Public Health England

Protecting and improving the nation's health

Water Fluoridation

Health monitoring report for England 2018

Executive summary

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Background

Dental caries (tooth decay) is largely preventable. Those with dental caries can suffer pain and infection and often have difficulties eating, sleeping and socialising. It is a significant public health problem internationally and in England with 12% of three-year-olds having caries in their primary teeth and 25% of five-year-olds, rising up to half of surveyed five-year-olds in the worst affected local authority areas[1, 2]. Sizeable inequalities in the prevalence of caries exist between affluent and deprived communities, and it is a common cause of hospital admissions in children[3].

Fluoride is naturally occurring and likely to be found in sources of drinking water, in varying amounts. It is also present in some foods and drinks, and in the majority of toothpastes. During the early 20th century, lower levels of dental caries were found to be associated with certain fluoride levels in drinking water. This observation led ultimately to water fluoridation schemes that adjust fluoride levels in community water supplies in an effort to reduce dental caries. In some parts of England the level of fluoride in the public water supply already reaches the target concentration of water fluoridation schemes (one milligram per litre (1mg/l), sometimes expressed as one part per million (1ppm)), as a result of the geology of the area. In other areas the fluoride concentration has been adjusted to reach this level as part of a fluoridation scheme. Currently, around 6 million people in England live in areas with fluoridation schemes. Many schemes have been operating for over 50 years. In 'Local authorities improving oral health: commissioning better oral health for children and young people'[4], Public Health England recommends water fluoridation as one of 9 evidence based community interventions and is satisfied that fluoridation is an effective community-wide public health intervention.

PHE monitoring role

PHE, on behalf of the Secretary of State for Health and Social Care, is required by legislation to monitor the effects of water fluoridation schemes on the health of people living in the areas covered by these arrangements, and to produce reports at no greater than four-yearly intervals. This report fulfils this requirement and we will consult with local authorities prior to publication of a further report within the next 4 years.

Methods

Firstly, we described the size of populations receiving different fluoride concentrations in their water supply and the source of this fluoride (ie whether adjusted by a scheme or from the surrounding geology). Though it should be noted that, in terms of chemistry and bioavailability it is likely there is no important difference between added and "natural" fluoride[5, 6].

We then compared the frequency of specified health effects across populations in receipt of public water supplies within different concentration categories of fluoride (<0.1mg/l, 0.1mg/l-<0.2mg/l, 0.2mg/l-<0.4mg/l, 0.4-<0.7mg/l, ≥0.7mg/l). Non-dental health outcomes were chosen by the PHE fluoridation working group after considering the toxicological and epidemiological evidence for previously suggested health risks of fluoride exposure, and the availability for analysis of data relevant to these health outcomes. To fulfil the requirement to monitor health effects in areas with water supplies fluoridated with a scheme (rather than fluoride deriving from the geology of the area), we additionally performed comparisons for the following subgroups:

- for non-dental health effects we compared populations in receipt of public water supplies with a fluoridation scheme where the fluoride concentration averaged ≥0.2mg/l, versus populations where the fluoride concentration averaged <0.2mg/l (a level considered as 'not fluoridated' (from any source) for this analysis). Selection of this concentration, lower than typically achieved by fluoridation schemes with a 1mg/l target, was chosen as it would be sensitive to the detection of adverse effects occurring even at relatively low fluoride concentrations (ie 0.2-0.7mg/l).
- for dental health effects we compared populations in receipt of public water supplies with a fluoridation scheme where the fluoride concentration averaged ≥0.7mg/l, versus populations where fluoride concentration averaged <0.2mg/l. We used the higher 0.7mg/l value here as we were monitoring the beneficial rather than adverse health effect of fluoridation. This change allowed us to quantify the likely public health impact of fluoridation schemes on caries and caries-related extractions. International research evidence suggested that beneficial dental health effects were more likely to be observed above 0.7mg/l than at lower values, hence we selected this higher value to better quantify the dental health benefits of fluoridation schemes achieving concentrations likely to be most effective for dental health

We used statistical models adjusted for factors, other than water supply fluoride concentrations, that could explain differences in rates of health outcomes between areas.

