

This section looks back to some ground-breaking contributions to public health, reproducing them in their original form and adding a commentary on their significance from a modern-day perspective. In this issue, Michael A Lennon reviews the first trial of a fluoridated public water supply. Extracts of the report of the trial by Francis A Arnold et al. in 1956 are reproduced below by permission of the Association of Schools of Public Health.

One in a million: the first community trial of water fluoridation

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During the 1930s and early 1940s, H Trendley Dean and his colleagues working from the US National Institutes of Health published a series of epidemiological studies describing the relationship between the level of fluoride naturally present in public drinking-waters and the prevalence and severity of dental fluorosis¹ and dental caries.² Dental fluorosis is a white — and in more severe cases an unsightly brown — developmental defect of dental enamel, while dental caries is a post-eruptive disease of the teeth caused by the action of certain oral bacteria on ingested dietary sugars. As the natural fluoride level rises from low levels (less than 0.1 mg/l), so the prevalence and severity of dental fluorosis increase while the extent of dental caries — usually summarized by the index of the mean number of decayed, missing and filled teeth (DMFT) — falls. Dean and his colleagues³ suggested that in temperate climates and at a fluoride concentration in drinking-water of around 1 mg/l, the level of dental caries was substantially less than that associated with low levels of fluoride, while the level of dental fluorosis had increased but only to a level that was clinically and aesthetically of no concern.

Furthermore, in parallel studies no significant other health effects could be seen in areas with fluoride levels in public drinking-water even as high as 8 mg/l. For example, a study in Bartlett, Texas,⁴ reported on potential health effects in people with long-term residence

of at least 15 years who consumed public water with a natural fluoride level of 8 mg/l, compared with long-term residents of nearby Cameron where the fluoride level was 0.4 mg/l. This study, involving a medical history, physical and dental examinations, X-ray, and blood and urine analyses, was conducted in 1943 and repeated in 1953. For the important bone changes the study reported that only 10–15% of humans who consumed a water supply with an excessive fluoride content (8 mg/l) for a long time may show radiographic (but not clinical) evidence of bone changes. The authors concluded: “no clinically significant physiological or functional effects resulted from prolonged ingestion of water containing excessive fluoride except for dental fluorosis”.

In the light of these and similar studies it was not surprising that a hypothesis was formulated that the adjustment of the fluoride level of public drinking-water supplies to 1 mg/l might have similar effects to naturally fluoridated water. To test this, a controlled community water fluoridation trial in the city of Grand Rapids started on 25 January 1945, with the nearby city of Muskegon acting as a control. Although this was the first water fluoridation trial, at least three other trials were established in the United States and Canada within the next year or so.

The first dental data from the Grand Rapids–Muskegon study were published in 1950⁵ and reported baseline data

collected in 1944–45 based on examinations of all 28 614 children in Grand Rapids and all 7786 children in Muskegon aged 4–16 years, together with follow-up data collected in 1949.

Annual examination of selected samples of children continuously resident in Grand Rapids continued for 15 years. Muskegon remained the non-fluoridated control city until July 1951, at which time, in response to the observed effects in Grand Rapids, city officials decided to fluoridate the supply in Muskegon also. Annual dental examinations of samples of children continuously resident continued for a further three years in Muskegon and provided some of the data in the 1956 report by Arnold et al.,⁶ extracts of which are reproduced below. The authors presented age-specific data for children aged 4–13 years for deciduous teeth and 6–16 years for permanent teeth and noted that water fluoridation was “remarkably effective” in reducing the incidence of dental caries in both groups.

Data for Grand Rapids after 15 years of fluoridation were published by Arnold et al.⁷ By this time the Muskegon data were not reported, but rather the comparison was made with the Grand Rapids baseline data. The authors concluded that, after 15 years, total caries experience was lowered by 50–63% in children aged 12–14 years, and by 48–50% in children aged 15 or 16 years. This paper also presented data on the prevalence of dental fluorosis in 12–16-year-old children:

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10.6% of the children showed some evidence of dental fluorosis but most (10.2%) of these cases were of the nearly imperceptible, questionable or very mild degrees of severity.

In 1950, the Chief Dental Officer of the United States Public Health Service, Bruce D Forsyth, issued a policy statement to the American Dental Association that “the fluoridation of public water supplies ... can be encouraged subject to the approval of the State and local health authorities and the dental and medical profession”. Surgeon General Leonard A Scheele reaffirmed fluoridation as an official policy of the Public Health Service in testimony before the Senate in April 1951.⁸ In 1958, a WHO Expert

Committee concluded that “drinking-water containing about 1 ppm fluoride (1 mg/l) has a marked caries-preventive action ... There is no evidence that water containing this concentration of fluoride impairs general health.”⁹

By 1960, water fluoridation was being widely implemented and around 50 million people in the United States were benefiting; by 2002, 46 of the 50 largest cities were fluoridated, with a total population covered of 171 million (68% of those on public water systems). Indeed, the United States appears to be on target towards meeting its *Healthy people 2010* objective on community water fluoridation: 75% of people on public water systems to receive water that

has the optimal level of fluoride recommended for preventing tooth decay,¹⁰ and, worldwide, around 350 million people to consume fluoridated water.¹¹

Of course, the quality of the Grand Rapids–Muskegon study was to some extent compromised by, among other issues, the decision to fluoridate the control community after five years. Subsequent studies have achieved higher quality standards.^{12–14} Nevertheless, because it was the first such study, because it was directly linked to and logically followed on from the earlier epidemiological studies, and because of its worldwide impact, the pioneering study by Arnold et al. rightly holds its place among the public health classics. ■

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Corrigendum

In Vol. 84, issue number 8, 2006, page 674, in the 20th line of the first full paragraph in column 2 and in the last bullet point in column 3, the “ > ” [greater than] symbol should be “ ≥ ” [greater than or equal to].