed inverse association
- Overall 95% inverse

53 medium to high risk of bias studies

- 46 showed inverse association
- Overall 86% inverse

Addendum (May 2020 – Oct 2023)

12 additional low risk of bias studies

- 12 inverse associations
- Overall 97% inverse

16 additional medium to high risk of bias studies

- 13 showed inverse association
- Overall 86% inverse

National Toxicology Program Fluoride Monograph

- Consistency
  - Directionality
  - Across populations
  - Design (cohort and cross sectional)
  - Data quality ratings (bias)
  - Group and individual
  - Outcome (different IQ tests)
- Strengthens the overall finding: Moderate confidence, that higher estimated fluoride exposures (e.g., >1.5 mg/L in drinking water) are consistently associated with lower IQ in children

NTP Report Summary of Meta Analyses

- All meta analyses reviewed in the NTP report showed an inverse association between fluoride and IQ
- Kumar et al 2023 – Split studies into high and low fluoride exposure – high showed an inverse, low did not

Addendum Table 2. Previous Meta-analyses on Exposures to Fluoride and Children's IQ

Analysis	Number of Studies	Pooled Effect Type, Estimate (95% CI)	Heterogeneity	
			p-value	I^2
Tang et al. (2008)	16	WMD, −5.03 (−6.51, −3.55)	NR	NR
Choi et al. (2012)	27	SMD, −0.45 (−0.56, −0.34)	<0.001	80%
Duan et al. (2018)	26	SMD, −0.52 (−0.62, −0.42)	<0.001	69.1%
Miranda et al. (2021)	10	OR, 3.88 (2.41, 6.23)	<0.0001	77%
Veneri et al. (2023)	30 (38 results)	WMD, −4.68 (−6.45, −2.92)	NR	98.75%
Kumar et al. (2023)	28 (31 results)	SMD, −0.33 (−0.44, −0.22)	<0.001	83%
DTT Meta-analysis, Taylor et al. (2024, in press)[a]	59	SMD, −0.45 (−0.57, −0.33)	<0.001	94%

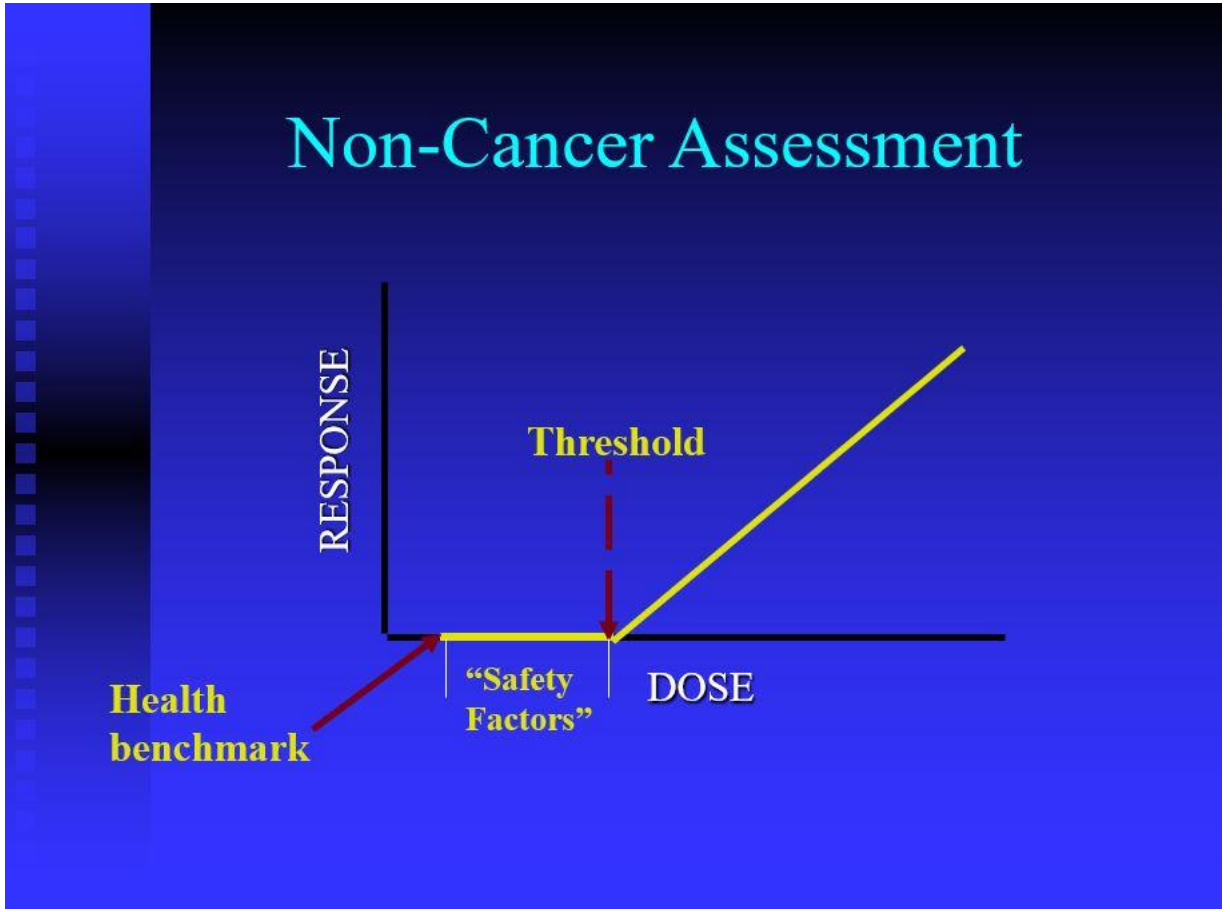
CI = confidence interval; NR = not reported; SMD = standardized weighted mean difference; OR = odds ratio of low IQ in the high fluoride versus low fluoride groups; WMD = weighted mean difference.
[a]The NTP authors of this monograph conducted a companion systematic review and meta-analysis of fluoride exposure and children's IQ (DTT Meta-analysis, Taylor et al. 2024, in press).