The most recent reporting of fluorosis prevalence and severity in England was measured in research commissioned by PHE to inform this health monitoring report. The population under examination was drawn from 4 cities; Newcastle upon Tyne (fluoridated), Birmingham (fluoridated), Liverpool (non-fluoridated) and Manchester (non-fluoridated). The results of this study were reported by Pretty et al [7].

Results and discussion

Fluoride concentration in public water supply in England

Almost all (97%) of the England annual fluoride concentration monitoring observations were linked to fluoride water supply mapping data for 2005 to 2015. On average, between 2005 to 2015, 72% of the population received a water supply with a low concentration of fluoride (less than 0.2mg/l). Ten per cent of the population received a water supply reaching a fluoride concentration of at least 0.7mg/l. Of these, almost all (92%) lived in an area where the fluoride concentration was adjusted by a fluoridation scheme; the remainder (some 400,000 people) lived in areas where fluoride was elevated due to the surrounding geology.

Dental health of five-year-olds

The analyses in this report show water fluoridation was associated with a reduction in the number of five-year-olds who experience caries and with a decrease in caries severity. At all levels of deprivation, the odds[1] of having experience of caries were lower in five-year-old children living in areas with the highest compared to the lowest fluoride concentrations. The higher the concentration of fluoride, the greater the protective effect observed. The odds of experiencing caries were reduced by 23% (95% confidence interval (CI) 9%-39%) for five-year-olds living in the least deprived areas and 52% (95% CI 47%-56%) for five-year-olds living in the most deprived areas at concentrations of ≥0.7mg/l, compared to the lowest fluoride concentration of <0.1mg/l. These are significant reductions from a public health perspective. As the greatest reductions in the odds of having caries experience were observed in children in the most deprived areas, fluoridation narrowed differences in dental health between more and less deprived children.

If all five-year-olds with drinking water with <0.2mg/l fluoride instead received at least 0.7mg/l from a fluoridation scheme, then the number experiencing caries would be lower. The fall would be 17% in the least deprived areas, rising to 28% in the most deprived areas. Given that 70% of the population of five-year-olds received water supplies where fluoride concentrations were less than 0.2mg/l, potentially many children could benefit from fluoridation.

[1] The odds of an event occurring is the probability that this event will occur divided by the probability that the event will not occur

Hospital admissions of children and young people aged 0 to 19 years

Hospital admissions for caries-related tooth extractions, as recorded in hospital statistics, were common, averaging approximately 40,000 per year. Admissions were 59% lower (95% CI 33% to 76%) in areas with fluoride of ≥0.7mg/l, compared to areas with <0.1mg/l. The higher the concentration of fluoride, the greater the protective effect observed. This is likely to have noticeable effects on the relative costs of dental service provision due to the high costs associated with treatment in hospital. The greatest absolute reduction in admissions was seen for the most deprived children, which would narrow dental health inequalities.

If all children and young people with drinking water with <0.2mg/l fluoride instead received at least 0.7mg/l from a fluoridation scheme, then the number with hospital admissions for tooth extraction would be lower by 45 to 68%. Given that 70% of the population of children and young people lived in areas where fluoride concentrations are less than 0.2mg/l, potentially many children could benefit from fluoridation. These results should be interpreted with caution due to limitations in data quality of hospital statistics, but are in keeping with the wider supporting evidence.

Dental fluorosis (mottles or flecks on teeth caused by fluoride)

The number of surveyed 11 to 14-year-olds with any positive score on examination for fluorosis was greater in the fluoridated cities (Newcastle and Birmingham 61%) compared to the non-fluoridated cities (Manchester and Liverpool, 37%). Fluorosis found on examination to be of a level corresponding to what would typically be considered to cause at least mild aesthetic concern, was 10.3% in the 2 fluoridated cities and 2.2% in the non-fluoridated cities. However, there was no significant difference in the mean aesthetic score[2] between respondents from fluoridated and non-fluoridated cities (p=0.572), suggesting that, in the age group considered, the presence of fluorosis does not appear to cause aesthetic concern or, where it does cause concern there is an equal level of dissatisfaction due to other factors eg trauma, orthodontic malalignment or caries.

