From: Lindsey Horan
Sent: Mon, 2 Nov 2020 18:45:43 +0000
To: D'Souza, Rena (NIH/NIDCR) [E]; Ventura, Jeff (NIH/NIDCR) [E]; Horsford, Jonathan (NIH/NIDCR) [E]; Meister, Alissa (NIH/NIDCR) [E]; Stredrick, Denise (NIH/NIDCR) [E]
Cc: Fox, Christopher (IADR); Makyba Charles-Ayinde; Susan Douglas; New, Suzanne (NIH/NIDCR) [E]
Subject: NIDCR-AADR Meeting Agenda - November 3, 2020
Attachments: November 2020 AADR NIDCR Agenda.pdf

Dear NIDCR team,

Please find attached the agenda for tomorrow's AADR/NIDCR monthly meeting. As always, we look forward to speaking with you!

Sincerely,

Lindsey Horan, M.A., Assistant Director of Government Affairs
International & American Associations for Dental Research
1619 Duke Street, Alexandria, VA 22314-3406, USA
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www.iadr.org www.aadr.org
Publishers of *Journal of Dental Research* and *JDR Clinical & Translational Research*

IADR CENTENNIAL

Upcoming Meetings:

NEW DATE		
IADR/AADR/CADR General Session & Exhibition	July 21-24, 2021	Boston, Mass., USA
AADR/CADR Annual Meeting & Exhibition	March 23-26, 2022	Atlanta, Ga., USA
IADR/APR General Session & Exhibition	June 22-25, 2022	Chengdu, CHINA

AADR®
American Association for Dental Research

NIDCR – AADR Monthly Meeting
Tuesday, November 3, 2020
4:00 p.m. ET

AGENDA

D'Souza, Horsford, Stredrick, Ventura, Meister, Fox, Charles-Ayinde, and Horan

1. Welcoming Dr. D'Souza and Remarks from Dr. D'Souza

2. COVID-19-Related Updates
    a. Updates from NIDCR
    b. Updates from AADR

3. Latest from AADR
    a. AADR Fall Focused Symposium | *Science for the Next Century: Deep Phenotyping*
    b. MIND the Future Program
    c. IADR/AADR/CADR General Session, July 21-24, Boston

4. Science Policy Update
    a. NIDCR Future Research Initiatives
    b. NASEM Fluoride Report
    c. Recommendations about the Use of Dental Amalgam in Certain High-Risk Populations: FDA Safety Communication | Research Implications

5. Legislative Update
    a. Executive Order on Creating Schedule F in the Excepted Service

6. NIDCR Updates

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From: Burns, Robert J.
Sent: Fri, 16 Oct 2020 22:53:13 +0000
To: D'Souza, Rena (NIH/NIDCR) [E]; Horsford, Jonathan (NIH/NIDCR) [E]; Stredrick, Denise (NIH/NIDCR) [E]
Cc: Araujo, Marcelo
Subject: ADA Comments on NTP Fluoride Monograph
Attachments: 201016_ntp_fluoride_monograph_sig.pdf

Hi, Rena, Jonathan, and Denise. Attached is a courtesy copy of comments we submitted to the NASEM panel that is peer reviewing the NTP monograph about the potential neurotoxicity of fluoride. As you well know, the current draft includes a blanket statement that fluoride is a "presumed neurotoxin" at any exposure level.

The ADA is questioning the integrity of studies NTP is using to justify its claim, as well as the universal applicability of the claim itself. We are asking NTP to either (1) change its neurotoxin classification from "presumed" to "unknown", (2) add a prominent statement clarifying that its neurotoxin claim applies only to abnormally high levels of fluoride exposure, or (3) discard its monograph and start over.

Happy reading!

-Bob

Robert J. Burns
Manager, Legislative and Regulatory Policy
Government and Public Affairs
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October 16, 2020

National Academies of Engineering, Sciences and Medicine
Board on Environmental Studies and Toxicology
500 Fifth Street NW
Keck WS625
Washington, DC 20001

Re: Revised NTP Monograph on Fluoride Exposure and Neurodevelopmental and Cognitive Health

To Whom It May Concern:

On behalf of our 163,000 dentist members, we are pleased to comment on the Revised National Toxicology Program Monograph on Fluoride Exposure and Neurodevelopmental and Cognitive Health. We would like to reiterate the concerns expressed in our letter of November 19, 2019, for consideration at your peer review meeting of October 19, 2020.

First, NTP should either discard its monograph and start over, or change its classification of fluoride from a "presumed" neurotoxin to an "unknown" neurotoxin. There is not a wide body of literature examining fluoride as a potential neurotoxin. The literature that *is* available, and which NTP used, is either lacking, unreliable, inconclusive, conflicting, or subject to widespread interpretation. Even NTP acknowledged that its claim of "presumed" neurotoxin are based on a "low-to-moderate level of evidence."

Second, if NTP *does* decide to move forward with its claim that fluoride is a "presumed" neurotoxin, it is critical to clearly and consistently qualify—throughout the document—that its claim applies only to abnormally high levels of fluoride exposure (≥1.5 mg/L). Failing to do so will endanger the public's health and leave the agency vulnerable to charges of risk bias. We suggest some version of the following:

> *The findings and conclusions in this monograph are based on fluoride concentrations that are higher (≥1.5 mg/L) than those typically found in fluoridated drinking water in the United States (0.7 mg/L). The preponderance of scientific literature has not demonstrated a relationship between exposure to fluoride at levels recommended by the Centers for Disease Control and Prevention and the U.S. Public Health Service (0.7 mg/L) and neurocognitive development.*

There are perhaps two or three places in the background, findings, and conclusions where NTP acknowledges that studies of fluoride exposure at levels recommended for community water fluoridation (0.7 mg/L) have not consistently or reliably demonstrated effect on cognitive neurodevelopment. It is a key finding that is overshadowed by the frequently repeated blanket statement that fluoride is presumed to be a neurotoxin—without any context or qualification.

We recognize that the oral health benefits of fluoride are not addressed in this monograph. However, failing to clearly and prominently acknowledge that NTP's findings apply only to abnormally high concentrations of fluoride (≥1.5 mg/L) will generate confusion about the safety of community water fluoridation at levels recommended by the Centers for Disease Control and Prevention and the U.S. Public Health Service (0.7 mg/L). This lack of clarity will add to the many myths and misperceptions about community water fluoridation, and likely undermine state and local efforts to expand the practice.

For your consideration, we are enclosing our comments of November 19, 2019, a critique of the literature used for the monograph, and a copy of the ADA's premier resource on community water fluoridation—*Fluoridation Facts*.

The 2018 edition of *Fluoridation Facts* contains evidence-based answers to the question of whether there is a relationship between consumption of optimally fluoridated water and lowered intelligence quotients or behavioral disorders in children. The evidence from individual studies and systematic reviews does not support claims of a causal relationship.

The CDC hailed community water fluoridation as one of ten great public health achievements of the 20th century.[1-2] It is an inexpensive way to reduce tooth decay by at least 25 percent in the population.[3] It would be a shame to distract from 75 years of public health success over a simple matter of communicating the science, which is often more nuanced than a sound bite can convey.

Whatever final form the monograph takes, we appreciate the opportunity to comment. If you have any questions, please contact Mr. Robert J. Burns at (b) (6) or (b) (6).

Sincerely,

(b) (6)

Chad P. Gehani, D.D.S.
President

(b) (6)

Kathleen T. O'Loughlin, D.M.D., M.P.H.
Executive Director

CPG:KTO:rjb
Enclosures (3)

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[1] Centers for Disease Control and Prevention. Ten Great Public Health Achievements United States, 1900 1999. MMWR 1999; 48 (12): 241 243.

[2] Vivek H. Murthy, Surgeon General's Perspectives: Community Water Fluoridation—One of CDC's 10 Great Public Health Achievements of the 20th Century, *Public Health Rep* 2015; 130(4): 296 298.

[3] American Dental Association, *Fluoridation Facts*, 2018.

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National Fluoridation Advisory Committee
Analysis and Comments

REVISED DRAFT NTP MONOGRAPH ON FLUORIDE EXPOSURE AND NEURODEVELOPMENTAL AND COGNITIVE HEALTH EFFECTS

October 16, 2020

The American Dental Association's National Fluoridation Advisory Committee is pleased to offer the following scientific/technical comments on the National Toxicology Program's Draft Monograph on the Systematic Review of Fluoride Exposure and Neurodevelopmental and Cognitive Health Effects.

The hazard rating of fluoride as *"presumed to be a cognitive neurodevelopmental hazard to humans"* is not supported by the systematic review of fluoride exposure.

Our team has two asks for the National Toxicology Program:

1. **A clear statement of no effect below 1.5 mg/L F in water is needed.**

The revised *Draft NTP Monograph on the Systematic Review of Fluoride Exposure and Neurodevelopmental and Cognitive Health Effects*[i] acknowledges that it lacks the dose-response assessment data to conclude a neurotoxic effect from the fluoride exposure that is present in fluoridated tap water in the US. The report correctly states that "the highest quality experimental animal study [NTP study] reviewed for this monograph (McPherson et al. 2018)[ii] did not find effects of fluoride on learning, memory or motor activity in the critical <20 ppm in drinking water concentration range (page 58)". It is also worth noting that the magnitude of effect changed from a "relatively large magnitude of effect" observed in the NTP 2019 Draft Monograph to one "where the overall pooled effect estimate from the meta-analysis of studies with individual-level measures does not demonstrate a large magnitude of effect" (Page 65). For epidemiological studies the "dose response assessment" Table A5-3 does not present the relationship between degree of exposure and magnitude of neurodevelopmental health effects at or below 0.7 mg/L (i.e., 0-0.7 mg/L, 0.8-1.5 mg/L, >1.6 mg/L etc.) (page 254). **The analysis below 1.5 mg/L F in water shows the absence of an effect [SMD 0.32 (−0.57, 1.20)].** Therefore, the statement that "When focusing on findings from studies with exposures in ranges typically found in drinking water in the United States (0.7 mg/L for optimally fluoridated community water systems) that can be evaluated for dose response effects on cognitive neurodevelopment are inconsistent and, therefore, unclear" is not supported by the analysis. **A clear statement of no effect below 1.5 mg/L F in water is needed.** This is consistent with the recent review from the Leibniz Research Centre, Germany[iii] that reported that "based on the totality of evidence the present review does not support the presumption that fluoride should be considered as a human developmental neurotoxicant at current exposure levels in European countries."