Food and Water Watch vs EPA Decision

The issue before this Court is whether the Plaintiffs have established by a preponderance of the evidence that the fluoridation of drinking water at levels typical in the United States poses an unreasonable risk of injury to health of the public within the meaning of Amended TSCA. For

Risk Characterization

- Point of departure (i.e. hazard level) compared to exposure level
- Point of departure is inadequate for protection – a margin must exist



O'Garro 2025

Risk Characterization: Conventional Methods

- Conventional risk assessment methods
  - POD = 4 mg/L water fluoride (NTP meta analysis)
  - UF = 10 for intraspecies variability
  - UF = 10 for LOAEL to NOAEL

$$Safe\ level = \frac{4\ mg/L}{10\ x\ 10} = 0.04\ mg/L$$

- 0.04 mg/L is:
  - Less than the community water fluoridation level of 0.7 mg/L
  - Risk is present

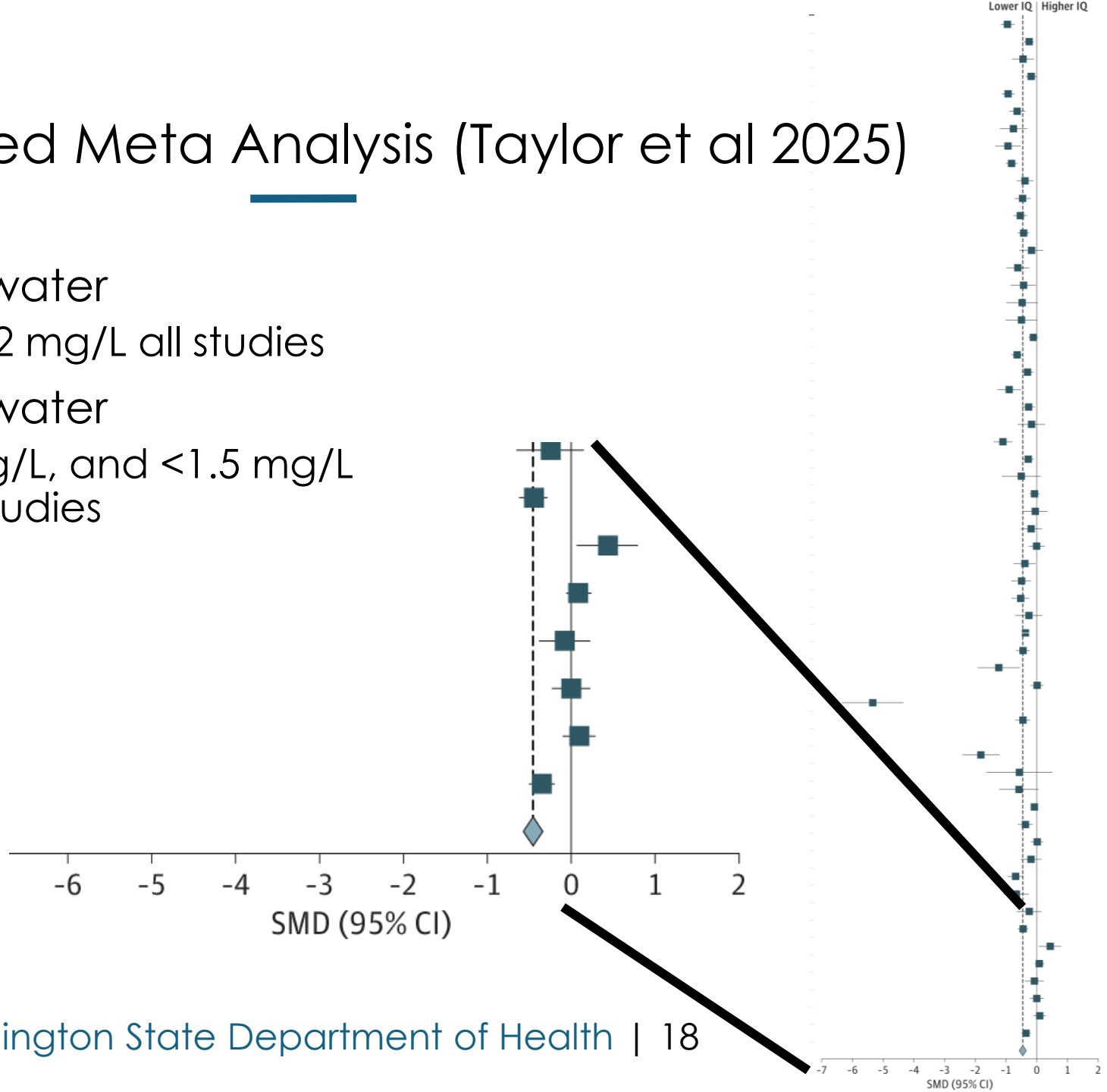
Risk Determination

- "Unreasonable" risk
  - Severity of the hazard
    - IQ loss
  - Exposure-related considerations
    - 2,000,000 pregnant people
    - over 300,000 exclusively formula-fed babies
  - Population characteristics
    - Very susceptible populations - pregnant people and infants
  - Confidence in the information used for hazard and exposure
    - High level of certainty of hazard between fluoride and IQ
    - Some uncertainty in which POD to use
  - Confidence in uncertainties and assumptions
    - Uncertainty in mechanism of action

NTP Author's Meta Analysis

NTP Published Meta Analysis (Taylor et al 2025)

- Low IQ w/ drinking water
  - < 4 mg/L and < 2 mg/L all studies
- Low IQ w/ drinking water
  - < 4 mg/L, < 2 mg/L, and <1.5 mg/L low risk of bias studies



