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Community Water Fluoridation and the Benefits for Adults

Abstract: While community water fluoridation (CWF) is widely endorsed by public health bodies around the world as an effective and safe public health measure to reduce levels of tooth decay, much of the evidence underpinning this, and therefore much of the stated rationale, is centred on the benefits for children, despite dental caries in adults being a significant public health problem. In this article, we explore why this is and what the available evidence tells us about the impact of CWF on adults.

CPD/Clinical Relevance: Fluoridation is an issue to consider when risk-assessing patients of all ages for dental caries.

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Dental caries in adults is a significant public health issue¹ and, in the UK, this is particularly relevant given our ageing dentate population. The risk of caries exists as long as there are teeth, and dental teams are often presented with older patients with extensive caries who also live with serious chronic health problems that make dental treatment more challenging and risky for the patient. The most recently published adult dental health survey for England¹ showed that just over one-third of adults reported a need for dental treatment or advice, and, of these, the commonest reported problem was a broken or decayed tooth, followed by toothache or mouth pain. These problems were more prevalent in older adults. The challenges of access to affordable dental care during and after the COVID-19 pandemic makes the prevention of disease at a population level particularly important.

The aim of this article is to review the evidence on the effect of CWF on caries in adults, and discuss the implications for oral health policy.

Community water fluoridation and dental caries in adults

It is tempting to assume that because community water fluoridation (CWF) is effective in reducing levels of dental caries in permanent teeth in children, this benefit is also seen in permanent teeth in adults. The reasonable logic models for this assumption include:

- Caries risk is greater in childhood and so preventing disease in childhood will address the period of greatest risk for individuals;
- Entering adulthood with fewer teeth affected by caries will translate into

longer-term benefits through, for example, not having restorations that will fail and require replacing; and

- The topical-systemic mechanism for caries prevention, through making low levels of fluoride available at the tooth surface throughout the day^{2,3} is just as likely to be effective for permanent teeth in adults as it is for children. Therefore, CWF is likely to confer ongoing reduction in risk of caries over and above any benefit received (or not received) in childhood.

While the above may be true, the evidence base for CWF contains more on children than it does on adults. This is likely to be for two main reasons:

- Epidemiological (population) studies of adults are more difficult and more expensive to conduct. Representative samples of children for surveys can be drawn from educational sources, such as school class lists, and groups of children can be examined in schools. This convenience is not applicable for adults.
- Assumptions over an individual's exposure to CWF, based on where they currently live, are probably valid for children, particularly younger children

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who are more likely to have lived in one general area all their lives. This assumption is less tenable for adults and would be an example of an ecological fallacy. Adult studies in particular would need to capture the lifetime exposure to fluoridated water, which requires careful investigation. Furthermore, estimating the experience of caries becomes progressively more difficult in adults with increasing age because other disease processes start to result in restorations and missing teeth.

Single studies can be difficult to interpret, due to methodological limitations as well as the effect of chance in the results. Evidence reviews are preferable, but much depends on the criteria used for inclusion.

The 2007 Griffin review

The review by Griffin *et al* in 2007⁴ was the first such review to attempt to summarize the effect in adults in studies published after 1979. The review included a meta-analysis to explore how effective fluoride was in preventing caries in adults, including self- and professionally applied fluorides and CWF. The prevalence of both coronal and root caries was studied.

There were strict entry criteria for selecting the research for the review and the authors found 20 studies that met their initial criteria, of which nine focused on the effectiveness of water fluoridation. There were seven studies that were cross-sectional in design and compared caries prevalence between life-long residents living in either a fluoridated or non-fluoridated community. Overall, the work showed that there was a reduction in caries attributable to fluoride for all methods of fluoride delivery. These results mirrored the reported reductions of tooth decay in children. The magnitude of this caries-reduction effect from any fluoride delivery system was around 25%. Community water fluoridation programmes resulted in similar caries reductions to other methods of fluoride delivery, both in coronal and root tissues.

Examples of studies of fluoridation in adults

There are two published surveys from the USA where the caries experience was compared over time and these are the First National Health and Nutrition Examination Survey, or NHANES I, which took place between 1971 and 1974, followed by

NHANES III (1988–1994). Details of access to the NHANES study materials and review is included in Slade *et al*.⁵ Comparisons between the two similar populations and the reduction in the number of carious surfaces was impressive. The decrease was measured at 27.26%, which when converted to number of carious surfaces, shows a decline from 38.20 in NHANES I to 27.86 surfaces in NHANES III.

The reduction in caries in children over the lifetime of the surveys was found to extend to adults. For example, untreated caries declined from 3.64 to 1.82 which was a decrease of 50%. In NHANES I, the young people examined grew up before widespread community water fluoridation. NHANES III was able to compare the same population who were then adults and had grown up with water fluoridation. Therefore, the survey reported on the effect of fluoridation and preventive dentistry. From these studies it is possible to conclude:

- Access to fluoridated water gives reductions in caries experience;
- Continual access to fluoridated water had the strongest association with caries outcome for young adults.