2. Include how Standardized Mean Difference calculations were completed

The meta-analysis was difficult to understand because the details are not described in the protocol. For example, it is not clear how the authors calculated standardized mean difference (SMD) when the means are not presented in the publications or how they handled multiple regression coefficients in generating pooled estimates. Another example is that Table A5-2 and Figure A5-16 list 6 studies that contributed to the analysis of Full-scale IQ, Verbal IQ, and Performance IQ. But the Verbal and Performance IQ data analysis are found only in the Green 2019 paper. How did NTP get the Verbal and Performance IQ data for the other 5 studies?

---

[i] NTP. Draft NTP Monograph on the Systematic Review of Fluoride Exposure and Neurodevelopmental and Cognitive Health Effects. Revised September 16, 2020.

[ii] McPherson CA, Zhang G, Gilliam R, Brar SS, Wilson R, Brix A, Picut C, Harry GJ. 2018. An evaluation of neurotoxicity following fluoride exposure from gestational through adult ages in Long-Evans hooded rats. Neurotoxicol Res: 1-18.

[iii] Guth S, Hüser S, Roth A. et al. Toxicity of fluoride: critical evaluation of evidence for human developmental neurotoxicity in epidemiological studies, animal experiments and in vitro analyses. Archives of Toxicology. Published online 08 May 2020. https://doi.org/10.1007/s00204 020 02725 2

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November 19, 2019

National Toxicology Program
c/o National Academy of Sciences
500 Fifth Street NW
Keck WS625
Washington, DC 20001

Re: Draft Monograph on the Systematic Review of Fluoride Exposure and Neurodevelopmental and Cognitive Health Effects

To Whom It May Concern:

On behalf of our 163,000 dentist members, we are pleased to comment on the National Toxicology Program's Draft Monograph on the Systematic Review of Fluoride Exposure and Neurodevelopmental and Cognitive Health Effects.

At appropriate concentrations, doses and frequency of use in drinking water and dental products, fluoride has proven to reduce the prevalence and severity of tooth decay, a disease with potentially serious consequences. Tooth decay is the most common chronic disease of childhood which also affects the majority of adults. The Centers for Disease Control and Prevention (CDC) hailed community water fluoridation as one of ten great public health achievements of the 20th century.[1-2]

For the last 75 years, people have raised well-meaning questions about the safety and effectiveness of fluoride exposure, including whether fluoride is somehow associated with neurological development. So, in 1977, the ADA established its National Fluoridation Advisory Committee (NFAC), a standing panel of experts who are able to provide ongoing advice about the safety and effectiveness of fluoride.

Enclosed you will find NFAC's observations and comments about the draft monograph and a roster of current members. Our panel of experts concluded that the available literature is insufficient to establish causation between fluoride exposure as experienced in the United States and neurocognitive development. It found that the literature generally is either lacking, unreliable, inconclusive, conflicting or subject to widespread interpretation.

We are also enclosing copy of *Fluoridation Facts* the ADA's premier informational resource on community water fluoridation. *Fluoridation Facts* provides answers to frequently asked questions about fluoride and community water fluoridation. Our goal is to provide clear answers—supported by numerous of credible scientific articles—to help policy makers and the public navigate through the many myths and misperceptions about fluoride.

The 2018 edition of *Fluoridation Facts* contains evidence based answers to the question of whether there is a relationship between consumption of optimally fluoridated water and lowered intelligence quotients or behavioral disorders in children. The evidence from systematic reviews and individual studies does not support claims of a causal relationship.

Given the state of the literature, we ask that you revisit the monograph's draft hazard rating that fluoride is "presumed to be a cognitive neurodevelopmental hazard to humans." It is also critical to the public's health that you include some type of modifier to distinguish the health benefits of optimally fluoridated drinking water, currently recommended at 0.7 parts per million (ppm), from the higher level exposures the monograph addresses (above 1.5 ppm).

Whatever final form the monograph takes, we appreciate the opportunity to comment. If you have any questions, please contact Mr. Robert J. Burns at (b) (6) or (b) (6)

Sincerely,

(b) (6)

Chad P. Gehani, D.D.S.
President

(b) (6)

Kathleen T. O'Loughlin, D.M.D., M.P.H.
Executive Director

CPG:KTO:rjb
Enclosures (3)

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[1] Centers for Disease Control and Prevention. Ten Great Public Health Achievements United States, 1900-1999. MMWR 1999; 48 (12): 241-243.

[2] Vivek H. Murthy, Surgeon General's Perspectives: Community Water Fluoridation—One of CDC's 10 Great Public Health Achievements of the 20th Century, *Public Health Rep* 2015; 130(4): 296-298.

ADA American Dental Association®

National Fluoridation Advisory Committee
Scientific/Technical Comments

on the

National Toxicology Program Draft Monograph on the Systematic Review of Fluoride Exposure and Neurodevelopmental and Cognitive Health Effects

November 19, 2019

The American Dental Association's National Fluoridation Advisory Committee is pleased to offer the following scientific/technical comments on the National Toxicology Program's Draft Monograph on the Systematic Review of Fluoride Exposure and Neurodevelopmental and Cognitive Health Effects.

On November 6, 2019, the Overview of the Systematic Review shared that the NTP found a "moderate level of evidence that high fluoride exposure is associated with decreased IQ and other cognitive effects in children".

However, we believe that the hazard rating of fluoride as *"presumed to be a cognitive neurodevelopmental hazard to humans"* is not supported by the systematic review of fluoride exposure.

We offer these comments and summarize our concerns in the following paragraphs:

1. **The literature review did not take into account the lack of support for a neurobehavioral effect of fluoride from animal studies conducted in the U.S.**

   The NTP animal study concluded that "At these exposure levels, we observed no exposure-related differences in motor, sensory, or learning and memory performance on running wheel, open-field activity, light/ dark place preference, elevated plus maze, pre-pulse startle inhibition, passive avoidance, hot-plate latency, Morris water maze acquisition, probe test, reversal learning, and Y-maze… No evidence of neuronal death or glial activation was observed in the hippocampus at 20 ppm F ." (McPherson et al., 2018, p. 781)[1]." Whitford et al. also concluded that "Chronic ingestion of fluoride at levels up to 230 times more than that experienced by humans whose main source of fluoride is fluoridated water had no significant effect on appetitive-based learning (Whitford, et al, 2009).[2]" It is worth noting these two US studies are not in agreement

[1] McPherson CA, Zhang G, Gilliam R, et al. An Evaluation of Neurotoxicity Following Fluoride Exposure from Gestational Through Adult Ages in Long-Evans Hooded Rats. Neurotox Res. 2018;34(4):781–798. doi:10.1007/s12640-018-9870-x

[2] Whitford, G, Whitford, J, Hobbs, S. Appetitive-based learning in rats: Lack of effect of chronic exposure to fluoride. *Neurotoxicology and Teratology*. 2009; 31(4):210-215. https://doi.org/10.1016/j.ntt.2009.02.003

with many of the animal studies conducted in China and India, thus raising questions about the validity of those other studies.

2. **No meta-analysis was conducted to determine a summary effect size. It appears that the determination that the IQ effect size was large is based on subjective assessment and does not take into account measurement error.**

   Figure D 7 in the review shows 53 beta estimates. Of these 23 are listed as significant (red) and the remaining 30 are not. None of these estimates accounted for the cluster sample design used (the samples were drawn from cities, schools or prenatal clinics). Accounting for cluster design effect may result in larger standard errors, thus reducing the p-value (statistical significance) associated with the results.

3. **The characterization that effect sizes observed were of relatively large magnitude is not consistent with the data that show small effect sizes.**

   IQ assessment in young children is subjective and influenced by multiple factors. Thus, small IQ score differences such as 1.5 points or even 4.5 points are not likely to be readily detectable due to measurement challenges between noise and signal nor have implications for normal children's activities. The review states that the IQ effect is relatively large and thus classifies fluoride as a "presumed" neurotoxin. There are differing views whether the IQ differences are large, and the Canadian Agency for Drugs and Technologies in Health (CADTH) have called the reported IQ effects as small[3]. Therefore, the panel should re-assess the clinical significance of the IQ studies.

4. **The NTP report's assertion that "There is a low expectation that new studies would change the hazard conclusion" is not adequately justified considering that there are no prospective epidemiological studies that were designed to assess the neurobehavioral effects of fluoride.**

   A reanalysis of the Canadian and Mexican studies that takes into account the cluster sampling design may not show an effect. Furthermore, a recent study conducted by Santa-Marina, et al., 2019, in Spain showed, "At the age of 4-5 years, an increase of 1 mg/l in the level of fluoride in urine during pregnancy (mean level of 1st and 3rd trimesters) was related to a higher score on the perceptual-manipulative scale of 4.44

[3] Canadian Agency for Drugs and Technology in Health. Community Water Fluoridation: A Review of Neurological and Cognitive Effects. Ottawa: CADTH; 2019 Oct. (CADTH rapid response report: summary with critical appraisal). ISSN: 1922 8147 (online)
Available at
https://cadth.ca/sites/default/files/pdf/htis/2019/RC1198%20Community%20Water%20Fluoridation%20Exposure%20Final.pdf

(0.13, 0.75) points.[4]" If additional consideration and peer review of this study's results are forthcoming, this certainly would contradict this assertion from the NTP draft report.

With the concerns about the validity, reliability, and generalizability of the research used, we ask the team to reconsider how they classify Fluoride's Hazard Conclusion. With the research community of experts raising questions about the evidence used, the correlation between fluoride exposure in drinking water as publicly available in the United States and neurocognitive development is still unknown.

Also, very importantly, even if the NTP report's classification does not change, an extremely important element that is missing from the conclusion is a modifier to distinguish the difference between a high level of fluoride exposure and any exposure. Without replicated study findings showing strong correlations between fluoride exposures near 0.7 ppm (which is much less than 1.5 ppm, and a relatively rare level in the US) and neurodevelopment, the results are misleading to the public.

The ADA is truly gratified when, in the interest of the public's health and welfare, communities provide optimally fluoridated water to their residents. The current classification is misleading to the public, could scare them unnecessarily, and could ultimately decrease the oral health status of individuals and communities.

