



Weekly
May 29, 1992 / 41(21);372-375, 381

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Public Health Focus: Fluoridation of Community Water Systems

Although fluoridation of community water is highly effective in reducing the occurrence of dental caries, the prevalence of dental caries remains high in the United States. For example, a survey of school-aged children during 1986-1987 indicated that 50% of those aged 5-17 years had caries in their permanent teeth, and among 17-year-olds, the prevalence of caries was 84% (1). In addition, among certain populations (e.g., rural and inner-city residents, children whose parents have less than a high school education, and some racial/ethnic minorities), the prevalence of dental caries among children ranges from 52% to 92%. This report summarizes information regarding the efficacy, effectiveness, and cost-effectiveness of fluoridation of public water supplies in the United States. Efficacy/Effectiveness

The association between fluoride in drinking water and reduction of dental caries was first documented in the 1930s in communities with naturally occurring fluoride (2). However, it became necessary to validate and quantify efficacy when alternate systemic and topical methods to deliver fluoride were proposed.

In 1945 and 1946, independently conducted community trials to assess the effectiveness of water fluoridation were initiated in four communities in Canada and the United States (Brantford, Ontario; Evanston, Illinois; Grand Rapids, Michigan; and Newburgh, New York) (Table 1). Four nearby and demographically similar communities were selected for comparison. Following fluoridation for 13-15 years, the prevalence of caries decreased 48%-70% among 12-14-year-olds in the four communities (2). Studies in other communities indicated that, following fluoridation for 10 years, the prevalence of caries decreased 45%-94% (median: 58%) among children (3).

By the early 1980s, epidemiologic evidence indicated that the prevalence of dental caries was declining throughout the United States (5). From 1971 through 1987, three national surveys of U.S. children demonstrated a continued decrease in caries prevalence (1,6,7) (Figure 1). The most recent national survey, conducted during 1986-1987 (1), indicated that the prevalence of caries among children with a history of lifelong exposure to optimally fluoridated water * decreased 18% when compared with the prevalence among children with no exposure to optimally fluoridated water. Prevalence decreased 25% when the analysis excluded children with any history of fluoride

therapy (e.g., dietary supplements or professionally applied topical treatments) (4). In addition, recent studies have found consistently lower caries prevalence, both on coronal and root surfaces, among adults who live in communities with optimal or greater fluoride than among those from communities with lower fluoride levels in the water supply (4) (Table 1).

In clinical trials, epidemiologic studies, and national surveys conducted during 1973-1988 (8), children aged 6-13 years living in fluoridated communities averaged 0.8 new dental caries (decayed, missing, or filled surfaces (DMFS)) per year. In comparison, an average of 1.5 DMFS occurred each year among children living in fluoride-deficient communities. Cost-Effectiveness

The direct cost of fluoridating public water supplies is related to a variety of factors, including size of the community, number of wells and treatment plants, amount and type of equipment, amount and type of fluoride chemical, and personnel costs (9). Annual costs of water fluoridation per capita varied inversely with community size, ranging from 12 cents to 21 cents for water systems serving populations greater than 200,000 persons, 18 cents to 75 cents for systems serving 10,000-200,000 persons, and 60 cents to \$5.41 for systems serving fewer than 10,000 persons; the mean national weighted estimate is 51 cents (10). Of all persons receiving optimally fluoridated community drinking water, approximately 85% are served by water systems for which the annual per capita cost of fluoridation is 12 cents-75 cents (11).

For 1990, the Health Care Financing Administration estimated that \$34 billion (5% of all U.S. expenditures for health care) was spent for dental services (12), of which \$4.5 billion (13.2%) may have been spent on dental amalgam restorations (American Dental Association, personal communication, 1992). Based on a national average cost per restoration of \$40 (13) and a mean national weighted cost of 51 cents per person per year to fluoridate drinking water (10), each \$1 expenditure for water fluoridation could result in a savings of \$80 in dental treatment costs. Estimated nondiscounted per capita expenditures for water fluoridation during a lifetime (\$38.25 at 51 cents per year for 75 years) are approximately equal to the average nondiscounted cost of one dental restoration.

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Editorial Note

Editorial Note: Since 1945, 9411 community water systems serving 8081 communities in the United States have instituted water fluoridation. By the end of 1989, approximately 70% of all U.S. cities with populations of more than 100,000 -- including 42 of the 50 largest cities -- were fluoridating water. Thirty-five states, Puerto Rico, and the District of Columbia provide fluoridated water to more than half of their populations (11) (Figure 2), and nine states and Puerto Rico have enacted legislation for mandatory water fluoridation. Approximately 135 million U.S. residents are served by water supplies in which the fluoride concentration either has been adjusted to an optimal level (126 million persons) or the natural fluoride content is sufficient for improved dental health (9 million persons) (11).

Because efforts to fluoridate drinking water were effective in reducing the risk for dental caries, dental researchers developed other methods to deliver fluoride to the public (e.g., fluoride-containing dentifrices, fluoride gels, fluoride mouth rinses, and dietary fluoride supplements). In addition, foods and beverages processed in fluoridated cities may be sold in nonfluoridated areas. The widespread use of these products assures that virtually all persons are exposed to fluoride.

This exposure may have contributed substantially to the decrease in caries reduction observed during 1986-1987 (1) when comparing fluoridated and nonfluoridated communities.

The possibility of adverse effects of water fluoridation has been investigated since this preventive measure was first introduced. Although recent reviews have confirmed the benefit of exposure to appropriate levels of fluoride for dental health (14,15), a Public Health Service report (14) recommended further assessment of potential problems associated with or other aspects of fluoride use, such as the relation between fluoride intake and bone (i.e., osteosarcoma and bone fractures); the mechanisms of fluoride action on bone and teeth at the molecular level; the marginal risks, costs, and benefits of multiple fluoride regimens; the caries effect after a community discontinues water fluoridation; temporal changes in the prevalence of dental caries; and the prevalence and extent of dental fluorosis.

One national health objective for the year 2000 is to increase to at least 75% the proportion of persons served by community water systems providing optimal levels of fluoride (objective 13.9) (16) -- a goal already achieved by 20 states and the District of Columbia (Figure 2) (11). To achieve this objective nationally, an additional 30 million persons must receive optimally fluoridated water from public water systems.

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 - o Ranges from 0.7 mg/L to 1.2 mg/L based on an annual average of the maximum daily air temperature.

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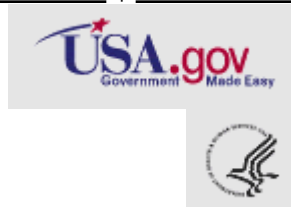
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This page last reviewed 5/2/01