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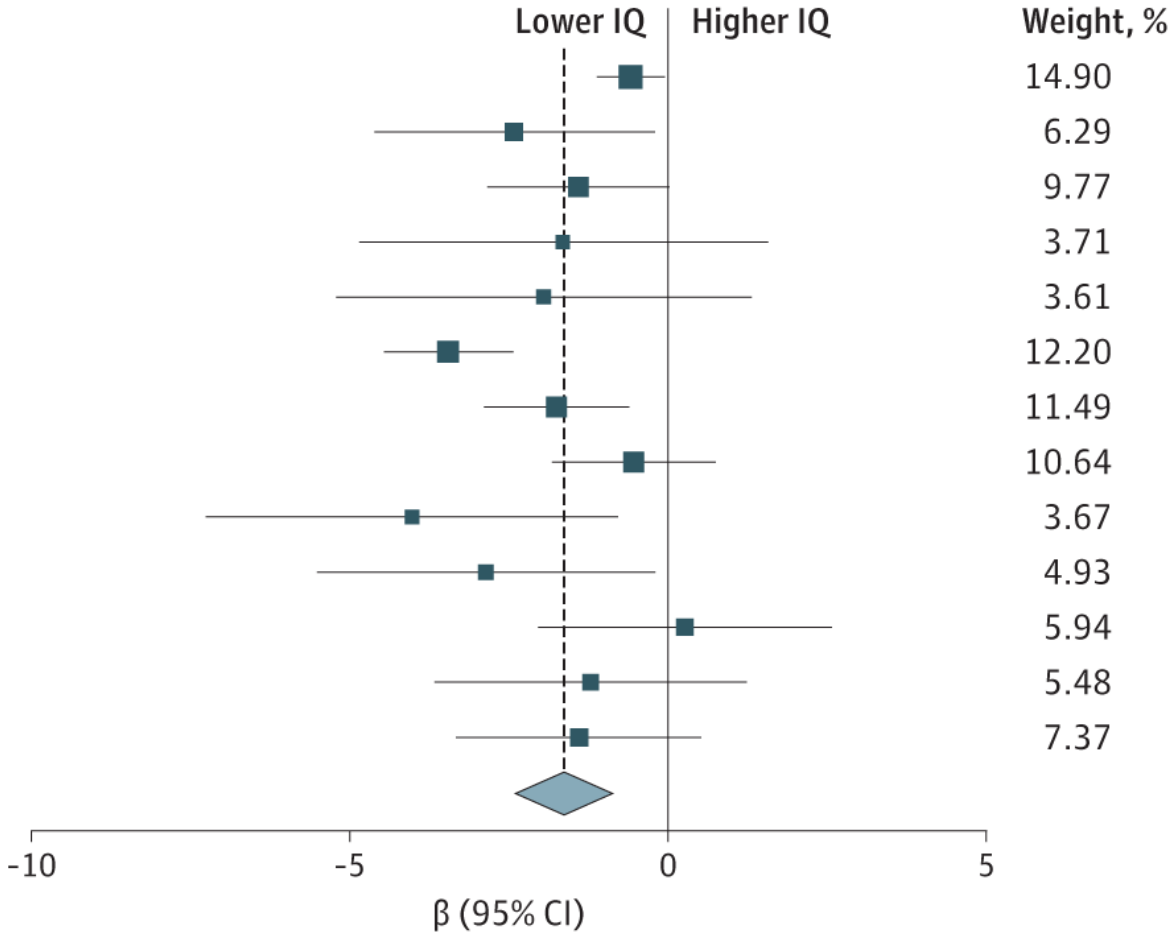
- For every 1 mg/L in increased MUF
  - -1.14 IQ points (low risk of bias only)
