

National Institute of Environmental Health Sciences Division of Translational Toxicology

NTP Monograph Fluoride Exposure and Neurodevelopment and Cognition A Systematic Review

Collaborative for Health and the Environment

December 3, 2024

Kyla W. Taylor, PhD, John Bucher, PhD, Andrew A. Rooney, PhD

Integrative Health Assessments Branch Division of Translational Toxicology National Institute of Environmental Health Sciences



National Institute of Environmental Health Sciences Division of Translational Toxicology

Talk outline

- What is fluoride? The history of U.S. water fluoridation
- NTP Monograph: Fluoride, neurodevelopment, and cognition
- Public health relevance
- Recent federal court ruling and role of the Monograph
- Questions and panel discussion



ITP National Toxicology Program U.S. Department of Health and Human Services

NTP Monograph

on the State of the Science Concerning Fluoride Exposure and Neurodevelopment and Cognition: A Systematic Review

What is fluoride?

- Naturally occurring mineral
- Topical contact reduces risk of cavities
- Added to drinking water
- Many other sources of exposure



History of U.S. water fluoridation

- Early 20th century researchers noticed that people living in areas with high levels of fluoride in drinking water had fewer cavities
- First added to drinking water in Grand Rapids, Michigan in 1945
- The U.S. Public Health Service (PHS) first recommended communities add fluoride to drinking water in 1962
- U.S. PHS recommends 0.7 mg/L fluoride added to drinking water
- Community water systems serve about 200 million US residents





Sources of added fluoride in North America



Public Health Agency of Canada, 2017

Adverse health effects and current drinking water standards and recommendations

Dental fluorosis is the

white discoloration

- Skeletal fluorosis
 - Bone disease caused by fluoride accumulation in the bones
 - Causes pain and tenderness of the major joints
- Dental fluorosis
 - Mild: Discoloration
 - Moderate to severe: Pitting





NORMAL



MILD

6

% total fluoride intake in children from various sources, by age



US EPA Fluoride: Exposure and Relative Source Contribution Analysis (2010)

Neurotoxic effects?

- 2006: National Research Council (NRC) reported evidence of neurotoxic effects of fluoride
- Fetal and developing brains are especially vulnerable to neurotoxicants
- Concern that some pregnant women and children may be getting more fluoride than they need because they now get fluoride from many sources and the combined total intake of fluoride may exceed safe amounts
- Fetal exposure
 - Fluoride from maternal blood crosses placenta
 - Fluoride stored in bone and remobilized into bloodstream during pregnancy
- Formula-fed infants residing in fluoridated communities:
 - 3-4 times greater exposure to fluoride than adults on a per body-weight basis
 - ~70-fold higher fluoride intake than exclusively breastfed infants





Fluoride as a topic for evaluation at the National Toxicology Program (NTP)

- 2015: Topic of fluoride exposure & adverse health effects nominated to NTP
- 2016: NTP Monograph (animal studies only) published
 - Systematic review of animal studies found <u>low to moderate</u> evidence of adverse effects on learning and memory

2nd NTP systematic review to evaluate potential neurodevelopmental and cognitive effects of fluoride in the human, animal, and mechanistic/*in vitro* literature

Published August 2024



A Systematic Review

August 2024

What is systematic review?

- Transparent and rigorous method for identifying, evaluating, and summarizing every single relevant study published on a topic
- Look for patterns across a body of evidence, and develop conclusions based on the best available evidence
- OHAT approach to systematic review, developed in 2014, is a framework for systematic review and evidence integration across human, animal, mechanistic studies
 - Developed to address challenges with reproducibility, transparency
 - Leading edge of bringing systematic review methodology to toxicology and environmental health
- Given **importance and scrutiny** of public health decisions, adherence to standardized methods is essential



