

COMMENTARY

Fluoridation and Social Equity

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Abstract

The overall reduction in caries prevalence and severity in the United States over recent decades is largely due to widespread exposure to fluoride, most notably from the fluoridation of drinking waters. Despite this overall reduction, however, caries distribution today remains skewed, with the poor and deprived carrying a disproportionate share of the disease burden. Dental caries, like many other diseases, is directly related to low socioeconomic status (SES). In some communities, however, caries experience has now diminished to the point where the need for continuing water fluoridation is being questioned. This paper argues that water fluoridation is still needed because it is the most effective and practical method of reducing the SES-based disparities in the burden of dental caries. There is no practical alternative to water fluoridation for reducing these disparities in the United States. For example, a school dental service, like those in many other high-income countries, would require the allocation of substantial public resources, and as such is not likely to occur soon. But studies in the United States, Britain, Australia, and New Zealand have demonstrated that fluoridation not only reduces the overall prevalence and severity of caries, but also reduces the disparities between SES groups. Water fluoridation has been named as one of the 10 major public health achievements of the 20th century by the Centers for Disease Control and Prevention, and promoting it is a Healthy People objective for the year 2010. Within the social context of the United States, water fluoridation is probably the most significant step we can take toward reducing the disparities in dental caries. It therefore should remain as a public health priority. [J Public Health Dent 2002;62(4):195-200]

Key Words: dental caries, fluoride, fluoridation, socioeconomic status, public health policy.

Controlled water fluoridation began in the United States in 1945, a time when dental caries was a serious public health problem. By 1992, some 56 percent of Americans were receiving fluoridated drinking water (<http://www.cdc.gov/nccdphp/oh/flfact.htm>), and that proportion has not changed much in more recent years. Since 1945, however, other sources of fluoride exposure have grown. Fluoride toothpaste got a substantial share of the toothpaste market by the mid-1970s and now dominates that market, and fluoride gels and mouthrinses have been applied or prescribed by dentists since the 1950s. Fluoride varnish, long used in Europe and Canada, became available in the United States

in 1994, and some fluoride is also found in processed food and drink (1-4). When all sources of fluoride are considered, virtually all Americans now have daily exposure to fluoride.

Over this period of increasing exposure to fluoride in the United States, the prevalence and severity of dental caries in children has declined substantially. The mean number of teeth affected by caries in children aged 6-18 years in the early 1970s was 4.44; this had dropped to 1.90 by the early 1990s (5). Nonetheless, this welcome reduction in caries severity has not been shared equally by children of all socioeconomic status (SES) levels. Caries distribution has become skewed, with many upper-SES chil-

dren being free, or almost so, of the disease, and with the bulk of the disease burden now found among the more socially deprived (6).

The principal reason for this substantial decline in caries is likely to be populationwide exposure to fluoride in all its forms (7), with a major impact in the United States considered to come from water fluoridation. Indeed, the Centers for Disease Control and Prevention (CDC) has ranked water fluoridation among the top 10 public health achievements of the 20th century for its role in reducing the dimensions of the caries problem (8). Nevertheless, the total benefits from water fluoridation may be underestimated because of the widespread diffusion of fluoride throughout American society (9). Promoting water fluoridation is also a Healthy People 2010 objective for the nation (<http://www.health.gov/healthypeople/document/html/volume2/21oral.htm>).

Despite this level of public recognition, many efforts to fluoridate local community water supplies still run into stubborn opposition. Public acceptance of fluoridation may not be as strong as it was simply because dental caries is less obvious than it used to be—a touch of irony when much of the reason for that fact can be attributed to fluoride. Parents of today's children are often themselves virtually caries free, and their honest questions about whether fluoridation is still necessary are not uncommon during fluoridation campaigns.

This paper presents a case for why water fluoridation is still needed in the United States, and why it should be retained as the cornerstone of caries control in public health. The argument is that fluoridation moves us toward achieving social equity in oral health, and is a practical and relatively inexpensive method of doing so. This pa-

per first examines the impact SES has on the health status of populations, and then how fluoridation can reduce that impact.

