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Oral Health in America: A Report of the Surgeon General

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Department of Health and Human Services
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CHAPTER 7

Community and Other Approaches to Promote Oral Health and Prevent Oral Disease

The remarkable improvements in oral health over the past half century reflect the strong science base for prevention of oral diseases that has been developed and applied in the community, in clinical practice, and in the home. This chapter presents the evidence for key preventive measures for those oral conditions that pose the greatest burden to U.S. society. Because the emphasis given to each condition discussed here reflects the extent of the evidence for the associated preventive measures, the chapter is heavily weighted toward the prevention and control of dental caries, for which multiple effective preventive modalities have been developed.

The dental profession has long championed disease prevention and health promotion approaches to oral health. The initial observations in the 1930s that people living in communities served by naturally fluoridated water had lower dental caries inspired the trailblazing clinical prevention studies of the 1940s and 1950s. Researchers compared whole cities agreeing to fluoridate their water supplies to control cities whose drinking water contained only trace amounts of fluoride. Five years into the studies, follow-up with schoolchildren who had been examined at baseline revealed dramatic reductions in dental caries in the children drinking fluoridated water, as compared to controls. The overwhelming success of the studies led to a widespread adoption of community water fluoridation in the United States as a high-benefit, low-cost preventive method that benefited old and young, rich and poor alike. It also provided momentum for health practitioners, researchers, industry, and public health directors to consider other kinds of community-wide, provider-based, and individual strategies aimed at improving oral and general health.

Most common oral diseases can be prevented through a combination of community, professional, and individual strategies. The strategies selected here include disease prevention and health promotion interventions directed toward the public, practitioners, and policymakers to create a healthy environment, reduce risk factors, inform target groups, and improve knowledge and behaviors. They were selected on the basis of the significance of the health problem they were designed to prevent, whether in terms of prevalence, incidence, severity, cost, or impact on quality of life (see Chapters 4 and 6). Table 7.1 summarizes the strategies for the primary prevention of caries, periodontal diseases, oral and pharyngeal cancers, inherited disorders, and trauma, distinguishing among those that can be implemented community-wide, through health professionals, or through the exercise of individual responsibility. Some strategies can be applied at multiple levels. Box 7.1 provides a glossary of terms related to community health programs.

This chapter also includes a discussion of knowledge and practices of the public and health care providers regarding the three oral conditions about which we have the most knowledge. The purpose of this discussion is not to outline specific health promotion strategies to enhance knowledge and practices but to indicate the opportunities and needs for both broad-based and targeted health promotion programs and activities.

WEIGHING THE EVIDENCE THAT INTERVENTIONS WORK

Researchers, policymakers, and practitioners make judgments about whether a health intervention works based on estimates of its efficacy or effectiveness. Estimates of an intervention's efficacy are best based on randomized controlled trials, which may be conducted under ideal circumstances. Evidence for whether an intervention works when applied in the community at large is referred to as its effectiveness

(O'Mullane 1976). The distinction between efficacy and effectiveness is often blurred in dental public health programs because the studies and their settings can be very similar. Nevertheless, the major difference between the two lies in the degree of control exerted over factors that can affect results. Effectiveness studies more accurately reflect results that may be expected from the implementation of interventions.

The current trend in health care and public health is to base recommendations on evidence derived from systematic reviews of the literature and an assessment of the quality of evidence. The U.S. Preventive Services Task Force (1996) and the Canadian Task Force on the Periodic Health Examination (Ismail and Lewis 1993, Lewis and Ismail 1995) are examples of groups that have used systematic reviews to establish the evidence of efficacy or

TABLE 7.1
Community, provider, and individual strategies for primary prevention of key oral diseases and conditions