[4] Santa-Marina, L, Jimenez-Zabala, A, Molinuevo, A, et al. Fluorinated water consumption in pregnancy and neuropsychological development of children at 14 months and 4 years of age. Environmental Epidemiology. October 2019 Volume 3 Supplement 1 p 386-387 doi: 10.1097/01.EE9.0000610304.33479.18

ADA American Dental Association®

NATIONAL FLUORIDATION ADVISORY COMMITTEE

Dr. Leon Stanislav
Chair, National Fluoridation Advisory Committee

Dr. Jayanth Kumar
Dental Director, State of California
Center for Chronic Disease Prevention and Health Promotion at the California Department of Public Health

Dr. Howard Pollick
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University of Iowa

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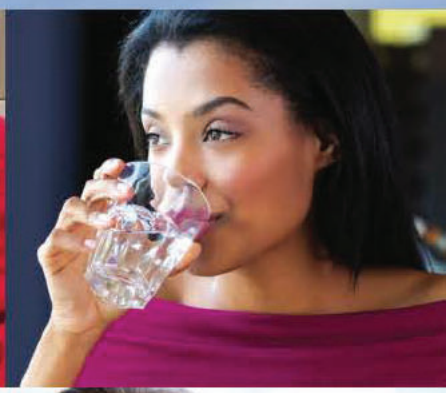
Clinical Director, Geriatric Center Program
Department of Public Health and Community Service

PRACTICAL GUIDE SERIES

Fluoridation Facts



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America's leading advocate for oral health

Dedication

This 2018 edition of Fluoridation Facts is dedicated to Dr. Ernest Newbrun, respected researcher, esteemed educator, inspiring mentor and tireless advocate for community water fluoridation.

About Fluoridation Facts

Fluoridation Facts contains answers to frequently asked questions regarding community water fluoridation. A number of these questions are responses to myths and misconceptions advanced by a small faction opposed to water fluoridation. The answers to the questions that appear in *Fluoridation Facts* are based on generally accepted, peer-reviewed, scientific evidence. They are offered to assist policy makers and the general public in making informed decisions. The answers are supported by over 400 credible scientific articles, as referenced within the document. It is hoped that decision makers will make sound choices based on this body of generally accepted, peer-reviewed science.

Acknowledgments

This publication was developed by the National Fluoridation Advisory Committee (NFAC) of the American Dental Association (ADA) Council on Advocacy for Access and Prevention (CAAP). NFAC members participating in the development of the publication included Valerie Peckosh, DMD, chair; Robert Crawford, DDS; Jay Kumar, DDS, MPH; Steven Levy, DDS, MPH; E. Angeles Martinez Mier, DDS, MSD, PhD; Howard Pollick, BDS, MPH; Brittany Seymour, DDS, MPH and Leon Stanislav, DDS.

Principal CAAP staff contributions to this edition of Fluoridation Facts were made by: Jane S. McGinley, RDH, MBA, Manager, Fluoridation and Preventive Health Activities; Sharon (Sharee) R. Clough, RDH, MS Ed Manager, Preventive Health Activities and Carlos Jones, Coordinator, Action for Dental Health. Other significant staff contributors included Paul O'Connor, Senior Legislative Liaison, Department of State Government Affairs. In addition to her legal review, Wendy J. Wils, Esq., Deputy General Counsel, Division of Legal Affairs provided greatly to the vision of this publication.

Disclaimer

This publication is designed to answer frequently asked questions about community water fluoridation, based on a summary of relevant published articles. It is not intended to be a comprehensive review of the extensive literature on fluoridation and fluorides or to promote professional advice. Readers must also rely on their own review of the literature, including the sources cited herein and any subsequently published, for a complete understanding of these issues.

American Dental Association
Fluoridation Facts 2018

Executive Summary

- Fluoridation of community water supplies is the single most effective public health measure to prevent tooth decay.
- Throughout more than 70 years of research and practical experience, the overwhelming weight of credible scientific evidence has consistently indicated that fluoridation of community water supplies is safe.
- Studies prove water fluoridation continues to be effective in reducing tooth decay by more than 25% in children and adults, even in an era with widespread availability of fluoride from other sources, such as fluoride toothpaste.
- Because of the important role it has played in the reduction of tooth decay, the Centers for Disease Control and Prevention has proclaimed community water fluoridation (along with vaccinations and infectious disease control) one of ten great public health achievements of the 20th century.
- Community water fluoridation is the controlled adjustment of fluoride that occurs naturally in all water to optimal levels to prevent tooth decay.
- Community water fluoridation benefits everyone, especially those without access to regular dental care. Fluoridation is a powerful tool in the fight for social justice and health equity.
- Simply by drinking water, people can benefit from fluoridation's cavity protection whether they are at home, work or school.
- Water that has been fortified with fluoride is similar to fortifying salt with iodine, milk with vitamin D and orange juice with vitamin C — none of which are medications.
- When compared to the cost of other prevention programs, water fluoridation is the most cost-effective means of preventing tooth decay for both children and adults in the United States. The cost of a lifetime of water fluoridation for one person is less than the cost of one filling.
- For community water systems that serve more than 1,000 people, the economic benefit of fluoridation exceeds the cost. And the benefit-cost ratio increases as the size of the population served increases (largely due to economies of scale). Fluoridation is a cost-saving method to prevent tooth decay.
- According to data from 2014, nearly 75% of the population (3 out of 4 people) in the United States are served by public water systems that are optimally fluoridated.
- Fluoridation has been thoroughly tested in the United States' court system, and found to be a proper means of furthering public health and welfare. No court of last resort has ever determined fluoridation to be unlawful.
- The ADA supports community water fluoridation as a safe, effective, cost-saving and socially equitable way to prevent tooth decay.
- One of the most widely respected sources for information regarding fluoridation and fluorides is the American Dental Association. The ADA maintains Fluoride and Fluoridation web pages at ***http://www.ADA.org/fluoride***.

Table of Contents

Introduction

Fluoridation Facts has been published by the American Dental Association (ADA) since 1956. Revised periodically, *Fluoridation Facts* answers frequently asked questions about community water fluoridation. In this 2018 edition, the ADA Council on Advocacy for Access and Prevention provides updated information for individuals and groups interested in the facts about fluoridation. The United States now has more than 70 years of extensive experience with community water fluoridation. Its remarkable longevity and success is testimony to fluoridation's significance as a public health measure. In recognition of the impact that water fluoridation has had on the oral and general health of the public, in 1999, the Centers for Disease Control and Prevention (CDC) named fluoridation of drinking water as one of ten great public health achievements of the 20th century.[1,2]

Many organizations in the United States and around the world recognize the benefits of community water fluoridation.

Support for Water Fluoridation

Since 1950, the American Dental Association (ADA) has continuously and unreservedly endorsed the optimal fluoridation of community water supplies as a safe and effective public health measure for the prevention of tooth decay. The ADA's policy is based on the best available scientific evidence on the safety and effectiveness of fluoridation. Since the ADA first adopted policy recommending community water fluoridation in 1950, the ADA has continued to reaffirm its position of support for water fluoridation and has strongly urged that its benefits be extended to communities served by public water systems.[3]

Over the years, additional support has come from numerous U.S. Surgeons General who are the leading spokespersons on matters of public health in the federal government. In 2016, Surgeon General Dr. Vivek H. Murthy in his "Statement on Community Water Fluoridation,"[4] noted:

> Water fluoridation is the best method for delivering fluoride to all members of the community, regardless of age, education, income level or access to routine dental care. Fluoride's effectiveness in preventing tooth decay extends throughout one's life, resulting in fewer — and less severe — cavities. In fact, each generation born over the past 70 years has enjoyed better dental health than the one before it. That's the very essence of the American promise.[4]

In addition to the American Dental Association, the American Medical Association,[5] the American Academy of Pediatrics[6] and the World Health Organization[7] also support community water fluoridation.

Many organizations in the United States and around the world recognize the benefits of community water fluoridation. The ADA has developed a list of "National and International Organizations that Recognize the Public Health Benefits of Community Water Fluoridation for Preventing Dental Decay." Please see the ADA website at *www.ADA.org/fluoride* for the most current listing as well as information on reproduction and distribution of the list.

Scientific Information on Fluoridation

The ADA's policies regarding community water fluoridation are based on the best available scientific knowledge. This body of knowledge results from the efforts of nationally recognized scientists who have conducted research using the scientific method, have drawn appropriate balanced conclusions based on their research findings and published their results in refereed (peer-reviewed) professional journals that are widely held or circulated. Studies showing the safety and effectiveness of water fluoridation have been confirmed by independent scientific studies conducted by a number of nationally and internationally recognized scientific investigators. While opponents of fluoridation have questioned its safety and effectiveness, none of their charges has ever been substantiated by scientific evidence.

With the advent of the Information Age, a new type of "pseudo-scientific literature" has developed. The public often sees scientific and technical information quoted in the press, printed in a letter to the editor or distributed via an internet web page. Often the public accepts such information as true simply because it is in print. Yet the information is not always based on research conducted according to the scientific method and the conclusions drawn from research are not always scientifically justifiable. In the case of water fluoridation, an abundance of misinformation has been circulated. Therefore, scientific information from all print and electronic sources must be critically reviewed before conclusions can be drawn. (See Figure 1.) Everyone is entitled to his or her own opinion but not his or her own facts. Pseudo-scientific literature can pique a reader's interest but when read as science, it can be misleading. The scientific validity and relevance of claims made by opponents of fluoridation might be

Figure 1. A Guide to Identifying and Using Trustworthy Information

Question The Author

Actively search for study authors' intellectual and financial conflicts of interest that may have affected the conduct of the study or results interpretation.

Correlation Does Not Imply Causation

The fact that two things happen together does not mean that one necessarily causes the other.

Mice vs. Humans

Wait for studies with human subjects to confirm animal studies' results before considering applying the research findings in practice.

Consider The Big Picture

Identify systematic reviews that comprehensively summarize the evidence instead of using single studies that present only a small part of the big picture.

High Impact Journals

Impact factor and reputation of a journal do not necessarily relate to the quality of the published study in question, so always remain skeptical.

The Right Study Design

Some clinical questions cannot be studied using the classic randomized control (RCT) study design and non-RCT designs may be a suitable alternative

best viewed when measured against criteria set forth by the U.S. Supreme Court.[8]

Additional information about this topic can be found in the Public Policy Section, Question 61.