  - -1.63 IQ points (all individual measure studies)



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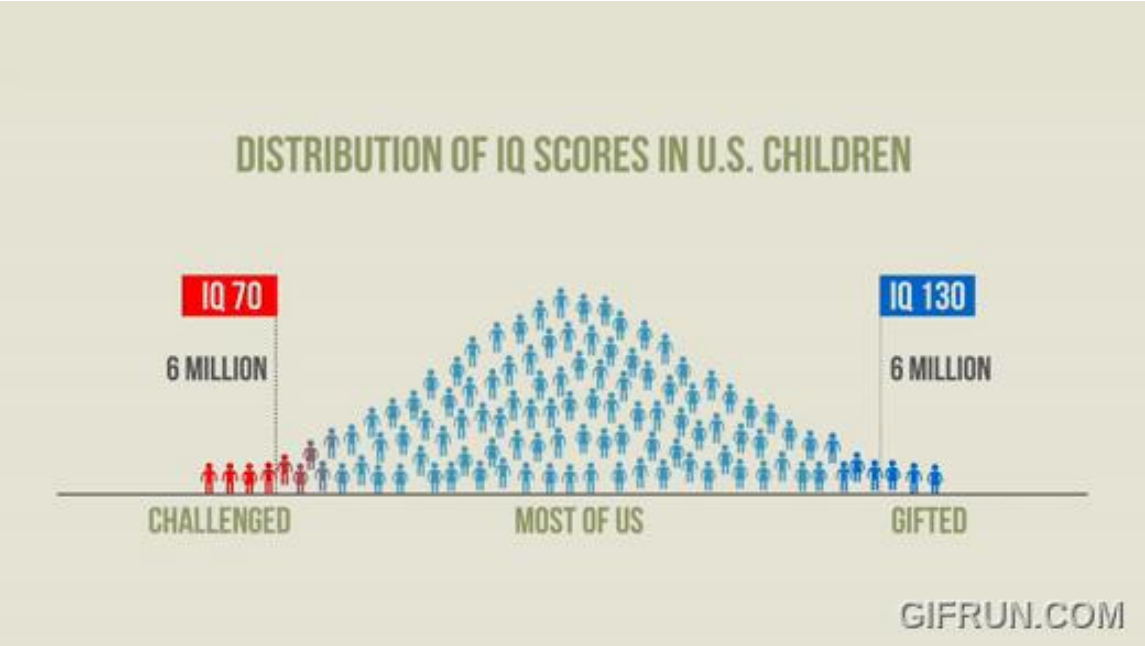