Socioeconomic Status and Health

Substantial differences in mortality and health status between people in the higher and lower SES strata have been documented in a number of countries, using a number of different outcomes (10,11). Given the individualistic philosophy that characterizes the United States, it is likely that these disparities are more pronounced in that nation than in other countries with more egalitarian traditions (12,13). In any event, the data show with remarkable consistency that people of higher SES enjoy better health than those of lower SES, and this observation has endured well over time (14-17). This finding is not dependent on how health status is measured, for it has been documented when health status was expressed in terms of overall mortality, heart disease, diabetes, or even subjective perceptions of ill-health (18-22). While there are numerous individual behavioral determinants involved in this profile (e.g., smoking, alcohol abuse, quality of diet, regular exercise), there is also evidence that social determinants (i.e., risk factors that apply to the whole community rather than to specific individuals) play a key role. These social determinants include the quality of housing, extent of community services, availability of transportation, prospects for employment, crime levels, access to parks, open space, and suitable recreational facilities.

Poor social circumstances are linked to disease by way of material, psychosocial, and behavioral pathways. Social and environmental disadvantages can lead directly to poor health behavior and the subsequent biological disturbances that lead directly to ill health. The argument therefore holds that excessive social stresses in themselves can negatively affect health (23). As one example, the gap in both mortality rates and cardiovascular disease levels between western European countries and those that were formerly part of the Soviet bloc were accentuated sharply following the breakup of the Soviet Union in 1991. This phenomenon has been attributed to the high degree of social stress that accompanied the breakup (24). Another ex-

ample is seen in the causative link between sustained economic hardship over a long period of time and poor general health (25).

Socioeconomic Status and Oral Health

Dental research in this area has not progressed to the extent seen in medical research, but there are indications that similar relations exist between social determinants and oral health. Ample recent British data show marked disparities between higher and lower social classes in terms of oral health and use of dental services (26-31). Locker's elegant review describes the reasons why social deprivation is a risk factor for poor oral health status (32), and these turn out to be very similar to those described above for mortality and general health measures.

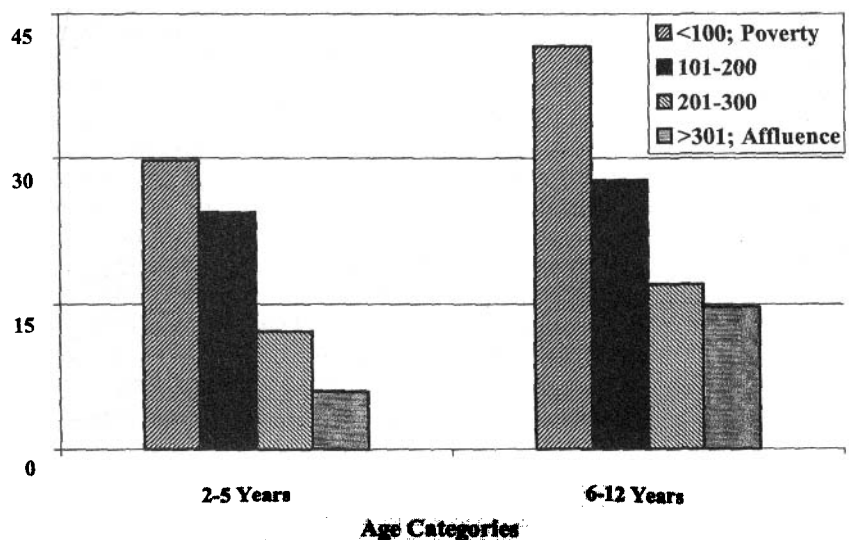
It is therefore not surprising that oral health disparities between SES levels are clearly evident in American society today. Figure 1, using data from the Third National Health and Nutrition Examination Survey (NHANES III), shows that lower-SES children had a higher prevalence of caries in the primary dentition than did those in higher levels. A survey of second grade children in New York State found similar distributions (33), as did a statewide survey of school-

children in Tennessee (34).