Community Strategies	Professional Strategies	Individual Strategies
Dental caries		
Community-wide health promotion interventions[a]	Counseling to follow measures to reduce risk of disease	Being informed about strategies to prevent disease
Fluoride use Community water fluoridation School-based dietary fluoride tablets School-based fluoride mouthrinse	Fluoride use Prescriptions for fluorides (supplements or rinses) Gels and other high-fluoride topicals Topical remineralization solutions Fluoride-containing restorative materials	Fluoride use Dentifrice Mouthrinse, over the counter
School-based and school-linked sealant programs	Provision of sealants Prescriptions for antimicrobial agents	Asking about sealants Use of antimicrobial agents
School-linked screening and referral	Individualized recall schedule	Self-initiated use of dental services
Periodontal diseases		
Community-wide health promotion interventions[a]	Counseling to follow measures to reduce risk of disease	Being informed about strategies to prevent disease
School-based personal hygiene, reinforcement of personal oral hygiene habits in Headstart or primary school classrooms	Control of plaque bacteria by mechanical means (prophylaxis or scaling) Chemical plaque control Chemotherapeutic agents	Oral hygiene measures Toothbrushing and flossing Toothbrushing with dentifrices Plaque control
School-linked screening and referral	Monitoring and early detection of disease	Self-initiated use of dental services
Oral and pharyngeal cancers		
Community-wide health promotion interventions[a]	Professional education and patient counseling on risk factors	Being informed about strategies to prevent disease Avoidance of tobacco use Reduction of alcohol use Use of sunscreen and lip protector
Cancer screening programs (such as health fairs)	Routine soft-tissue oral examination for early detection of precancerous lesions	Self-initiated use of dental services Request for cancer screening
Inherited disorders		
Early detection programs	Interdisciplinary early detection programs	
Trauma		
Community-wide health promotion interventions[a]	Professional education and patient counseling on risk factors	Being informed about strategies to prevent trauma
Mouth protector fittings for entire team	Fabrication of mouth protectors	Use of mouth protectors and helmets

[a]Community-wide health promotion interventions (education, political, regulatory, and organizational) are directed toward the public, practitioners, and policymakers to create a healthy environment, reduce risk factors, inform target groups, and improve knowledge and behaviors.

BOX 7.1
Glossary: The Nature of Community Health Programs

Community health programs are defined as health promotion and disease prevention activities that address health problems in populations. Community health programs often provide a level of organization and resources beyond those available to an individual. The programs thus complement personal care and professional services. Many programs target populations with limited access to professional services or limited resources to pay for services. Government agencies, religious organizations, charities, schools, foundations, and other private and public groups may spearhead such programs, tapping into the expertise, enthusiasm, and knowledge of community values of staff and volunteers. Some programs are sponsored by national, state, and local dental societies and their members.

Five terms related to community health programs—community, health promotion, health literacy, health education, and disease prevention—have been further articulated by experts in the field.

Community. According to Last (1995), a community is "a group of individuals organized into a unit, or manifesting some unifying trait or common interest." The unit can be a town, a geographic area, the state, nation, or body politic (Last 1995). The unit may also be a selected subgroup, such as disadvantaged children living in a large city or women urged to have mammograms according to specified schedules.

In designing and implementing community programs, planners must take into consideration that no two communities are identical. In a classic expression of this concept, McGavran (1979) wrote that a community is "an entity different from every other community as an individual is different from his neighbor: different in its physical makeup, its geographic and demographic limitation, different in its social structure, its power structure, its governmental and legal structure, different in mental and emotional patterns, in its ethnic groups, its mores, its religious and nutritional patterns, and different in its educational procedure, its institutions, and its community organization." On the other hand, communities may have similar risk factors for poor oral health, allowing common solutions to similar problems. Lessons learned in one community may be applicable to those with similar characteristics.

In recent years, investigators have begun to examine characteristics of communities, noting that some communities provide an environment that contributes to the overall health and well-being of the members, whereas others appear to be detrimental. All communities, however, have both positive and negative influences on health and well-being—the challenge is to minimize the negative factors and maximize the positive in each community. Healthy communities have been characterized as having a degree of openness and cooperation—neighbors helping neighbors. Healthy communities also are ones in which there are less extreme separations of individuals by social class (Wilkinson 1996).