	March 4, 2019	
Offic	e of Health Assessment and Translation (DHAT)
Natio	anal Institute of Environmental Health Sc	ences
All 1/P - Contents is accessible to indeviduals with obtainin HTML version of this article is available at <u>http://dx.doi.c</u>	nt. A mary accessible paceton see-compliane) ing/10.1289/obp.1307972.	Resear
Sciences, National Institutes of Health, Depart	ment of Health and Human Services, Nesearch I	hazard identification conclusions or s
BACKCROUND: Systematic review methodolog process of collecting and synthesizing scientific er	ies provide objectivity and transparency to the idence in reaching conclusions on specific research	hazard identification conclusions or a of-the-science evaluations regarding hi effects from exposure to environme
questions. There is increasing interest in appl health questions. OBJECTIVES: The real was to develop a restem	ying these procedures to address environmental atic review framework to address environmental	substances. The seven-step framework lines methods to increase transparency consistency in the preserve has it also pre-
health questions by extending approaches develo data relevant to environmental health sciences (e,	opportunities to increase efficiencies in management and data display that facil	
authorities on systematic review and sought ad through consultation with technical experts in sy	rice during development of the OHAT Approach stematic review and human health assessments, as	hazard identification conclusions.
well as scientific advisory groups and the public, public comments and through application to case RESULTS AND DISCUSSION: Here we present a	The method was refined by considering experi and studies. seven-step framework for systematic review and	Methods In 2011, OHAT began exploring system
evidence integration for reaching hazard identit protocol development, 2) search for and select 1 (4) assess the quality or risk of bias of individu	feation conclusions: 1) problem formulation and tudies for inclusion, 3) extract data from studies, al studies, 5) rate the confidence in the body of	transparency and increase efficience summarizing and synthesizing find
evidence, 6) translate the confidence ratings into from different evidence streams (human, animal, to atima structure) to deviden herenel identification c	levels of evidence, and 7) integrate the information and "other relevant data" including mechanistic or seclusions	from studies in its literature-based b assessments. OHAT used a multipro strategy to develop the OHAT Appro-
CONCLUSION: The principles of systematic revi health questions to provide greater objectivity	iew can be successfully applied to environmental r and transparency to the process of developing	working with advisors to adapt and es existing methods from clinical medicine
conclusions. CITATION: Rooney AA, Boyles AL, Wolfe MS, B coldence internation for Internation-based environ	ucher JR, Thayer KA. 2014. Systematic review and mental health science assessments. Environ Health	obtaining input from technical experts the public on early drafts (see Supplem Material, Table S1). The meth
Perspect 122:711-718; http://dx.doi.org/10.128	9/ehp.1307972	development process is described in des Supplemental Material ("Process for dev involte OHAT Assessed "are 2.72 https://
Introduction Systematic-review methodologies increase the	need to integrate data from multiple evidence streams (human, animal, and "other rele-	ing ine OHA1 Approach," pp. 2-7). In OHAT reviewed guidance from authoritive systematic-review groups (AHRQ 2
objectivity and transparency in the process of collecting and synthesizing scientific evi-	vant data" including mechanistic or <i>in vitro</i> studies) in order to reach conclusions regard-	Guyatt et al. 2011a; Higgins and G 2011) in developing an initial draft
dence on specific questions. The product of a systematic review can then be used to inform	ing potential health effects from exposure to substances in our environment.	sought additional advice through web- discussions and consultation with tee
decisions, reach conclusions, or identity research needs. There is increasing interest in	(NTP) Office of Health Assessment and	the NTP Board of Scientific Counse
apprying the principles of systematic review to questions in environmental health [European	annuarion (OHA1) conducts literature- based evaluations to assess the evidence	and the public (N1P 2012a, 2012b, 20 2013c, 2013d, 2013e). The rendring O
National Research Council (NRC) 2011,	stances, or mistures (collectively referred to	Approach has been retined based or input received and through application
Sunon 2011].	and provides opinions on whether these	can model.
Attnough systematic-review methodol- ogies are well established in clinical medi-	substances may be of concern given levels of current human exposure (Bucher et al. 2011). Belding on a brown of a	Address correspondence to A.A. Rooney, NI P.O. Box 12253, Mail Drop K2-04, Res
come to assess data for reaching health care recommendations [Agency for Healthcare Record and Ocalian (AMRO) 2012. C	objective scientific review, OHAT has been	 range Park, NG 27/09 USA. Telephone: 541-2999, E-mail: andrew.rooney@mlh.gov Supplemental Material is available online fl
research and Quality (AHRQ) 2013; Guyatt et al. 2011a; Higgins and Green 2011; Vieweerberg et al. 2012) shows a	working to incorporate systematic-review procedures in its evaluations since 2011 downed a mean that has included	ds.dot.org/10.1289/dsp.1307972). We appreciate the valuable advice and com-
are most developed for human clinical	unouge a process that has included adop-	on the development of this systematic review i
states and dependent paracette consider small	tion of current practice, as well as methods	the Matianal Taniashan Descent Copies, on p
data sets of similar study design in develop-	tion of current practice, as well as methods development (Birnbaum et al. 2013; NTP 2012a, 2012b, 2013c). Here we explain the formerands developed by OMAT.	the National Toxicology Program (NTP) lize Committee, and the NTP Board of Scien Counselors.
data sets of similar study design in develop- ing conclusions. Questions in environmental health require the evaluation of a broader range of relevant data inclusion car	tion of current practice, as well as methods development (Birnbaum et al. 2013; NTP 2012a, 2012b, 2013c). Here we explain the framework developed by OHAT that uses procedures to integrate multiple evidence streams including observational human mul-	the National Toucology Program (NTT) fato Committee, and the NTP Board of Scie Councelon. The authors declare they have no actual or por competing financial interests.
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- Systematic Review
 - Planning and protocol development
 - \circ Identify evidence
 - Comprehensive literature search
 - Literature screening
 - Evaluate evidence
 - Extract data
 - Risk of bias assessment