History of Water Fluoridation

Research into the effects of fluoride began in the early 1900s. Dr. Frederick McKay, a young dentist, opened a dental practice in Colorado Springs, Colorado, and was surprised to discover that many local residents exhibited brown stains on their permanent teeth. Dr. McKay could find no documentation of the condition in the dental literature and eventually convinced Dr. G.V. Black, dean of the Northwestern University Dental School in Chicago, to join him in studying the condition. Through their research, Drs. Black and McKay determined that mottled enamel, as Dr. Black termed the condition, resulted from developmental imperfections in teeth. Drs. Black and McKay wrote detailed descriptions of mottled enamel.[9,10] (Mottled enamel is a historical term. Today, this condition is called dental or enamel fluorosis.)

In the 1920s, Dr. McKay, along with others, suspected that something either in or missing from the drinking water was causing the mottled enamel. Dr. McKay wrote to the Surgeon General in 1926 indicating that he had identified a number of regions in Colorado, New Mexico, Arizona, California, Idaho, South Dakota, Texas and Virginia where mottled enamel existed. Also in the late 1920s, Dr. McKay made another significant discovery — these stained teeth were surprisingly resistant to decay.[10]

Following additional studies completed in the early 1930s in St. David, Arizona[11] and Bauxite, Arkansas,[12] it was determined that high levels of naturally occurring fluoride in the drinking water were causing the mottled enamel. In Arizona, researchers studied in great detail 250 residents in 39 local families and were able to rule out hereditary factors and environmental factors, except for one — fluoride in the water which occurred naturally at levels of 3.8 mg/L to 7.15 mg/L.[11] In Bauxite, H. V. Churchill, chief chemist with the Aluminum Company of America (later changed to ALCOA), was using a new method of spectrographic analysis in his laboratory to look at the possibility that the water from an abandoned deep well in the area might have high levels of aluminum-containing bauxite that was causing mottled teeth. What he found was that the water contained a high level of naturally occurring fluoride (13.7 mg/L). When McKay learned of this new form of analysis and Churchill's findings, he forwarded samples of water from areas where mottled enamel was commonplace to Churchill. All of the samples were found to have high levels of fluoride when compared to waters tested from areas with no mottled enamel.[10]

During the 1930s, Dr. H. Trendley Dean, a dental officer of the U.S. Public Health Service, and his associates conducted classic epidemiological studies on the geographic distribution and severity of fluorosis in the United States.[13] These early studies quantified the severity of tooth decay and dental fluorosis, called mottled enamel at that time, according to fluoride levels in the water. In so doing, it was observed that "at Aurora, IL where the domestic water contained 1.2 ppm of fluoride (F) and where a relatively low tooth decay prevalence was recorded, mottled enamel as an esthetic problem was not encountered."[14] Dean and his staff had made a critical discovery. Namely, fluoride levels of up to 1.0 ppm in drinking water did not cause enamel fluorosis in most people and only mild dental fluorosis in a small percentage of people.[14-16]

In 1939, Dr. Gerald J. Cox and his associates at the Mellon Institute evaluated the epidemiological evidence and conducted independent laboratory studies. While the issue was being discussed in the dental research community at the time, they were the first to publish a paper that proposed adding fluoride to drinking water to prevent tooth decay.[17] In the 1940s, four classic, community-wide studies were carried out to evaluate the controlled addition of sodium fluoride to fluoride-deficient water supplies. The first community water fluoridation program, under the direction of Dr. Dean, began in Grand Rapids, Michigan, in January 1945 with Muskegon, Michigan as the nonfluoridated control community. The other three studies were conducted in the following three pairs of cities with the fluoridated city listed first: Newburgh and Kingston, New York (May 1945); Brantford and Sarnia, Ontario, Canada (June 1945) and Evanston and Oak Park, Illinois (February 1947).[18-20]

In the 1940s, four classic, community wide studies were carried out to evaluate the controlled addition of sodium fluoride to fluoride deficient water supplies.

The astounding success of these comparison studies firmly established the practice of water fluoridation as a practical, safe and effective public health measure to prevent tooth decay that would quickly be embraced by other communities.

The history of water fluoridation is a classic example of a curious professional making exacting clinical observations which led to epidemiologic investigation and eventually to a safe and effective community-based public health intervention which even today remains the cornerstone of communities' efforts to prevent tooth decay.

In addition to the studies noted above, a number of reviews on fluoride in drinking water have been issued over the years. For example, in 1951 the National Research Council (NRC), of the National Academies, issued its first report stating fluoridation was safe and effective. The NRC has continued to issue reports on fluoride in drinking water (1977[21] and 1993[22]) with the most recent review published in 2006.[23] Additional reviews completed over the ten year period from 2007-2017 include:

2017 Australian Government. National Health and Medical Research Council (NHMRC). *Information Paper — Water Fluoridation: Dental and Other Human Health Outcomes.*[24]

2016 O'Mullane DM, Baez RJ, Jones S, Lennon MA, Petersen PE, Rugg-Gunn AJ, Whelton H, Whitford GM. *Fluoride and Oral Health.*[25]

2016 American Water Works Association. *Water Fluoridation Principles and Practices.* AWWA Manual M4. Sixth edition.[26]

2015 Water Research Foundation. *State of the Science: Community Water Fluoridation.*[27]

2015 The Network for Public Health Law. *Issue Brief. Community Water Fluoridation.*[28]

2015 Ireland Health Research Board. *Health Effects of Water Fluoridation: An Evidence Review.*[29]

2015 U.S. Department of Health and Human Services Federal Panel on Community Water Fluoridation. *U.S. Public Health Service Recommendation for Fluoride Concentration in Drinking Water for the Prevention of Dental Caries.*[30]

2014 Public Health England. *Water Fluoridation: Health Monitoring Report for England.*[31]

2014 Royal Society of New Zealand and the Office of the Prime Minister's Chief Science Advisor. *Health Effects of Water Fluoridation: a Review of the Scientific Evidence.*[32]

2013 U.S. Community Preventive Services Task Force. The Guide to Community Preventive Services. *Preventing Dental Caries: Community Water Fluoridation.*[33]

2011 European Commission of the European Union Scientific Committee on Health and Environmental Risks (SCHER). *Fluoridation.*[34]

2008 Health Canada. *Findings and Recommendations of the Fluoride Expert Panel.*[35]

2007 Australian Government. National Health and Medical Research Council *A Systematic Review of the Efficacy and Safety of Fluoridation; Part A: Review Methodology and Results.*[36]

Water Fluoridation as a Public Health Measure

Throughout decades of research and more than 70 years of practical experience, fluoridation of public water supplies has been responsible for dramatically improving the public's oral health. In 1994, the U.S. Department of Health and Human Services (HHS) issued a report which reviewed public health achievements.[37] Along with other successful public health measures such as the virtual eradication of polio and reductions in childhood blood lead levels, fluoridation was lauded as one of the most economical preventive interventions in the nation.[37]

Because of the important role fluoridation has played in the reduction of tooth decay, the Centers for Disease Control and Prevention proclaimed community water fluoridation one of ten great public health achievements of the 20th century.[1, 2] Other public health achievements included in the 1999 announcement were vaccinations (which have been responsible for the elimination of polio in the Americas), recognition of tobacco use as a health hazard and the decline in deaths from coronary heart disease and stroke. In 2000, U.S. Surgeon General Dr. David Satcher issued the first ever Surgeon General

report on oral health, *Oral Health in America: a Report of the Surgeon General*.[38] In the report, Dr. Satcher stated that community water fluoridation continues to be the most cost-effective, practical and safe means for reducing and controlling the occurrence of tooth decay in a community. Additionally, Dr. Satcher noted that water fluoridation is a powerful strategy in efforts to eliminate health disparities among populations. Studies have shown that fluoridation is the most significant strategy employed to reduce disparities in tooth decay.[38-42]

Additional information about this topic can be found in the Public Policy Section, Question 59.

Because of the important role fluoridation has played in the reduction of tooth decay, the Centers for Disease Control and Prevention proclaimed community water fluoridation one of ten great public health achievements of the 20th century.[1, 2]

In the 2003 *National Call to Action to Promote Oral Health,*[43] U.S. Surgeon General Dr. Richard Carmona called on policymakers, community leaders, private industry, health professionals, the media and the public to affirm that oral health is essential to general health and well-being. Additionally, Dr. Carmona urged these groups to apply strategies to enhance the adoption and maintenance of proven community-based interventions such as community water fluoridation.

Writing in *Public Health Reports* in 2010, Surgeon General Dr. Rebecca Benjamin noted that, "Community water fluoridation continues to be a vital, cost-effective method of preventing dental caries."[44]

In a 2015 Surgeon's General Perspective[45] issued to coincide with the release of the updated USPHS recommendation on fluoride levels in drinking water to prevent tooth decay, Surgeon General Dr. Vivek H. Murthy stated, "As Surgeon General, I encourage all Americans to make choices that enable them to prevent illness and promote well-being. Community water fluoridation is one of the most practical, cost-effective, equitable, and safe measures communities can take to prevent tooth decay and improve oral health."[45]

Established by the U.S. Department of Health and Human Services (DHHS), Healthy People 2020[46] provides a science-based, comprehensive set of ambitious, yet achievable, ten-year national objectives for improving the health of the public. Included under oral health is an objective to expand the fluoridation of public water supplies. Objective 13 states that at least 79.6% of the U.S. population served by community water systems should be receiving the benefits of optimally fluoridated water by the year 2020.[47] In 2014, the CDC indicated that 74.4% of the U.S. population on public water systems, or a total of 211.4 million people, had access to fluoridated water.[48]

After more than four years of additional research and review following the initial notice of intent, in 2015 the DHHS announced that the U.S. Public Health Service had made a final recommendation on the fluoride level in drinking water[30] that updated and replaced the 1962 Drinking Water Standards related to community water fluoridation. In this guidance, the optimal concentration of fluoride in drinking water of 0.7 mg/L (milligrams per liter) was defined as "the concentration that provides the best balance of protection from dental caries while limiting the risk of dental fluorosis."[30]

Additional information about this topic can be found in the Safety Section, Question 19.

