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# Water fluoridation for the prevention of dental caries

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## Abstract

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### Background

Dental caries is a major public health problem in most industrialised countries, affecting 60% to 90% of school children. Community water fluoridation (CWF) is currently practised in about 25 countries; health authorities consider it to be a key strategy for preventing dental caries. CWF is of interest to health professionals, policymakers and the public. This is an update of a Cochrane review first published in 2015, focusing on contemporary evidence about the effects of CWF on dental caries.

### Objectives

To evaluate the effects of initiation or cessation of CWF programmes for the prevention of dental caries.

To evaluate the association of water fluoridation (artificial or natural) with dental fluorosis.

### Search methods

We searched CENTRAL, MEDLINE, Embase and four other databases up to 16 August 2023. We also searched two clinical trials registers and conducted backward citation searches.

### Selection criteria

We included populations of all ages.

For our first objective (effects of initiation or cessation of CWF programmes on dental caries), we included prospective controlled studies comparing populations receiving fluoridated water with those receiving non-fluoridated or naturally low-fluoridated water. To evaluate change in caries status, studies measured caries both within three years of a change in fluoridation status and at the end of study follow-up.

For our second objective (association of water fluoridation with dental fluorosis), we included any study design, with concurrent control, comparing populations exposed to different water fluoride concentrations. In this update, we did not search for or include new evidence for this objective.

# Data collection and analysis

We used standard methodological procedures expected by Cochrane.

For our first objective, we included the following outcomes as change from baseline: decayed, missing or filled teeth (‘dmft’ for primary and ‘DMFT’ for permanent teeth); decayed, missing or filled tooth surfaces ('dmfs' for primary and 'DMFS' for permanent teeth); proportion of caries-free participants for both primary and permanent dentition; adverse events. We stratified the results of the meta-analyses according to whether data were collected before or after the widespread use of fluoride toothpaste in 1975.

For our second objective, we included dental fluorosis (of aesthetic concern, or any level of fluorosis), and any other adverse events reported by the included studies.

# Main results

We included 157 studies. All used non-randomised designs. Given the inherent risks of bias in these designs, particularly related to management of confounding factors and blinding of outcome assessors, we downgraded the certainty of all evidence for these risks. We downgraded some evidence for imprecision, inconsistency or both. Evidence from older studies may not be applicable to contemporary societies, and we downgraded older evidence for indirectness.

**Water fluoridation initiation (21 studies)**

Based on contemporary evidence (after 1975), the initiation of CWF may lead to a slightly greater change in dmft over time (mean difference (MD) 0.24, 95% confidence interval (CI) -0.03 to 0.52; P = 0.09; 2 studies, 2908 children; low-certainty evidence). This equates to a difference in dmft of approximately one-quarter of a tooth in favour of CWF; this effect estimate includes the possibility of benefit and no benefit. Contemporary evidence (after 1975) was also available for change in DMFT (4 studies, 2856 children) and change in DMFS (1 study, 343 children); we were very uncertain of these findings.

CWF may lead to a slightly greater change over time in the proportion of caries-free children with primary dentition (MD -0.04, 95% CI -0.09 to 0.01; P = 0.12; 2 studies, 2908 children), and permanent dentition (MD -0.03, 95% CI -0.07 to 0.01; P = 0.14; 2 studies, 2348 children). These low-certainty findings (a 4 percentage point difference and 3 percentage point difference for primary and permanent dentition, respectively) favoured CWF. These effect estimates include the possibility of benefit and no benefit. No contemporary data were available for adverse effects.

Because of very low-certainty evidence, we were unsure of the size of effects of CWF when using older evidence (from 1975 or earlier) on all outcomes: change in dmft (5 studies, 5709 children), change in DMFT (3 studies, 5623 children), change in proportion of caries-free children with primary dentition (5 studies, 6278 children) or permanent dentition (4 studies, 6219 children), or adverse effects (2 studies, 7800 children).

Only one study, conducted after 1975, reported disparities according to socioeconomic status, with no evidence that deprivation influenced the relationship between water exposure and caries status.

**Water fluoridation cessation (1 study)**

Because of very low-certainty evidence, we could not determine if the cessation of CWF affected DMFS (1 study conducted after 1975; 2994 children). Data were not available for other review outcomes for this comparison.

**Association of water fluoridation with dental fluorosis (135 studies)**

The previous version of this review found low-certainty evidence that fluoridated water may be associated with dental fluorosis. With a fluoride level of 0.7 parts per million (ppm), approximately 12% of participants had fluorosis of aesthetic concern (95% CI 8% to 17%; 40 studies, 59,630 participants), and approximately 40% had fluorosis of any level (95% CI 35% to 44%; 90 studies, 180,530 participants). Because of very low-certainty evidence, we were unsure of other adverse effects (including skeletal fluorosis, bone fractures and skeletal maturity; 5 studies, incomplete participant numbers).