Slade *et al* reported on two adult cohorts that were followed from the 2004–2006 National Australian Survey of Adult Oral Health.² These adults were born before 1960, prior to widespread fluoridation ($n = 2270$). Another group consisted of adults born between 1960 and 1990 ($n = 1509$). This was at a time when population coverage of fluoridation increased from <1% to 67%. Therefore the research compared a greater than 75% lifetime exposure to fluoridation versus a less than 25% lifetime exposure. The results showed that there were 11% and 10% fewer DMF-teeth in pre-1960 compared to the 1960–1990 cohort, respectively. The corresponding reductions in DF-Surfaces were 30% and 21% respectively. This study showed that adults do benefit from water fluoridation as shown by a corresponding reduction in caries. The effect was at least as great in adults born before widespread implementation of fluoridation as after widespread implementation of fluoridation.

Spencer *et al* reported a longitudinal cohort study of children from South Australia who were followed into adulthood.⁶ Importantly, lifetime exposure to CWF was assessed, expressed as a percentage lifetime access to fluoridated water (%LAFW). Like all such studies, there was difficulty in tracing all those examined

at baseline, but half were ($n = 1221$, aged 20–35 year). The numbers and nature of the sample restricted analysis to comparing those with lifetime exposure (100%LAFW) to those with 0–74% and 75–99%LAFW, but even with this comparison, those adults without lifetime exposure had 1.26 times the amount of caries experience compared with those with 0–74% lifetime exposure. Interestingly, the results also suggested that early-years exposure was as strongly associated with outcomes as ongoing exposure, supporting the topical-systemic effect over the purely systemic effect.

A cross-sectional study was conducted by the National Lithuanian Oral Health Survey between 2017 and 2019.⁷ The study included a stratified random sample of 1398 adults between the ages of 35 and 74 years. The researchers looked at the association between fluoride levels in drinking water and dental caries experience in adults of varying tooth surface susceptibility. It was found that high fluoride levels in drinking water were associated with lower dental caries experience in adults.⁷

A study of young adults was undertaken in Canada. This was a national sample and focused on newly enrolled Canadian Armed Forces members.⁸ The researchers were able to identify those adults who had residence in a Canadian municipality with water fluoridation. The average age of the recruits was 24 years and the group was predominantly male. When the young adults were adjusted for age and gender, there were reductions (in caries?) for those recruits from areas where there was water fluoridation. These lower amounts of disease were reported as for DMFT by 0.67 (CI: -0.55– -0.79) points and DMFS by 1.77 (CI: -1.46– -2.09) points. These reductions were across the board for age and rank of the individuals.⁸

Reduced caries experience has been reported by several other studies that have looked at older populations in fluoridated areas. Findings include older adults having more teeth,⁹ less caries¹⁰ and an overall lasting improvement in the state of the dentition.¹¹ This improvement has been seen across ethnic and economic inequalities in oral health.

Using tooth loss as a measure of the success of water fluoridation has also found that there are benefits. An investigation into the causal effect of tooth loss on the instrumental activities of daily living (IADL) among older adults in England showed that being exposed to fluoridated water was

associated with having more natural teeth in later life.¹²

More recent evidence reviews

The evidence for the 2015 Cochrane review was restricted to before and after studies that met the reviewers' criteria for inclusion.¹³ The review identified no evidence that met the criteria to determine the effectiveness of water fluoridation for preventing caries in adults. There is a strong view that the inclusion criteria were too restrictive and so excluded informative evidence.¹⁴ The 2019 Canadian review (CADTH) was broader in scope, and concluded that, overall, there was consistent evidence that CWF reduced caries in permanent teeth in both children and adults.¹⁵ The 2021 New Zealand update to an earlier 2014 review also concluded that CWF was beneficial for adults.¹⁶

More evidence needed?

No single study is without its limitations, and attempts to introduce more sophisticated methodologies can introduce more challenges. The ideal results would probably come from further longitudinal studies that have low rates of drop-out and capture individual CWF exposure and other factors relevant to caries risk in detail, along with robust measures of caries experience and impact. Given the risk of caries into old age, such studies might take decades to conclude. Even if such challenging studies could be successfully undertaken, it could be argued that the results might not be applicable to contemporary child cohorts who might have a different lifetime caries trajectory to those currently in adulthood.

Ecological studies in adults are fraught with difficulty in ascertaining CWF exposure and caries experience, well-conducted cross-sectional studies involving individual assessment of lifetime exposure, interviews to assess impact of caries experience, and dental examinations to quantify caries experience, might be the best we could aim for in future studies.

Summary

A series of evidence reviews from around the world have concluded that CWF confers dental health benefits for adults. One additional review found no evidence that matched the systematic review's inclusion criteria. Individual studies using a range of methodologies, but including longitudinal

studies, have identified dental health benefit for adults. Studies of the effect of CWF on caries in adults are challenging to undertake and the results can be hard to interpret. There is little evidence on older adults who are increasingly a group of concern. Further well-conducted studies, within the practical limitations we describe, would add to the evidence base.

Conclusion

The balance of evidence currently available supports the view that CWF benefits adults, as well as children.

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Compliance with Ethical Standards

Conflict of Interest: The authors declare that they have no conflict of interest.

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