Closing the SES Disparities Gap

Reducing the oral health disparities between SES levels is a more complicated issue than simply providing services, for even when dental services are readily available and free of charge, they tend to be underused by lower-SES people (35). Even in those countries with extensive publicly funded social services, where high-quality health care is readily available at no charge to the recipient, oral health disparities between social classes are still apparent. One example is from Sweden, a nation where an extensive system of social services has been constructed for the specific purpose of promoting an egalitarian society. Excellent school dental services are in place as part of that system; even so, some unexpected disparities between SES levels in oral health and use of dental services were disclosed in a national survey (36). Similar SES disparities in caries experience have been reported from Finland, where equal access to health care is also a social value (37). These SES disparities in Europe appear to be less extensive than those seen in the US, but European society for the most part is ethnically and culturally less diverse. It is noteworthy, however, that disparities in caries experience based on SES and

FIGURE 1
Prevalence of Dental Caries in US Children Aged 2-5 Years and 6-14 Years, by Percent of Federal Poverty Level (Ref. 6).



ethnicity are being recorded in Europe as a result of the extensive immigration from eastern Europe during the 1990s (38,39).

School dental services of the type found in Scandinavia and some other countries have excellent facilities and staff, and they ensure that all school-children receive close dental attention at least once each year. School-based dental services of this kind have never been part of the way health care is provided in the United States, and the expense of running such services, even where there is political will to implement them, do not encourage their development. Other prevention-based approaches thus need to be devised if the disparities gap is to be reduced in the United States, and the first obvious step is to fluoridate drinking water wherever feasible. Fluoridation is a true public health procedure in that it reaches all members of the community who receive municipal water, thus ensuring a good level of fluoride exposure for everyone.

Fluoridation and Socioeconomic Status

Thus the issue becomes whether water fluoridation, by itself, will reduce the SES disparities in oral health. The evidence, on balance, suggests that it will reduce them, though not remove them completely. Data from Britain (40-44), Australia (45,46) and New Zealand (47,48) show that when caries experience is measured against SES level and the presence or absence of water fluoridation, the disparities by SES level are reduced in the area with water fluoridation. Figure 2, using data from northern England (49), gives a graphic example of this relationship. It demonstrates that both SES and water fluoridation are strong influences on caries experience, although the caries disparity between the SES levels is reduced more in the fluoridated area than in the nonfluoridated area.

SES is a complex issue, so it is not surprising that studies from Britain, Finland, and New Zealand found, in regression analysis, no interaction between social class and water fluoridation (31,50,51). It is possible that these results were confounded by high levels of restorative dental treatment (in Finland and New Zealand), or by relationships being more difficult to dis-

cern at low population levels of caries (31). Another study from New Zealand concluded that social class was a stronger correlate of children's oral health than was community fluoridation, though this result was confounded by widespread exposure to fluoride other than from drinking water. The use of treatment statistics to measure oral health in this study was also questionable (52).

An assessment of whether fluoridation reduces the social class gradient (i.e., the disparity in caries experience between higher and lower SES groups) was one objective of the systematic review of water fluoridation's effects carried out by the Centre for Reviews and Dissemination at the University of York, Britain (53). This review is probably the most rigorous scrutiny of existing knowledge about fluoridation yet carried out. It has been criticized by both proponents and opponents of fluoridation, mainly because the stringent inclusion and exclusion criteria for published reports led to many papers being omitted from consideration. However, adherence to strict inclusion/exclusion criteria for scientific papers is an integral part of any systematic review summing up the evidence base for an issue.

Most of the 15 papers (not all of them published) included for the fluoridation/social gradient issue presented data for 5-year-old children. The review found no difference in the social gradient between children from fluoridated or nonfluoridated areas when caries was measured only as prevalence; however, a favorable social gradient reduction in fluoridated areas was seen with severity measures (mean dmf, def, df indexes scores). Data for ages other than 5 years were too limited to permit conclusions.