Little Things Matter 2014

- Shifts in population IQ associated:
  - Education, Health, Income, Crime

European Food Safety Authority Updated Consumer Risk Assessment of Fluoride in Food and Drinking Water

EFSA

- 15 cohort studies
  - "…studies reviewed above, conducted in populations exposed to low levels of fluoride in drinking water, do not allow for firm conclusions on a possible adverse association between exposure to fluoride and neurodevelopmental outcomes in children at the exposure ranges reported in these studies"
- 53 cross-sectional studies
  - "…studies suggest that living in an area with elevated water fluoride concentrations is associated with lower performance on intelligence tests by children. On their own these studies are suggestive but not robust as a standalone line of evidence to derive a health-based guidance value."
- Also included a number of animal and mechanistic studies

EFSA

- "…for neurodevelopment and neurotoxicity, the Scientific Committee concluded that there is reasonable confidence in the evidence from both human and animal studies suggesting that an association with neurodevelopmental outcomes may occur at relatively high fluoride exposures, i.e. above 1.5 mg/L in drinking water."

- Effects on the developing CNS were selected as the critical endpoint applicable to pregnant women and the developing offspring.

EFSA

- Considered different exposure scenarios.
  - Using 1.5 mg fluoride/L, the current legal limit for drinking water, for aggregate intake (drinking water, food, and other sources) -> P95 exceedance for all age groups
  - As a result, the current legal limit of 1.5 mg/L for fluoride in drinking water is not considered sufficiently protective.

  - Using "typical" drinking water concentrations (86% < 0.3 mg/L and 97% < 0.7 mg/L) -> P95 exceeds "slightly" for toddlers and for children 4-8 years.

WA DOH Fluoride Science Panel

WA DOH Panel

- January 2025 – July 2025
  - NTP Report
  - Food and Water Watch vs EPA
  - Oral Health Benefits
  - Equity
  - Economics
  - Heard from experts

- Developed
  - Consensus statements
  - Recommendations

WA DOH Panel Consensus

- **SURE** that fluoride prevents tooth decay.
- **LESS SURE** that community water fluoridation contributes a significant added oral health benefit beyond other common exposures to fluoride.
- **LESS SURE** that community water fluoridation has an impact on oral health inequities.
- **MODERATELY SURE** that exposure to higher levels of fluoride coming from a combination of sources poses an IQ risk to developing fetuses and babies.
- **LESS SURE** that optimally fluoridated water poses an IQ risk for developing fetuses and babies in today's environment that has additional sources of fluoride.

WA DOH Panel Recommendations

- Keep the current optimal level of fluoride concentration for now. Community water fluoridation should remain a local decision. Communities should carefully weigh the benefits and risks of water fluoridation.
- Begin the rulemaking process to consider adopting a State Action Level of 1.5 mg/L for fluoride.
- Coordinate with the Department of Health and public health partners to update messaging on fluoride to include guidance to limit fluoride exposure for pregnant people, fetuses, and infants.

Key Takeaways

- Fluoride is considered to be a neurodevelopmental toxin with moderate/reasonable confidence according to the NTP and EFSA
- More exposure data is needed
- Risk does not consider benefits

This is good news, not bad news

Questions