Water Fluoridation's Role in Reducing Tooth Decay

Water fluoridation has played a significant role in improving oral health. Numerous studies and reviews have been published making fluoridation one of the most widely studied public health measures in history. Fluoridation of community water supplies is the single most effective public health measure to prevent tooth decay. Studies show that community water fluoridation prevents at least 25 percent of tooth decay in children[49] and adults,[50] even in an era with widespread availability of fluoride from other sources, such as fluoride toothpaste. Fluoridation helps to prevent, and in some cases, reverse tooth decay across the life span. Increasing numbers of adults are retaining their teeth throughout their lifetimes due in part to the benefits they receive from water fluoridation. Dental costs for these individuals are likely to have been reduced and many

hours of needless pain and suffering due to untreated tooth decay have been avoided. By preventing tooth decay, community water fluoridation has been shown to save money, both for families and the health care system. The return on investment for community water fluoridation varies with size of the community, and in general, increases as the community size increases. Community water fluoridation is cost-saving, even for small communities.

Additional information about this topic can be found in the Cost Section, Question 68.

Fluoridation of community water supplies is the single most effective public health measure to prevent tooth decay. Studies show that community water fluoridation prevents at least 25 percent of tooth decay in children and adults, even in an era with widespread availability of fluoride from other sources, such as fluoride toothpaste.

Community water fluoridation is a most valuable public health measure because:

- Optimally fluoridated water is accessible to the entire community regardless of socioeconomic status, educational attainment or other social variables.[51]
- Individuals do not need to change their behavior to obtain the benefits of fluoridation.
- Frequent exposure to small amounts of fluoride over time makes fluoridation effective through the life span in helping to prevent tooth decay.[52]
- Community water fluoridation is more cost-effective and cost-saving than other forms of fluoride treatments or applications.[53,54]

Tooth decay is caused by sugars in snacks, food and beverages being converted into acid by the bacteria in dental plaque, a thin, sticky, colorless deposit on teeth. The acid attacks the tooth enamel (the hard surface of the tooth) or root surface. After repeated attacks, the enamel or root surface loses minerals (demineralization) and the acids and bacteria penetrate the dentin and finally the pulp. The soft tissue of the pulp contains nerves and blood vessels. Once the decay enters the pulp, it becomes infected and without treatment, the infection progresses and travels into the surrounding tissues. It can enter the bloodstream and potentially spread the infection to other parts of the body which can be life-threatening.

Additional information about this topic can be found in the Benefits Section, Question 2.

There are a number of factors that increase an individual's risk for tooth decay:[54-59]

- Recent history of tooth decay
- Elevated oral bacteria count
- Inadequate exposures to fluorides
- Exposed roots
- Frequent intake of sugar/sugary foods and sugar-sweetened beverages
- Poor or inadequate oral hygiene
- Decreased flow of saliva
- Deep pits and fissures on the chewing surfaces of teeth

Exposure to fluoride is a key component in any recommended decay prevention strategy; however, the use of fluoride alone will not prevent all tooth decay. In formulating a decay prevention program, in additional to consuming fluoridated tap water, a number of intervention strategies may be considered such as improved daily home care, reducing sugar in the diet, placement of dental sealants and prescription strength fluoride toothpaste for home use and professionally applied topical treatments.

Ongoing Need for Water Fluoridation

Because of the risk factors for tooth decay noted previously, many individuals and communities still experience high levels of tooth decay. Although water fluoridation demonstrates an impressive record of effectiveness and safety, only 74.4% of the United States population on public water supplies in 2014 received fluoridated water containing protective levels of fluoride.[48] Unfortunately, some people continue to be confused about this effective public health measure. If the number of individuals drinking fluoridated water is to increase, the public must be accurately informed about its benefits and safety.

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Benefits

1. What is fluoride?

Answer.

Fluoride is a naturally occurring mineral that can help prevent tooth decay.

Fact.

The element fluorine is abundant in the earth's crust as a naturally occurring fluoride compound found in rocks and soil.[1] As ground water moves through the earth, it passes over rock formations and dissolves the fluoride minerals that are present, releasing fluoride ions that are naturally occurring fluoride in the rocks. This increases the fluoride content of the water. The concentration of fluoride in ground water (e.g., wells, springs) varies according to such factors as the depth at which the water is found and the quantity of fluoride-bearing minerals in the area.

Fluoride is present at varied concentrations in all water sources including rainwater and the oceans. For example, the oceans' fluoride levels range from 1.2 to 1.4 mg/L.[2] In the United States, the natural level of fluoride in ground water varies from very low levels to over 4 mg/L.[3] In comparison, the fluoride concentrations in surface water sources such as lakes and rivers is very low. For example, the water analysis completed by the city of Chicago for the year 2016 lists the range for Lake Michigan's natural fluoride level as 0.11 to 0.13 mg/L.[4]

2. How does fluoride help prevent tooth decay?

Answer.

Tooth decay begins when the outer layer of a tooth loses some of its minerals due to acid produced by bacteria in dental plaque breaking down the sugars that we eat. Fluoride protects teeth by helping to prevent the loss of these minerals and by restoring them with a fluoride-containing mineral that is more resistant to acid attacks. In other words, fluoride protects teeth by reducing demineralization and enhancing remineralization. Fluoride also works to hinder bacterial activity necessary for the formation of tooth decay.

Fact.

One of fluoride's main mechanism of action is its ability to prevent or delay the loss of minerals from teeth.[5,6] Cavities start to form when minerals are lost due to acid attacks from bacteria in dental plaque (a soft, sticky film that is constantly forming on teeth). Bacteria grow rapidly by feeding on the sugars and refined carbohydrates that we consume. This process of losing minerals is called demineralization.

Fluoride's second mechanism of action is called remineralization, which is the reversal of this demineralization process.[6,7] Teeth gain back the minerals lost during acid attacks through remineralization but with an important difference. Some of the hydroxyapatatite crystal lost is replaced with fluorapatite. This fluoride-rich replacement mineral is even more resistant to acid attacks than the original tooth surface.[6]

Studies indicate fluoride has a third mechanism of action that hinders the ability of bacteria to metabolize carbohydrates and produce acids.[5] It can also hinder the ability of the bacteria to stick to the tooth surface.[8]

Fluoride and minerals, including calcium and phosphate, are present in saliva[6,8] and are stored in dental plaque. To halt the formation of tooth decay or rebuild tooth surfaces, fluoride must be constantly present in low concentrations in saliva and plaque.[6] Frequent exposure to small amounts of fluoride, such as that which occurs when drinking fluoridated water, helps to maintain the reservoir of available fluoride in saliva and plaque to resist demineralization and enhance remineralization.[6,9] In other words, drinking fluoridated water provides the right amount of fluoride at the right place at the right time. Fluoride in water and water-based beverages is consumed many times during the day, providing frequent contact with tooth structures and making fluoride available to fluoride reservoirs in the mouth. This helps explain why fluoride at the low levels found in fluoridated water helps to prevent tooth decay.[6]

Additionally, studies have concluded that fluoride ingested during tooth formation becomes incorporated into the tooth structure making the teeth more resistant to acid attacks and demineralization.[10-14] In particular, this pre-eruptive exposure to fluoride, before the teeth come into the mouth during childhood, can play a significant role in preventing tooth decay in the pits and fissures of the chewing surfaces, particularly of molars.[6,15,16] Sources of fluorides in the United States that provide this pre-eruptive effect include fluoridated water and dietary fluoride supplements as well as fluoride present in foods and beverages. Additionally, young children often swallow substantial percentages of the fluoride toothpaste and other fluoride-containing dental products which adds to their intake of fluoride. Originally, it was believed that fluoride's action was exclusively pre-eruptive, meaning the benefit occurred only during tooth formation, but by the mid-1950s there was growing evidence of the importance of fluoride's important roles in demineralization and remineralization.[11]

Pre-eruptive effects are sometimes called systemic, while post-eruptive effects are called topical. These terms refer to different things. Pre- and post-eruptive refer to the timing of fluoride benefits while systemic and topical refer to the mode of administration or source of fluoride. Defining the effects of fluoride from a specific source as solely systemic or topical is not entirely accurate. For example, water fluoridation provides both a systemic (during tooth development) and topical effect (at the time of ingestion strengthening the outside of the tooth).

Today it is understood that the maximum reduction in tooth decay occurs when both effects are combined, that is when fluoride has been incorporated into the tooth during formation and when it is available at the tooth surface during demineralization and remineralization. Water fluoridation works in both ways to prevent tooth decay.[8,11,13,15-16]

Today it is understood that the maximum reduction in tooth decay occurs when both effects are combined, that is when fluoride has been incorporated into the tooth during formation and when it is available at the tooth surface during demineralization and remineralization. Water fluoridation works in both ways to prevent tooth decay.

3. What is water fluoridation?

Answer.

Water fluoridation is the controlled adjustment of the natural fluoride concentration in community water supplies to the concentration recommended for optimal dental health. Fluoridation helps prevent tooth decay in children and adults.

Fact.

In 2015, the U.S. Department of Health and Human Services (HHS), using the best available science, established the recommended concentration for fluoride in the water in the United States at 0.7 mg/L.[17] This level effectively reduces tooth decay while minimizing dental fluorosis.

The level of fluoride in water is measured in milligrams per liter (mg/L) or parts per million (ppm). When referring to water, a concentration in milligrams per liter is identical to parts per million and the notations can be used interchangeably. Thus, 0.7 mg/L of fluoride in water is identical to 0.7 ppm. The preferred notation is milligrams per liter.

At 0.7 mg/L, there are seven-tenths of one part of fluoride mixed with 999,999.3 parts of water. While not exact, the following comparisons can be of assistance in comprehending 0.7 mg/L:

- 1 inch in approximately 23 miles
- 1 minute in approximately 1000 days
- 1 cent in approximately $14,000.00
- 1 seat in more than 34 Wrigley Field baseball parks (seating capacity 41,268)

The following terms and definitions are used in this publication:

- **Community water fluoridation** is the controlled adjustment of the natural fluoride concentration in water up to 0.7 mg/L, the level recommended for optimal dental health. Other terms used interchangeably are water fluoridation, fluoridation and optimally fluoridated water. Optimal levels of fluoride can be present in the water naturally or by adjusted means.

- **Sub-optimally fluoridated water** is water that naturally contains less than the optimal level (below 0.7 mg/L) of fluoride. Other terms used are nonfluoridated water and fluoride-deficient water.

Additional information on this topic can be found in this Section, Question 6.

The level of fluoride in water is measured in milligrams per liter (mg/L) or parts per million (ppm). When referring to water, a concentration in milligrams per liter is identical to parts per million and the notations can be used interchangeably. Thus, 0.7 mg/L of fluoride in water is identical to 0.7 ppm. The preferred notation is milligrams per liter.

4. How much fluoride is in your water?

Answer.