Fewer data exist from the United States (compared to British data) to assess how water fluoridation affects SES disparities in caries, but those that do exist are compelling. In a Louisiana study of Medicaid-eligible children aged 1-5 years, the Medicaid-eligible children in communities without fluoridated water were three times more likely than those from fluoridated communities to receive dental treatment in a hospital operating room, and the cost of dental treatment per eligible child was approximately twice as high (54). This finding, which reflects caries severity, is consistent with the results of the York review, stated above. Figure 3 shows data from fluoridated Newburgh and non-

FIGURE 2
Caries Experience by Social Class Among British 5-year-olds in Fluoridated and Nonfluoridated Areas: County Durham (Ref. 49)

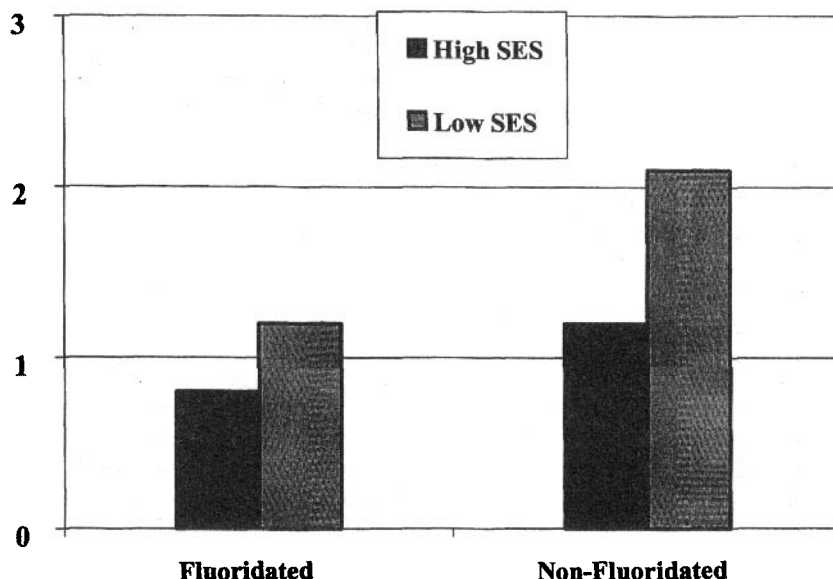
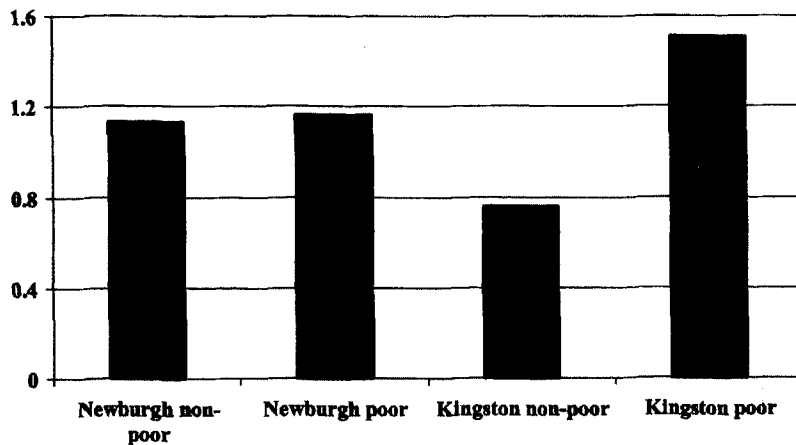


FIGURE 3
Caries Experience, Expressed as Covariate-adjusted Mean DMF Surfaces per Child, in 7–14-year-old Children in Newburgh and Kingston, NY, by Poverty Status ("Poor" defined as children participating in the free school lunch program) (Ref. 55)

**Mean No.
 Permanent
 Teeth Affected**



fluoridated Kingston, New York, after 50 years of fluoridation in Newburgh (55). The overall mean age-standardized DMFS values were slightly lower in Kingston, which reflects the higher SES status in that city. However, when the data are split by poverty status, Figure 3 shows that the difference between SES levels in Newburgh was very small, while there was still a noticeable disparity between the SES groups in nonfluoridated Kingston.