Hip fracture admission

No clear pattern of association was observed for the 50 to 64 or 65 to 79 age groups. In the younger age group 0 to 49, there was statistical evidence that fluoride concentrations greater than 0.1 mg/l were associated with lower risk of hip fracture

[2] Based on the response of the surveyed participants to a question asking them to rate their satisfaction with the aesthetic appearance of their teeth

admission, whereas in older adults (80+), fluoride concentrations of at least 0.1mg/l were generally associated with a small increase in hip fracture admission risk. However, there was no consistent change in hip fracture admission risk within the age groups as the concentration of fluoride increased. These inconsistencies by fluoride concentration/age, taken together with the overall existing evidence from published epidemiological and toxicological studies, do not provide convincing evidence for a causal association.

Kidney stones

The rate of hospital admissions for kidney stones was 10% lower (95% CI 2%-18%) in areas with a fluoridation scheme. However, when the association between admissions and fluoride concentration categories was examined, an increase in admissions was seen at some fluoride concentrations, whilst no increased risk was observed at others. There was no consistent change in kidney stone admission risk as the concentration of fluoride increased. These inconsistencies by fluoride concentration, the lack of wider evidence supporting a reliably demonstrated relationship, and concerns about data quality, do not provide convincing evidence for a causal association.

Down’s syndrome

In areas with a fluoridation scheme the rate of Down’s syndrome was 8% lower than in areas without a scheme, but the 95% confidence interval overlapped one (95% CI 0.84-1.02), indicating very limited statistical evidence for such an association. However, when the association between Down’s syndrome and fluoride concentration categories was examined, an increase in cases was seen at some fluoride concentrations whilst no increase was observed at others. There was no consistent change in risk of Down’s syndrome as the concentration of fluoride increased. These inconsistencies by fluoride concentration, and the lack of wider evidence supporting a reliably demonstrated association, do not provide convincing evidence for a causal association.

Bladder cancer

In areas with a fluoridation scheme the rate of bladder cancer was 6% lower (95% CI 2%-10%). A similar reduction was observed in populations with the highest compared to lowest fluoride concentration categories. However, there was no consistent decrease in risk as the concentration of fluoride increased. There was very little wider evidence supporting a protective effect of fluoride exposure on bladder cancer occurrence. These inconsistencies by fluoride concentration and the lack of wider supportive evidence do not provide convincing evidence for a protective relationship.

Osteosarcoma (a form of bone cancer) among people aged less than 50

There was no evidence of an association between fluoridation and osteosarcoma in 0 to 49-year-olds.

Conclusion

The findings of this report are consistent with the view that water fluoridation is an effective and safe public health measure to reduce the prevalence and severity of dental caries, and reduce dental health inequalities.

This 2018 monitoring report has provided a more detailed description of the size of populations receiving different concentrations of fluoride in their water supply and consequently a more in-depth examination of the association between fluoridation and health outcomes than the 2014 report.

The reduction in the number of five-year-olds experiencing caries and the decrease in the severity of this dental disease was significant in those receiving a fluoridated water supply, and most clearly so in more deprived areas, narrowing differences in dental health between more and less deprived children. The effect of fluoridation on admission for tooth extraction was also substantial. A larger number of the most deprived children and young people benefited, again lessening differences in dental health between more and less deprived children and young people.

We have also been able to explore associations with potential adverse health effects in more detail: despite some suggestion of associations between water fluoridation and certain health effects, the overall results of our analysis, and weight of wider evidence means causal associations are unlikely.

The ecological design of this report has some limitations. We can estimate the potential exposure to fluoride in water using the concentration as a proxy, but we do not know how much people drink or whether they have other sources of fluoride. Additionally, the adjustment for factors other than fluoride/fluoridation that may influence the health outcomes studied can only be done on the basis of area averages, which may incompletely adjust for these factors. Therefore, this report alone does not allow conclusions to be drawn regarding any causative or protective role of fluoride; similarly, the absence of any associations does not provide definitive evidence for a lack of a relationship. This is particularly the case for non-dental health outcomes, where the weight of wider epidemiological evidence for a causal relationship at drinking water fluoride concentrations typical of those in England, and toxicological evidence for a biological mechanism of action, is generally much more limited. It may be beneficial to further evaluate outcomes in other populations, with contrasting fluoride levels, and alternative study designs, to assess if these findings can be replicated.

PHE continues to keep the wider evidence under review and will consult with local authorities prior to publication of a further report within the next 4 years.

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