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- Refined research question, developed detailed protocol with input from technical experts
- Formal peer review of protocol Transparency Posted to NTP website in 2017

Who We Are

The State of the Science Monograph is now available.

National Toxicology Program

U.S. Department of Health and Human Services

Data & Resources



What We Study 🔹

What We Study

Cognition

Topic Overview

Publications

Fluoride Exposure: Neurodevelopment and

» Health Effects Assessments » Noncancer Health Effects » Completed Evaluations

CASRN: 16984-48-8 Status: Evaluation completed

On This Page

https://ntp.niehs.nih.gov/go/785076

- Background Information
- Documents
- 12 Meetings & Events

Support

SEARCH

https://ntp.niehs.nih.gov/go/fluoride 🕻

Systematic Review

- Planning and protocol development
- Identify evidence
 - Comprehensive literature search
 - Literature screening
- Evaluate evidence
 - Extract data
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- Comprehensive literature search of eight databases through May 1, 2020 (Addendum update through October 2023)
 - BIOSIS, EMBASE, PsychINFO, PubMed, Scopus, Web of Science, CNKI, and Wanfang
 - Peer reviewed articles, no language restrictions
- References screened for relevance (2 independent reviewers)
 - Selection based on predefined Population, Exposure, Comparator, and Outcome (PECO) criteria to avoid bias



https://hawcproject.org/summary/visual/assessment/405/Figure-2/

Systematic review focuses on the human studies

- 547 human, animal, mechanistic/ in vitro studies considered relevant
- Experimental animal learning and memory data *inadequate* to inform assessment of neurodevelopment and cognitive effects in humans
- In vitro/mechanistic studies too heterogeneous and limited to make determination on biological plausibility (e.g., changes in thyroid hormone)

Details for each evidence stream available in NTP Monograph



HA

Put

Systematic Review

- Planning and protocol development
- Identify evidence
 - Comprehensive literature search
 - Literature screening
- **o** Evaluate evidence
 - Extract data
 - Risk of bias assessment