If your water comes from a public/community water supply, the options to learn the fluoride level of the water include contacting the local water supplier or the local/county/state health department, reviewing the Consumer Confidence Report (CCR) issued by your local water supplier, and using the Centers for Disease Control and Prevention's internet based "My Water's Fluoride." If your water source is a private well, it will need to be tested and the results obtained from a certified laboratory.

Fact.

The fluoride content of the local public or community water system can be obtained by contacting the local water supplier or the local/county/state health department. The name of your water system might not be the same as the name of your community.

In 1999, the U.S. Environmental Protection Agency (EPA) began requiring water suppliers to make annual drinking water quality reports accessible to their customers. Available prior to July 1 each year for the preceding calendar year, these Consumer Confidence Reports (CCRs), or Water Quality Reports,[18] can be mailed to customers, placed in the local newspaper or made available through the internet. To obtain a copy of the report, contact the local water supplier. If the name of the community water system is unknown, contact the local health department.

There are two sites on the internet that supply information on water quality of community water systems. The online source for Water Quality Reports or CCRs is the EPA website[19] at: ***https://ofmpub.epa.gov/apex/safewater/f?p=136:102***. Additionally, the Centers for Disease Control and Prevention's (CDC) fluoridation website, "My Water's Fluoride,"[20] is available at: ***https://nccd.cdc.gov/DOH_MWF/Default/Default.aspx***. The website allows consumers in currently participating states to learn the fluoridation status of their water system. It also provides information on the number of people served by the water system, the water source, and if the water system is naturally fluoridated or adjusts the fluoride level in the water supply.[20]

The EPA does not have the authority to regulate private drinking water wells. However, the EPA recommends that private well water be tested once a year.[21] For

the most accurate results, a state certified laboratory that conducts drinking water tests should be used for fluoride testing. For a list of state certified laboratories, contact the local, county or state water/health department.

The EPA does not specifically recommend testing private wells for the level of fluoride. However, if a household with a private well has children under 16 years of age, their health professionals will need to know the fluoride level of the well water prior to consideration of prescription of dietary fluoride supplements[8] or to counsel patients about alternative water sources to reduce the risk of fluorosis if the natural fluoride levels are above 2 mg/L.

Dietary fluoride supplements (tablets, drops or lozenges) are available only by prescription and are intended for use by children ages six months to 16 years living in nonfluoridated areas and at high risk of developing tooth decay. Your dentist or physician can prescribe the correct dosage.[8]

Additional information on this topic can be found in this Section, Question 12 and in the Safety Section, Questions 21, 27, 28 and 29.

5. What additives are used to fluoridate water supplies in the United States?

Answer.

Sodium fluoride, sodium fluorosilicate and fluorosilicic acid are the three additives approved for use in community water fluoridation in the United States. Sodium fluorosilicate and fluorosilicic acid are sometimes referred to as silicofluoride additives.

Fact.

The three basic additives used to fluoridate water in the United States are: 1) sodium fluoride which is a white, odorless material available either as a powder or crystals; 2) sodium fluorosilicate which is a white or yellow-white, odorless crystalline material and 3) fluorosilicic acid which is a white to straw-colored liquid.[22]

Water fluoridation began in the U.S. in 1945 with the use of sodium fluoride; the use of silicofluorides began in 1946 and by 1951, they were the most commonly used additives.[23] First used in the late 1940s, fluorosilicic acid is currently the most commonly used additive to fluoridate communities in the United States.[24] To ensure the public's safety, regardless of where the additives are manufactured, they should meet safety standards for water treatment in the U.S.[22] Specifically, additives used in water fluoridation should meet standards of the American Water Works Association (AWWA). With respect to NSF/ANSI certification, fluoride additives are considered no different than other water additives. Fluoride additives, like any other water additive should also meet NSF/ANSI Standards.[22] In the United States, the authority to regulate products for use in drinking water, including additives used to fluoridate community water systems, rests with individual states. In 2013, AWWA reported that 47 states had adopted the NSF/ANSI Standard 60 which specifies the product quality with validation supplied by independent certification entities.[22]

To ensure the public's safety, regardless of where the additives are manufactured, they should meet safety standards for water treatment in the U.S.

Additional information on the topic of fluoride additives can be found in the Fluoridation Practice section of this publication and at the CDC's fluoridation website, "Water Operators and Engineers" at ***https://www.cdc.gov/fluoridation/engineering/index.htm***.

6. Is there a difference in the effectiveness between naturally occurring fluoridated water (at optimal fluoride levels) and water that has fluoride added to reach the optimal level?

Answer.

No. The dental benefits of optimally fluoridated water occur regardless of the fluoride's source.

Fact.

Fluoride is present in water as "ions" or electrically-charged atoms.[25] These ions are the same whether acquired by water as it seeps through rocks and sand or added to the water supply under carefully controlled conditions.

It has been observed that the major features of human fluoride metabolism are not affected by the three fluoride additives used in community water fluoridation nor are they affected by whether the fluoride is present naturally or added to drinking water.[26] In more simple terms, there is no difference chemically between natural and adjusted fluoridation.

When fluoride is added under controlled conditions to fluoride-deficient water, the dental benefits are the same as those obtained from naturally fluoridated water. Fluoridation is merely an increase of the level of the naturally occurring fluoride present in all drinking water sources to the level recommended for optimal dental health.

Fluoridation is merely an increase of the level of the naturally occurring fluoride present in all drinking water sources to the level recommended for optimal dental health.

For example, a fluoridation study conducted in the Ontario, Canada, communities of Brantford (optimally fluoridated by adjustment), Stratford (optimally fluoridated naturally) and Sarnia (fluoride-deficient), revealed much lower decay rates in both Brantford and Stratford as compared to nonfluoridated Sarnia. There was no observable difference in the decay-reducing effect between the naturally occurring fluoride and adjusted fluoride concentration water supplies, proving that dental benefits were similar regardless of the source of fluoride.[27]

Some individuals use the term "artificial fluoridation" to imply that the process of water fluoridation is unnatural and that it delivers a foreign substance into a water supply when, in fact, all water sources contain some fluoride. The fluoride ion released in water is the same regardless of the source[25] and is metabolized (processed) by the body in the same way no matter what the source.[26] Community water fluoridation is a natural way to improve oral health.

7. Is water fluoridation effective in helping to prevent tooth decay?

Answer.

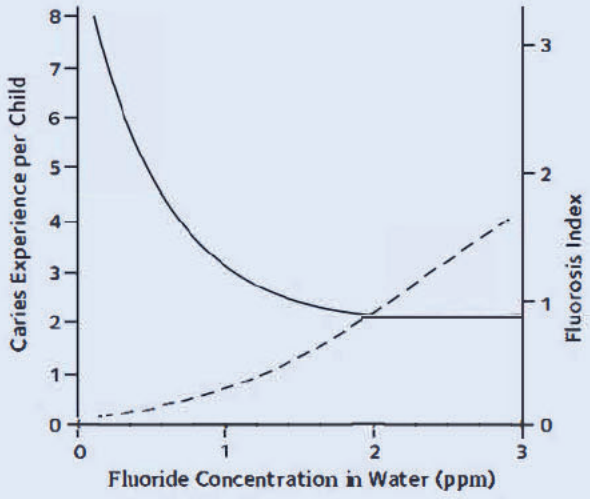
Yes. According to the best available scientific evidence, community water fluoridation is an effective public health measure for preventing, and in some cases, reversing tooth decay, in children, adolescents and adults. With hundreds of studies published in peer-reviewed, scientific journals, fluoridation is one of the most studied public health measures in history and it continues to be studied today.

Fact.

The effectiveness of fluoride in drinking water to prevent tooth decay has been documented in the scientific literature for over 70 years. Before the first community fluoridation program began in 1945, epidemiologic data from the 1930s and 1940s were collected and analyzed.[28-30] What began as research to learn what caused "Colorado Brown Stain" (dental fluorosis) led to the discovery of strikingly low tooth decay rates associated with fluoride in drinking water at approximately 1 ppm (mg/L). Figure 2 shows the results of early research by Dr. H. Trendley Dean noting the relationship between children's experience with tooth decay (solid line), dental fluorosis (dotted line) and the fluoride concentration in drinking water.[28,29]

Additional information on this topic can be found in the Introduction Section.

Figure 2. Dean's Graph
Relationships of tooth decay experience (solid line), dental fluorosis index (dashed line) and the fluoride concentration of drinking water.[28,29]



Since that time, hundreds of studies have been done, including a number of systematic reviews which continue to show fluoride's effectiveness in helping to prevent tooth decay. A systematic review is an analysis of studies that identifies and evaluates all of the evidence with which to answer a specific, narrowly focused question. It entails a systematic and unbiased review process that locates, assesses and combines high quality evidence from a collection of scientific studies to obtain a comprehensive, valid and reliable review on a specific topic. Systematic reviews provide the highest level of scientific evidence about a specific research question. Below is a discussion of major reviews of community water fluoridation, beginning with two systematic reviews published in 2017 and 2013, respectively, demonstrating that water fluoridation is effective in reducing tooth decay.