Some use the issue of childhood immunizations as an analogy to water fluoridation. The major infectious diseases of the 19th century are rarely seen in the United States today, so do we need to continue with childhood immunizations? Obviously we do, because immunizations are a prime reason these diseases are rarely seen, and laxity with immunization will lead to their resurgence. The parallel argument is that exposure to fluoride is the main reason for lower caries levels, and water fluoridation is the prime exposure to fluoride for millions of Americans.

Data from Wisconsin (56), Germany (57), and Scotland (58) showed a resurgence of caries following defluoridation. But these three cases are from several decades ago, when drinking

water was virtually the only source of fluoride exposure; thus, with defluoridation the increased caries incidence was to be expected. More recent examples from Germany (59), as well as from Cuba (60), Canada (61), and Finland (62,63), show a different pattern. In those cases, caries incidence did not rise after defluoridation, and in fact continued to fall in some instances. However, in all of these communities the children all were well exposed to other sources of fluoride, e.g., from toothpaste, mouthrinse, or professionally applied varnish. In Cuba, for example, a program of biweekly fluoride rinsing commenced when water fluoridation ceased, and children aged 2–5 years received 1–2 applications of fluoride varnish annually. In Finland, the comprehensive school dental service ensured that children received regular applications of fluoride varnish and made good use of fluoride toothpaste. The Canadian children, in British Columbia, were generally from an affluent area where caries levels were low and use of fluoride toothpaste and dental services was high.

The most interesting data come from Germany, where sweeping social changes took place following German reunification in 1990. Sugar consump-

tion dropped, despite the greater availability of sugar-rich foods, as more sugar substitutes were consumed (64). The previous state-run health care system was restructured for private practice, so the school dental service and community prevention services were ended. This included water fluoridation, which previously had been established in 35 towns and reached 18 percent of the East German population. Some changes favored better oral health: fluoride toothpaste, which had 15 percent of the toothpaste market prior to 1990, rose to 88 percent market share by 1993–95, and fluoridated salt became available in 1992. The dental treatment level increased significantly, despite the ending of the school dental service, and this resulted in widespread application of fissure sealants. By 1995, more than 40 percent of children in the former East Germany had sealants, with an average of 3.6 sealed teeth per child (64).

Between the 1980s and 1993–95, the mean DMFT for 12-year-old children in the former East Germany dropped from 3.8 to 2.5. Given the tumultuous changes that took place over a short period of time, interpretation of these events would have been easier had there been a control city that retained fluoridation and also received the additional preventive services. In Ireland, as an example, with widespread fluoridation it was shown that caries levels were reduced in both fluoridated and nonfluoridated communities after the introduction of fluoride toothpaste, but the drop was greater in the fluoridated communities (65). The substantial drop in DMF scores in Germany over a short period of time is intriguing, and leads to questions about the direct effect of major social change on dental caries.

All of this suggests that what is important in caries control is regular fluoride exposure, especially maintaining ambient fluoride levels within the oral cavity (66). Relative to those in higher SES levels, people in lower SES strata do not visit the dentist as often and do not brush their teeth as often (67–69). This means they are likely to have less exposure to fluoride from professional applications and from toothpaste than do people in higher SES strata, which essentially leaves fluoridated water as the only practical method of bringing fluoride exposure to the whole population.

These data collectively suggest that both SES and water fluoridation are determinants of caries status. Whether one of these factors is more important than the other, while an interesting and complex research issue, is irrelevant in terms of social policy. The concern of dental public health workers is to reduce caries as far as possible in their communities of interest. Little can be done about changing SES, but public health workers can strive to institute water fluoridation where it is needed and to maintain it where it already exists. The bulk of the evidence cited above indicates that fluoridation has the effect of reducing the dental caries disparities between the different SES strata, and that is an important enough reason to keep water fluoridation as a public health priority in the United States.

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