- Open source, web-based application for data extraction and visualizations
- Health Assessment Workspace Collaborative (HAWC) developed at DTT, NIEHS (*Shapiro et al., 2018*)



https://hawcproject.org/assessment/405

		Transparency						
VC Home	Home / Fluoride (2024)	All d	ata	pub	licly availab	ole, downloadable so		
lic Assessments	Fluoride (2024)	re	sea	rche	rs can replic	ate or extend work	-	
oride (2024)	Assessment name	Fluoride					I	
terature review	CASRN	7681-49-4					I	
anagement dashboard	DSSTox substance identifiers		Common	Common name	Sodium fluoride	0		
udy list	(DTXSID)					DTXSID	DTXSID2020630	
sk of bias		Na⁺	F ⁻		CASRN	7681-49-4	ľ	
ndpoint list					SMILES	[F-].[Na+]		
ummary tables					Molecular weight 41.98817244			
sualizations					Chemical information provided by	y USEPA Chemicals Dashboard		
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ownloads	Version	Draft						
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VC Resources		quality guide	mes. It i	nas not be	en iormany disseminated b	y NTF. IL UUES HULTEPIESENL AND SHOUID HUL		

Systematic Review

- Planning and protocol development
- Identify evidence
 - Comprehensive literature search
 - Literature screening
- Evaluate evidence
 - Extract data
 - Risk of bias assessment '

- Evaluate 7 risk-of-bias domains
 - Confounding bias
 - ✓ Exposure characterization
 - ✓ Outcome assessment
 - $\circ\,$ Selection bias
 - Attrition bias
 - Selective reporting
 - Other (e.g., statistical analyses)

Transparency

Interactive risk of bias ratings and rationale for each individual study available in HAWC

of a study Risk of Bias Ratings -- Definitely high

Key domains: Greatest

potential to impact results

- /NR Probably high or NR+ Probably low
- ++ Definitely low

NR: Not reported

https://hawcproject.org/assessment/405

Identify "high quality" and "low quality" studies

High quality studies represent **the best evidence**, and are basis for the Monograph's conclusions

- A high-quality study's **risk of bias ratings** are:
- ++ For most domains
 - No more than one in a key domain
 - -- None in any domain

Risk of Bias Ratings				
	Definitely high			
-/NR	Probably high or NR			
+	Probably low			
++	Definitely low			
NR: Not reported				

Individual studies Broadbent 2015 Bai et al. 2014 Bashash 2017 An et al. 1992 Cantoral 2021 Aravind et al. Chen 2008 Cui 2018 **Risk of bias domains** ✓ Confounding NR Exposure NR \checkmark ✓ Outcome ++ Selection ++ Attrition NR NR ++ ++ Reporting ++ + ++ Other NR NR ++ ++ + **High-quality studies**

Characteristics of high-quality studies Important for determining confidence

- Most established exposure occurred prior to outcome assessment (i.e., temporality)
 - e.g., prospective cohort studies or prevalence of dental fluorosis in children, limiting study populations to children who lived in an area for long periods of time
- Used IQ tests that were appropriate for the population being studied, outcome assessors were blind to fluoride exposure status
- Accounted for **key confounders** (e.g., age, sex, socioeconomic status) including potential co-exposures to other neurotoxins (e.g., arsenic, lead intake)
- Used individual-level exposure assessment measures (e.g., urine or water)
 - Or, if using group-level data, confirmed regions being compared had differences in fluoride exposure
- Used appropriate sampling techniques for study populations and statistical approaches for analyses
 - e.g., stratified multistage random sampling, regression techniques that account for clustering

Study quality and year of publication in studies of fluoride exposure and children's IQ



Exposure data fell into two general categories



- Reported group-level exposure measures
- Compared mean IQ of children living in "high" fluoride areas to children living in "low" fluoride areas
- Measures included
 - Village or area of residence (endemic vs. non-endemic)
 - Drinking water
 - Children's urine
 - Severity of dental fluorosis
 - Coal burning



- Reported individual-level exposure measures
- Reported regression coefficients for change in children's IQ per 1 mg/L increase in urinary fluoride levels
- Measures included
 - Children's urine
 - Maternal urine
 - Drinking water
 - Fluoride intake
 - Serum