On November 9, 2017, the Australian Government's National Health and Medical Research Council (NHMRC) released the *NHMRC Public Statement 2017 — Water Fluoridation and Human Health in Australia*[31] recommending community water fluoridation as a safe, effective and ethical way to help reduce tooth decay. Based on a comprehensive review of the evidence, published in 2016, and the translation of that evidence into the *NHMRC Information Paper — Water Fluoridation: Dental and Other Human Health Outcomes*,[32] published in 2017, the Public Statement notes that the NHMRC found that water fluoridation reduces tooth decay by 26% to 44% in children and adolescents, and by 27% in adults. Additionally, it notes that recent Australian research found that access to fluoridated water from an early age is associated with less tooth decay in adults. The Statement notes that NHMRC supports Australian states and territories fluoridating their drinking water supplies within the range of 0.6 to 1.1 mg/L.[31]

Established by the U.S. Department of Health and Human Services in 1996, the Community Preventive Services Task Force develops and disseminates guidance on which community-based health promotion and disease prevention intervention approaches work, and which do not work, based on available scientific evidence. The Task Force issues findings based on systematic reviews of effectiveness and economic evidence. The Guide to Community Preventive Services ("The Community Guide") is a collection of evidence-based findings of the Community Preventive Services Task Force and is designed to assist decision makers in selecting interventions to improve health and prevent disease.[33]

The Community Guide reviews are designed to answer three questions:

1. What has worked for others and how well?

2. What might this intervention approach cost, and what am I likely to achieve through my investment?

3. What are the evidence gaps?[33]

In a 2013 update of the evidence, the Community Preventive Services Task Force continued to recommend community water fluoridation to reduce tooth decay, noting that cavities decreased when fluoridation was implemented and that cavities increased when fluoridation was stopped, as compared to communities that continued fluoridation.[33]

A summary of systematic reviews by the Oral Health Services Research Centre at the University Dental School in Cork, Ireland, published in 2009, reviewed results from three systematic reviews, all of which were published between 2000 and 2007. The summary of results concluded that the best available scientific evidence demonstrated that water fluoridation was an effective community-based method to prevent tooth decay, especially for the disadvantaged who bear the greatest burden of disease.[35]

A meta-analysis (a type of systematic review that seeks to determine a statistical estimate of an overall benefit based on the results of the collection of studies included in the review), which was published in 2007 in the Journal of Dental Research, demonstrated the effectiveness of water fluoridation for preventing tooth decay in adults. Twenty studies representing over 13,500 participants were included in the analysis. Of the 20 studies, nine examined the effectiveness of water fluoridation. The review of these studies found that fluoridation prevents approximately 27% of tooth decay in adults.[36]

Besides systematic reviews, significant additional studies conducted since the initiation of water fluoridation in 1945, also have demonstrated the effectiveness of water fluoridation in reducing the occurrence of tooth decay.

- In Grand Rapids, Michigan, the first city in the world to fluoridate its water supply, a 15-year landmark study showed that children who consumed fluoridated water from birth had 50-63% less tooth decay than children who had been examined during the original baseline survey completed in nonfluoridated Muskegon, Michigan.[37]

- In 1985, the National Preventive Dentistry Demonstration Program[38] analyzed various types and combinations of school-based preventive dental services to determine the cost and effectiveness of these types of prevention programs. Ten sites from across the nation were selected. Five of the sites had fluoridated water and five did not. Over 20,000 second and fifth graders participated in the study over a period of four years. Students were examined and assigned by site to one or a combination of the following groups:
  - biweekly in class brushing and flossing plus a home supply of fluoride toothpaste and dental health lessons (ten per year);
  - in-class daily fluoride tablets (in nonfluoridated areas);
  - in-school weekly fluoride mouthrinsing;
  - in-school professionally applied topical fluoride;
  - in-school professionally applied dental sealants, and
  - a control.[38]

After four years, approximately 50% of the original students were examined again. The study affirmed the value and effectiveness of community water fluoridation. At the sites where the community water was fluoridated, students had substantially fewer cavities, as compared to those sites without fluoridated water where the same preventive measures were implemented. In addition, while sealants were determined to be an effective prevention method, the cost of a sealant program was substantially more than the cost of fluoridating the community water, confirming fluoridation as the most cost-effective preventive option.[38]

- In another review of studies conducted from 1976 through 1987 and published in 1989,[39] data for different age groups were separated into categories by the types of teeth present in the mouth. The results demonstrated a 30-60% reduction in tooth decay in primary teeth, a 20-40% reduction in the mixed dentition (having both baby and adult teeth) and a 15%-35% reduction in the permanent dentition (adults and seniors) for those living in fluoridated communities.[39]

- In the United States, an epidemiological survey of nearly 40,000 schoolchildren was completed in 1987.[40] Nearly 50% of the children aged 5 to 17 years who participated in the study were decay free in their permanent teeth, which was a major change from a similar survey conducted in 1980 in which approximately 37% were decay free. This dramatic decline in decay rates was attributed primarily to the widespread use of fluoride in community water supplies, toothpastes, dietary fluoride supplements and mouthrinses. Although decay rates had declined overall, data also revealed that the decay rate was 25% lower in children with continuous residence in fluoridated communities when the data were adjusted to control for exposure to dietary fluoride supplements and topical fluoride treatments.[40]

- In 1993, the results of 113 studies in 23 countries (over half of the studies were from the U.S.) were compiled and analyzed.[41] This review provided effectiveness data for 66 studies of primary teeth and 86 studies of permanent teeth. The analysis of the studies demonstrated a 40-49% decay reduction for primary (baby) teeth and a 50-59% decay reduction for permanent (adult) teeth for those living in fluoridated communities.[41]

- A comprehensive analysis of the first 50 years of community water fluoridation in the United States concluded that "Community water fluoridation is one of the most successful public health disease prevention programs ever initiated."[42] While noting that the difference in tooth decay between optimally fluoridated communities and fluoride-deficient communities was smaller than in the early days of fluoridation, largely due to additional sources of fluoride, the difference was still significant and the benefits for adults should be emphasized. The report ended by noting that water fluoridation is a near-ideal public health measure whose benefits can transcend racial, ethnic, socioeconomic and regional differences.[42]

The systematic reviews and studies noted above provide science-based evidence that, for more than 70 years, fluoridation has been effective in helping to prevent tooth decay.

8. With other sources of fluoride now available, is water fluoridation still an effective method for preventing tooth decay?

Answer.

Yes. Even in an era with widespread availability of fluoride from other sources, studies show that community water fluoridation prevents at least 25% of tooth decay in children and adults throughout the life span.

Fact.

During the 1940s, studies demonstrated that children in communities with optimally fluoridated drinking water had reductions in tooth decay rates of approximately 40% to 60% as compared to those living in nonfluoridated communities.[37,44] At that time, drinking water was the only source of fluoride other than fluoride that occurred naturally in foods.

Increase in the Number of Sources of Fluoride

Fluoride is available today from a number of sources including water, beverages, food, dental products (toothpaste, rinses, professionally applied fluoride foams, gels and varnish and dietary supplements.)[17] As a result of the widespread availability of these various sources of fluoride, the difference between decay rates in fluoridated areas and nonfluoridated areas is somewhat less than several decades ago, yet it is still significant.[17] Studies show that community water fluoridation prevents at least 25% of tooth decay in children and adults throughout the life span.[36,45] The benefits of fluoridation are extended to everyone in a community where they live, work, attend school or play — and it does not require a change of behavior or access to dental care.

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The Diffusion or Halo Effect

The diffusion or "halo" effect occurs because foods and beverages processed in optimally fluoridated cities generally contain higher levels of fluoride than those processed in nonfluoridated communities. This exposure to fluoride in nonfluoridated areas through the diffusion effect lessens the differences in the amount of tooth decay between communities.[39,42,43] The best available national data demonstrate that the failure to account for the diffusion effect results in an underestimation of the total benefit of water fluoridation especially in areas where large quantities of fluoridated beverage and food products are brought into nonfluoridated communities.[46]

Exposure to Fluoridation over the Life Span

Another factor in the difference between decay rates in fluoridated areas and nonfluoridated areas is the high geographic mobility of our society. On a day-to-day basis, many individuals may reside in a nonfluoridated community but spend a significant part of their day in a fluoridated community at work, school or daycare. Additionally, over their lifetime, people tend to move and reside in a number of communities, some with optimally fluoridated water and some without. This mobility makes it increasingly difficult to study large numbers of people who have spent their entire lives in one (fluoridated or nonfluoridated) community.[39] It also means that many individuals receive the benefit of fluoridation for at least some part of their lives. For children who have resided in fluoridated communities their entire lives, studies demonstrated they had less tooth decay than children who never lived in fluoridated communities.[40]

Despite fluoride from a number of other sources, the "halo effect" and the mobility of today's society, studies show that community water fluoridation prevents at least 25% of tooth decay in children and adults throughout the life span.[36,45]

9. What happens if water fluoridation is discontinued?

Answer.

Tooth decay can be expected to increase if water fluoridation in a community is discontinued even if topical products such as fluoride toothpaste and fluoride mouthrinses are widely used.

Fact.

In 2013, using an updated systematic review, the Community Preventive Services Task Force, established by the U.S. Department of Health and Human Services, continued to recommend community water fluoridation to reduce tooth decay, noting that cavities decreased when fluoridation was implemented and that cavities increased when fluoridation was stopped, as compared to communities that continued fluoridation.[34] This confirmed the Task Force's earlier systematic review published in 2002[45] which also noted an increase in tooth decay when fluoridation was halted (a median 17.9% increase in tooth decay during 6 to 10 years of follow-up).

Historical Studies Noting an Increase in Tooth Decay after Discontinuation of Fluoridation

Antigo, Wisconsin, began water fluoridation in June 1949 and ceased adding fluoride to its water in November 1960. After five and one-half years without optimal levels of fluoride, second grade children had a 200% increase in tooth decay experience, fourth graders a 70% increase and sixth graders a 91% increase in decay experience compared with the levels of those of the same ages in 1960. Residents of Antigo re-instituted water fluoridation in October 1965 on the basis of the severe deterioration of their children's oral health.[47]

A study that reported the relationship between fluoridated water and tooth decay prevalence focused on the city of Galesburg, Illinois, a community whose public water supply contained naturally occurring fluoride at 2.2 mg/L. In 1959, Galesburg switched its community water source to the Mississippi River. This alternative water source provided the citizens of Galesburg a sub-optimal level of fluoride at approximately 0.1 mg/L. In the period of time between a baseline survey conducted in 1958 and a new survey conducted in 1961, data revealed a 10% decrease in the percentage of decay free 14-year-olds (oldest group observed), and a 38% increase in mean tooth decay experience. Two years later, in 1961, the water was fluoridated at the recommended level of 1.0 mg/L.[48]

Because of a government decision in 1979, fluoridation in the northern Scotland town of Wick was discontinued after eight years. The water was returned to its sub-optimal, naturally occurring fluoride level of 0.02 mg/L. Data collected to monitor the oral health of Wick children clearly demonstrated a negative health effect from the discontinuation of water fluoridation. Five years after the cessation of water fluoridation, decay in primary (baby teeth) had increased 27%. This increase in decay occurred during a period when there had been a reported overall reduction in decay nationally and when fluoride toothpaste had been widely adopted. These data suggest that decay levels in children can be expected to rise where water fluoridation is interrupted or terminated, even when topical fluoride products are widely used.[49]

In a similar evaluation, the prevalence of tooth decay in 5- and 10-year-old children in Stranraer, Scotland, increased after the discontinuation of water fluoridation. This increase in tooth decay was estimated to result in a 115% increase in the mean cost of restorative dental treatment for decay. These data support the important role water fluoridation plays in the reduction of tooth decay.[50]

Historical Studies and Factors Noting No Increase In Tooth Decay after Discontinuation of Fluoridation

There have been several studies from outside the United States that have not reported an increase in tooth decay following the discontinuation of fluoridation. In all of these, the discontinuation of fluoridation coincided with the implementation of other measures to prevent tooth decay.