# Authors' conclusions

Contemporary studies indicate that initiation of CWF may lead to a slightly greater reduction in dmft and may lead to a slightly greater increase in the proportion of caries-free children, but with smaller effect sizes than pre-1975 studies. There is insufficient evidence to determine the effect of cessation of CWF on caries and whether water fluoridation results in a change in disparities in caries according to socioeconomic status. We found no eligible studies that report caries outcomes in adults.

The implementation or cessation of CWF requires careful consideration of this current evidence, in the broader context of a population's oral health, diet and consumption of tap water, movement or migration, and the availability and uptake of other caries-prevention strategies. Acceptability, cost-effectiveness and feasibility of the implementation and monitoring of a CWF programme should also be taken into account.

## PICOs

## Plain language summary

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# Does adding fluoride to water supplies prevent tooth decay?

**Key messages**

- Adding fluoride to water supplies may lead to slightly less tooth decay in children’s baby teeth.

- It may also lead to slightly more children being free of tooth decay.

- The benefits of fluoride in water supplies may be smaller than they were before the widespread addition of fluoride to toothpaste.

**Tooth decay and the use of fluoride**

Tooth decay is a worldwide problem affecting most adults and children. Untreated decay may cause pain and lead to teeth having to be removed.

Fluoride is a mineral which occurs naturally in water at different concentrations. It prevents tooth decay. Since 1975, fluoride has been an ingredient in most toothpastes. It is available in some mouth-rinses, and dentists use treatments that contain fluoride. It is possible to add fluoride to the local water supply. In this case, everyone in a community will have access to fluoride.

If young children swallow too much fluoride while their permanent teeth are forming, marks may develop on those teeth – this is called dental fluorosis. This can be very mild, with barely noticeable white lines or streaks. Rarely, some fluorosis is more noticeable, and people can dislike how their teeth look.

**What did we want to find out?**

We wanted to find out if water with added fluoride in the local water supply is better than water without added fluoride at:

- reducing the number of teeth, or tooth surfaces, with signs of decay;

- increasing the number of people who have no tooth decay.

We also wanted to find out about unwanted effects.

**What did we do?**

We searched for studies comparing communities that had fluoride added to their water supplies with communities that had no additional fluoride in their water.

The last time we published this Cochrane review, we also searched for studies that reported dental fluorosis and the concentration of fluoride in the water. Because the association of fluoridated water with dental fluorosis is widely accepted, we did not update the evidence on this occasion.

**What did we find?**

We found 21 studies that assessed the effects of adding fluoride to a water supply. We also found one study that assessed the effects of stopping artificially-added fluoride in a water supply. Studies only measured tooth decay in children.

In the last version of the review – not updated on this occasion – we found 135 studies that assessed the association of fluoridated water with dental fluorosis.

**Main results**

Studies conducted after 1975 showed that adding fluoride to water may lead to slightly less tooth decay in children's baby teeth. We could not be sure whether adding fluoride to water reduced tooth decay in children's permanent teeth or decay on the surfaces of permanent teeth.

Adding fluoride to water may slightly increase the number of children who have no tooth decay in either their baby teeth or permanent teeth. However, these results also included the possibility of little or no difference in tooth decay.

Studies conducted in 1975 or earlier showed a clear and important effect on prevention of tooth decay in children. However, due to the increased availability of fluoride in toothpaste since 1975, it is unlikely that we will see this effect in all populations today.

We were unsure whether there were any effects on tooth decay when fluoride is removed from a water supply.

We were unsure if fluoride reduces differences in tooth decay between richer and poorer people.

In the last version of the review, we found that adding fluoride to water supplies increases the number of people with dental fluorosis. If water contains 0.7 mg/L of fluoride, about 12% of people may have dental fluorosis that causes them to be bothered about how their teeth look, and about 40% of people may have dental fluorosis of any level. We were unsure whether fluoride in water leads to other unwanted effects.

**What are the limitations of the evidence?**

Our confidence in the evidence is limited because this review included studies in which communities were deliberately selected to have changes to fluoride levels in the water supply. Although a common study approach for this topic, it can mean that there are differences between communities that might affect the results. In addition, the findings in some studies were different from others, and some results included the possibility of benefit and no benefit.

Older studies were conducted before the widespread use of fluoride toothpaste and other improvements in tooth decay prevention. This meant we could not tell if these results were applicable to current times. However, they may still be relevant to countries in which tooth decay is very high and people don't have easy access to fluoride toothpaste and other prevention strategies.

**How current is this evidence?**

For the effects of water fluoridation on tooth decay, this review updates our previous review and the evidence is current to August 2023.

For the association of fluoridated water with dental fluorosis, the review evidence is current to February 2015.