Consistency across high- and low-quality studies *Group-level data Reference Reference Reference Reference Reference*



 Standardized mean difference (SMD) for studies comparing children's IQ in a "high" fluoride exposure area vs. a "low" fluoride exposure area

Children in high fluoride communities have statistically significantly **lower IQ**



CI: Confidence intervals

Not all high-quality studies reporting group level data are displayed (e.g., studies that did not report data in a way that could be plotted as an SMD)

Consistency across high- and low-quality studies

Individual-level data



 Regression coefficients (β) and 95% CIs for change in children's IQ per 1 mg/L increase in maternal or children's urinary fluoride

For every 1 mg/L increase in urinary fluoride there is a statistically significant **decrease children's IQ**



ELEMENT and MIREC cohorts reported maternal urinary fluoride levels **comparable to the United States** (Ugyturk 2020, Malin 2024)

- Green et al 2019 (MIREC): β = **-1.95** (95% CI: -5.19, 1.28)
- Bashash 2017 (ELEMENT): β = **-5.16** (95% CI: -9.12, -1.19)

Interpretation: Per 1 mg/L increase in maternal urinary fluoride, \rightarrow 2 to 5 point decrease in children's IQ

Confidence ratings

- Rate confidence in bodies of evidence that overall findings *reflect the true exposure-effect relationship*
- Four-point scale:
 - High confidence
 - Moderate confidence
 - Low confidence
 - Very Low confidence
- Performed for bodies of evidence on outcome basis
- Considers principles that are *consistent with causation*

3 steps for determining confidence



Considerations for confidence ratings Studies of fluoride exposure and children's IQ

- Consistent inverse association across:
 - 18 of 19 high quality studies
 - 46 of the 53 low quality studies
 - Study populations from different countries
 - Study designs (cross-sectional, prospective cohort)
 - Risk of bias ratings
 - Exposure matrices (water and urine)
 - Type of exposure data (group and individual level data)
 - Timing of exposure (pre- and post-natal)
 - Outcome assessment type (different types of IQ tests)
- Heterogeneity in methods, NOT heterogeneity in results
- Each level of consistency strengthens overall confidence
- Determined confounding could not explain these results (see NTP Monograph for details)





Group level

VS.

Individual level

Low exposure

High exposure







NTP Conclusion:

Moderate confidence that

higher fluoride exposure is associated with lower IQ children

Extensive peer review

2021

provided

conclusions

National Academies of Science, **Engineering, Medicine (NASEM)** committee reviewed initial (2019) & revised (2020) drafts

NTP revised Monograph in response to these reviews

2019-2020



DTT Scientific Director approves NTP Monograph to be published (May 2022)

NTP/NIEHS Director asks NTP Board of Scientific Counselors (BSC) to review authors' responses to external peer review & *interagency comments on Monograph & meta-analysis (MA)

2022

2024 2023 NTP BSC working group review of author responses to external peer review & *interagency comments on Monograph & MA

Both NASEM reviews & author responses provided

Issued recommendations for language refinement & clarification

No major issues identified with methods, analyses, conclusions

Encouraged rapid publication

Authors respond to all NTP BSC comments

*Agencies and offices that provided comments on Monograph & MA Office of the Director, NIH Office of the Assistant Secretary of Health (OASH) Food and Drug Administration (FDA) Centers for Disease Control (CDC) National Institute of Dental and Craniofacial Research (NIDCR) National Institute of Child Health and Development (NICHD)



NTP Board of Scientific Counselo Working Group Report on the Draft State of the Science Monograp d the Draft Meta-Analysis Ma I Report: Approved by the NTP Board of Scient selors on May 16, 2023

August 2024

(MA in press)