In La Salud, Cuba, a study on tooth decay in children indicated that the rate of tooth decay did not increase after fluoridation was stopped in 1990. However, at the time fluoridation was discontinued a new preventive fluoride program was initiated where all children received fluoride mouthrinses on a regular basis and children two to five years of age received fluoride varnish once or twice a year.[51]

In Finland, a longitudinal study in Kuopio (fluoridated from 1959 to 1992) and Jyväskylä (with low levels of natural fluoride) showed little difference in

decay rates between the two communities that are extremely similar in terms of ethnic background and social structure.[52] This was attributed to a number of factors. The dental programs exposed the Finnish children to intense topical fluoride regimes and dental sealant programs. Virtually all children and adolescents used the government-sponsored, comprehensive, free dental care. As a result, the effect of water fluoridation appeared minimal. Because of this unique set of factors, it was concluded that these results could not be replicated in countries with less intensive preventive dental care programs.[52]

No significant decrease in tooth decay was seen after fluoridation was discontinued in 1990 in Chemniz and Plauen, located in what was formerly East Germany.[53] The intervening factors in these communities include improvements in attitudes toward oral health behaviors, and broader availability and increased use of other preventive measures including fluoridated salt, fluoride toothpaste and dental sealants.[53]

A similar situation was reported from the Netherlands. A study was conducted of 15-year-old children in Tiel (fluoridated 1953 to 1973) and Culemborg (nonfluoridated) comparing tooth decay rates from a baseline in 1968 through 1988. The lower tooth decay rate in Tiel after the cessation of fluoridation was attributed in part to the initiation of a dental health education program, free dietary fluoride supplements and a greater use of professionally applied topical fluorides.[54]

In the preceding examples, communities that discontinued fluoridation either found higher tooth decay rates in their children or a lack of an increase that could be attributed to the availability and use of free dental services for all children or the implementation of wide-spread decay prevention programs that require significant professional and administrative support and are less cost-effective than fluoridation.

10. Is tooth decay still a serious problem in the United States?

Answer.

Yes. Tooth decay is an infectious disease that continues to be a significant oral health problem.

Fact.

Good oral health is often taken for granted by many people in the U.S. Yet, while largely preventable, tooth decay, cavities or dental caries (a term used by health professionals) remains a common, debilitating, chronic condition for many children and adults.

Tooth decay begins with a weakening and/or breakdown (loss of minerals) of the enamel (the hard outer layer of teeth) caused by acids produced by bacteria that live in plaque. Dental plaque is a soft, sticky film that is constantly forming on teeth. Eating foods or drinking beverages that contain sugars or other refined carbohydrates allow the bacteria in the plaque to produce acids that attack the enamel. The plaque helps to keep these acids in contact with the tooth surface and demineralization (loss of mineral) occurs. After repeated acid attacks, the enamel can breakdown creating a cavity. Left unchecked, bacteria and acid can penetrate the dentin (the next, inner layer of teeth) and then finally the pulp, which contains nerves and blood vessels. Once the bacteria enter the pulp, the tooth becomes infected (abscessed) and, without treatment, the infection can progress and travel into the surrounding tissues. The infection can enter the bloodstream and potentially spread the infection to other parts of the body which, in rare cases, becomes life-threatening.

Additional information on this topic can be found in this Section, Question 2.

Tooth decay can negatively affect an individual's quality of life and ability to succeed. Tooth decay can cause pain — pain that can affect how we eat, speak, smile, learn at school or succeed at work. Children with cavities often miss more school and receive lower grades than children who are cavity-free.[55] More than $6 billion of productivity is lost each year in the U.S, because people miss work to get dental care.[56]

While cavities are often thought of as a problem for children, adults in the U.S. are keeping their teeth longer (partially due exposure to fluoridation) and this increased retention of teeth means more adults are at risk for cavities — especially decay of exposed root surfaces.[57,58] Toothroot surfaces are covered with cementum (a softer surface than the enamel) and so are susceptible to decay. As Baby Boomers age, root decay experience is expected to increase in future years possibly to the point where older adults experience similar or higher levels of new cavities than do school children.[57]

Additional information on this topic can be found in this Section, Question 11.

Additionally, once an individual has a cavity repaired with a filling (restoration), that filling can break down over time especially around the edges. These rough edges (or margins) can harbor bacteria that start the cavity process over again or leak which allows the bacteria to enter the tooth below the existing filling. These fillings often need to be replaced — sometimes multiple times over decades — each time growing larger to the point where the best restoration for the tooth is a crown that covers the entire tooth surface. Preventing cavities and remineralizing teeth at the earliest stages of decay is very important not only in saving tooth structure but also in reducing the cost for dental care. Community water fluoridation is an effective public health measure that is a cost-saving and cost-effective approach to preventing tooth decay.

Additional information on this topic can be found in the Cost Section, Question 68.

Oral health disparities exist in the United States and have been documented through extensive studies and reviews.[59-61] Despite the fact that millions of people in the U.S. enjoy good dental health, disparities exist for many racial and ethnic groups, as well as by socioeconomic status, sex, age and geographic location.[62] Water fluoridation helps to reduce the disparities in oral health at the community level as it benefits all residents served by community water supplies. In his 2001 Statement on Community Water Fluoridation,[63] former Surgeon General Dr. David Satcher noted:

> ...community water fluoridation continues to be the most cost-effective, practical and safe means for reducing and controlling the occurrence of dental decay in a community...water fluoridation is a powerful strategy in efforts to eliminate health disparities among populations.[63]

Additional information on this topic con be found in the Public Policy Section, Question 59.

Today, the major focus for achieving and maintaining oral health is on prevention. Established by the U.S. Department of Health and Human Services, Healthy People 2020[64] provides a science-based, comprehensive set of ambitious, yet achievable, ten-year national objectives for improving the health of the public. Included under oral health is an objective to expand the fluoridation of public water supplies. Objective 13 states that at least 79.6% of the U.S. population served by community water systems should be receiving the benefits of optimally fluoridated water by the year 2020.[65] Data from the CDC indicate that, in 2014, 74.4% of the U.S. population on public water systems, or a total of 211.4 million people, had access to fluoridated water.[66] Conversely, approximately 25% or more than 72.7 million people on public water systems do not receive the decay preventing benefits of fluoridation.

While cavities are often thought of as a problem for children, adults in the U.S. are keeping their teeth longer (partially due exposure to fluoridation) and this increased retention of teeth means more adults are at risk for cavities especially decay of exposed root surfaces.

11. Do adults benefit from fluoridation?

Answer.

Yes. Fluoridation plays a protective role against tooth decay throughout life, benefiting both children and adults.

Fact.

While the early fluoridation trials were not designed to study the possible benefits fluoridation might have for adults, by the mid-1950s, it became evident from the results of the first fluoridation trial in Grand Rapids, Michigan, that the beneficial effects of fluoridation were not confined to children drinking the fluoridated water from birth. The fact that a reduction in tooth decay was observed for teeth which had already been calcified or were erupted when fluoridation was started indicated that a beneficial effect could be gained by older age groups.[67, 68] Today it is understood that the maximum reduction in tooth decay occurs when fluoride has been incorporated into the tooth during formation and when it also is available at the tooth surface during demineralization and remineralization. Fluoridation works in both ways to prevent tooth decay.[9,12,14,16,17]

Fluoride and minerals, including calcium and phosphate, are present in saliva[7,9] and are stored in dental plaque (a soft, sticky film that is constantly forming on teeth). To halt the formation of tooth decay or rebuild tooth surfaces, fluoride must be constantly present in low concentrations in saliva and plaque.[7] Frequent exposure to small amounts of fluoride, such as occurs when drinking fluoridated water, helps to maintain the reservoir of available fluoride in saliva and plaque to resist demineralization and enhance remineralization.[7,10] In other words, drinking fluoridated water provides the right amount of fluoride at the right place at the right time. Fluoride in water and water-based beverages is consumed many times during the day, providing frequent contact with tooth structures and making fluoride available to fluoride reservoirs in the mouth. This helps explain why fluoride at the low levels found in fluoridated water helps to prevent tooth decay in teeth after they have erupted.[7]

Additional information on this topic can be found in this Section, Question 2.

While teeth already present in the mouth when exposure to water fluoridation begins receive the benefit of decay protection, studies have indicated that adults who have consumed fluoridated water continuously from birth receive the maximum protection against tooth decay.[10-14]

An Australian study published in 2008 investigating decay experience among Australian Defense Force personnel showed that a longer period of exposure to water fluoridation was associated with lower decay rates in adults between the ages of 17 and 44. Adults who lived at least 90% of their lifetime in communities with fluoridated water had 24% less decay than adults who lived in fluoridated areas for less than 10% of their lifetimes.[69]

A meta-analysis published in 2007 examining the effectiveness of fluoridation for adults found that fluoridation prevents approximately 27% of tooth decay in adults. It included only studies that were published after 1979. The studies were limited to participants who were lifelong residents of communities with fluoridated water and a control group of lifelong residents of communities without fluoridated water.[57]

A study published in 2002 examined the differences in tooth decay patterns between two cohorts of young adults: the first grew up before fluoridation was widely available and the second after fluoridation became more widespread. Comparing data from two different U.S. National Health and Nutrition Examination Surveys (NHANES), NHANES I (1971-1974) and NHANES III (1988-84), results indicated that total tooth decay declined among people aged 45 years and younger. No decline was observed in people aged 46 to 65, a cohort that grew up during the late 40s and early 50s before fluoridation was widely available. This was identified as the major reason this older cohort did not show a decline in tooth decay.[70]

In 1989, a study conducted in the state of Washington found that adults (20-34 years of age) who had a continuous lifetime exposure to fluoridation water had 31% less tooth decay experience compared to similar aged adults with no exposure to fluoridated water. It also concluded that exposure to fluoridation only during childhood has lifetime benefits since adults exposed to fluoridated water only during childhood had decay experience similar to those adults exposed to fluoridated water only after age 14.[71]

An important issue for adults is the prevention of root decay.[57,58] People in the United States are living longer and retaining more of their natural teeth than ever