DRAFT	Fluoride Exposure and Neurodevelopment and Cognition: A Systematic Review
NTP Monograph on the	Peer Review
State of the Science Concerning Fluoride Exposure and Neurodevelopmental and Cognitive Health Effects: A Systematic Review	Science Training Program (VTP) conducted a per review of the memoryheneritid VDP Memoryheneritid and Cognitive Infection (Concern Cherneric Provide Deserver) and inderdopmental and Cognitive Fields (Editor: Al promute Parietor by Interio Deserver 1) Reviewer solutions and documents areas (Infection Califordia WTP) enters on the Cognition (Infection Califordia and Infection) when one charged to: (1) Concerners on the Coholical accuracy and whether the mesograph control (Logd) NTP
NTP Monograph 08	Neurodevelopmental and Cognitive Health Effects: A Systematic Review is clearly stated and objectively presented.
September 2022	(2) Determine whether the scientific evidence support the NTP's confidence unings for the bodies of evidence regarding neurodevelopmental and cognitive health effects associated with expresser to flowide.
	7 carefully considered reviewers' comments in finalizing his monograph. Peer Besiewers
National Training Program U.S. Dynamic Radia Science Strain U.S. Dynamic Radia Science Science Science ISSN 2778-5144 Research Training Pach, North Carolina, U.S.A.	 and A. S. M. 2024. and A. S. M. 2024
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External peer review by 5 independent

reviewers of 2021 draft NTP Monograph

Both NASEM reviews & author responses

Reviewers unanimously agree with NTP's

(typical NTP peer review process)

Of note...

- Final confidence conclusions based primarily on high-quality studies (i.e., the best evidence)
 - Consideration of low-quality studies does not decrease confidence in overall body of evidence
- Conclusions based primarily on non-US studies where total fluoride exposure approximated *>1.5 mg/L fluoride in drinking water
 - Several high-quality prospective birth cohort studies with maternal urinary fluoride levels comparable to the United States

*>1.5 mg/L refers to WHO Drinking Water Guideline of 1.5 mg/L; chosen to describe "higher" fluoride exposure in the NTP Monograph based on an overall assessment of the epidemiology literature; represents a useful total fluoride exposure equivalent metric (no alternative safety guidelines for total fluoride exist)

- Review *does not*
 - Evaluate benefits of fluoride or provide a risk/benefit analysis
 - Address whether *sole exposure* to fluoride at 0.7 mg/L in drinking water is associated with neurodevelopment and cognitive effects
- Targeted research that prospectively examines the association between fluoride exposure and children's IQ in optimally fluoridated areas of the United States would add clarity to the existing data at lower levels



Exposure considerations

- Fluoride in drinking water
 - Provides useful estimates of long-term population exposures
 - May underestimate total exposure because it does not capture the amount of water ingested or other sources of ingested fluoride
- Fluoride in urine
 - Biological measure that captures individual's total fluoride exposure
 - Represents a limited (recent) time-period
 - Multiple measurements would be more robust, e.g., cohort studies with maternal urinary fluoride had multiple measures throughout pregnancy
- Small number of studies at low exposure levels
 - Limited exposure contrasts, which makes it more difficult to detect a true effect, if it exists







Relevance to the United States

- NTP conclusions are relevant to some pregnant women, infants, and children living in the United States
 - People may have total fluoride exposures higher than levels in drinking water
 - Over 2.9 million people in the United States served by CWS receive drinking water with >1.5 mg fluoride/L

BY MICHAEL SCHULSON 05.06.2024



NEWS & FEATURES

In Millions of Homes, High Fluoride in Tap Water May Be a Concern

In communities across the U.S., water contains levels of fluoride some experts say could be harm developing brains.

Top: Water tower in Comfort, Texas. Visual: Marcus Wennrich/iStock/Getty Images Plus

Lost in that debate are the roughly 3 million Americans whose water naturally contains higher concentrations of fluoride — often at levels that could have neurodevelopmental effects.

Estimated fluoride levels in community water systems by county



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In Millions of Homes, Hig Water May Be a Concern

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Top: Water tower in Comfort, Texas. Visual: Marcus Wennrich/iStock/Getty Images Plus

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Concentration of fluoride in mg/L

imated fluoride levels in community water systems by county



Fetal and developing brains are especially vulnerable

- Benefits of fluoride are from topical contact with teeth
- No benefit from gestational exposure
- Fetal exposure:
 - Fluoride from maternal blood crosses placenta
 - Fluoride stored in bone and remobilized into bloodstream during pregnancy
- Formula-fed infants residing in fluoridated communities at higher risk of fluoride toxicity
 - 3-4 times greater exposure to fluoride than adults on a per body-weight basis
 - ~70-fold higher fluoride intake than exclusively breastfed infants
 - Retain more fluoride than breastfed infants

The New York Times

Is Fluoridated Drinking Water Safe for Pregnant Women?

New research suggests a link between prenatal fluoride levels and behavioral issues in children. Experts are divided on the study's



By <u>Alice Callahan</u> and <u>Christina Caron</u>



NTP Monograph played central role in recent federal trial

- What was the lawsuit about?
 - Plaintiffs petitioned EPA to evaluate fluoride in drinking water, EPA denied the petition and under Amended Toxic Substances Control Act (TSCA), Plaintiffs were entitled to a judicial review
- Monograph relied on by both Plaintiffs and EPA as a "high-quality review"
- What was the Court's ruling?
 - On September 24, 2024, a federal district judge found that the 0.7 mg/L fluoride in drinking water, level considered "optimal" in the United States, poses an *"unreasonable risk"* of IQ loss in children which, under the toxics law, requires *"a regulatory response"*
 - Finding did not conclude with certainty that fluoridated water is injurious to public health
 - Court finds the risk is *sufficient* to require the EPA to engage with a regulatory response, but does not dictate what that response must be, decision left to the EPA,
 - TSCA allows wide spectrum of potential risk-management measures from warning labels or public advisories to prohibiting the manufacturing and distribution of a chemical

Public health community can use the NTP systematic review as part of ongoing evaluations of the role of fluoride in drinking water

GREENWIRE

EPA 'in a really tough spot' after landmark fluoride ruling

By Ellie Borst, Miranda Willson | 10/18/2024 01:30 PM EDT

Experts say the precedent-setting court decision backing a Toxic Substances Control Act citizen petition could spur other bids to force new chemical rules.



A district court judge ruled that fluoride in drinking water "poses an unreasonable risk of reduced IQ in children." EPA's regulatory response to the ruling remains unclear. Claudine Hellmuth/E&E.hou News(Illustration);EPA(text);Jenn Durfey/Flickr(faucet);Freepik(hands); with glass);umanoide/Unsplash(teeth)

Literature since May 1, 2020?

• Addendum updated through October 2023 to match timeframe of meta-analysis (in press)



Study location and year of publication in studies of fluoride exposure and children's IQ

Year of publication

Literature since May 1, 2020?

- Addendum updated through October 2023 to match timeframe of meta-analysis (in press) ٠
- 28 new studies ٠
 - 12 of 12 high quality studies reported inverse associations (6 in new study populations) _
 - 13 of 16 low quality reported inverse associations —





Acknowledgements

DTT co-authors



Andrew Rooney, PhD Acting Branch Chief IHAB, DTT, NIEHS



John Bucher, PhD (retired)

Former Scientific Director of DNTP

and Associate Director of NTP

ICF co-authors and COR

Sorina Eftim, PhD Christopher Sibrizzi, MPH Robyn Blain, PhD Kristen Magnuson, MESM Pamela Hartman, MEM Kelly Shipkowski, PhD

Integrative Health Assessments Branch

Brandy Beverly, PhD Kembra Howdeshell, PhD Ruth Lunn, DrPH Suril Mehta, DrPH Anisha Singh, PhD Vickie Walker Amy Wang, PhD

Internal reviewers (NIEHS)

Mamta Bell, PhD *(currently Neurocrine Biosciences, Inc.)* Jesse Cushman, PhD Kelly Ferguson, PhD Kimberly Gray, PhD Freya Kamel, PhD *(retired)* Ruth Lunn, DrPH Suril Mehta, DrPH



National Institute of Environmental Health Sciences Division of Translational Toxicology



Thank you! Questions?

email: kyla.taylor@nih.gov