Health Promotion. Health promotion is "any planned combination of education, political, regulatory, and organizational supports for action and conditions of living conducive to the health of individuals, groups, or communities" (Green and Kreuter 1999). Examples of broad-based health promotion activities include programs encouraging people of all ages to stop using tobacco, regulations requiring the use of mouthguards in contact sports, laws to prohibit tobacco sales to minors, and labels that indicate the amount of sugar in a product.

Health Literacy. Health literacy is "the capacity of individuals to obtain, interpret, and understand basic health information and services and the competence to use such information and services in ways which enhance health" (Joint Commission on National Health Education Standards 1995). Health literacy is correlated with general literacy, and both vary by educational achievement, socioeconomic status, race, and ethnicity. This is an important concern in a society that is becoming more diverse in terms of language, religion, culture, race, and ethnicity. Programs intending to serve, immigrants, for example, must attend to ensuring that information, programs, and systems are accessible, understandable, and culturally sensitive, particularly if the target audience for health information and services does not speak English, if there are unique cultural and religious beliefs at variance with those of the dominant culture, or if living arrangements are such that individuals lack access to sources of health information and care.

Health Education. Health education is an important part of health promotion. It is defined as "any planned combination of learning experiences designed to predispose, enable, and reinforce voluntary behavior conducive to health in individuals, groups, or communities" (Green and Kreuter 1999). Examples include the multiple campaigns to prevent tobacco use among youth. An example at the statewide level is Arizona's promotion of the use of dental sealants with an educational campaign that says "Sealants Are in the Groove."

Disease Prevention. The term *prevention* embodies the goal of promoting and preserving health and minimizing suffering and distress. Community health programs generally focus on either *primary* prevention—removing or reducing risks or providing protection from disease before it occurs—or *secondary* prevention—screening and early detection and intervention to arrest the progress of disease after it occurs. *Tertiary* prevention—rehabilitating and restoring structure and function—is provided in some community-based programs, such as clinical dental care organized and delivered under conditions determined by the community.

effectiveness of clinical preventive services for the purpose of making recommendations. Similar reviews of the evidence of effectiveness for community preventive services are currently under way by the Task Force on Community Preventive Services (2000). These reports provide clear statements about the evidence and recommendations for or against a given strategy.

The discussion in this chapter is more illustrative than comprehensive. Readers are encouraged to seek specific guidance from the reports of the U.S. Preventive Services Task Force where available. Furthermore, because of the interest in community preventive services, "expert opinion" about the merits of community interventions is included, even though the work of the Task Force on Community Preventive Services has not been completed. Expert opinion is formed by less systematic reviews of the literature or addresses interventions to be applied in settings other than those previously studied.

In particular, suggestions are offered for several interventions intended to reduce oral disease and promote oral health that reflect the opinion of experts who contributed to this report. Until findings from additional research are available, expert opinion remains the best guidance for community interventions where only efficacy studies have been done or where they were applied to populations with different attributes or risk factors than those of current interest. Also, expert opinion has been used where there is an interest in criteria that were not considered in previous efficacy studies, such as cost-effectiveness and practicality.

Readers interested in more detailed information about interventions in areas such as control of tobacco use or motor vehicle safety are directed to the upcoming report of the Task Force on Community Preventive Services (2000).

Interventions included in this chapter (and highlighted in Table 7.1) are those that have been shown to be effective in certain settings, but which can be applied in other settings. The anticipated benefits may be difficult to determine. In general, the per capita cost of an intervention is lower for community interventions and is usually a function of the number of people reached for a given level of professional effort. Effectiveness, however, is often a function of the risk characteristics of a given individual in the group receiving the intervention. Such risk factors are often easier to target by individual practitioners than by community programs. In the absence of contemporary data, the promotion of strategies deemed to be more cost-effective than others relies on the opinion of experts. Individual decision making regarding self- or provider care further reflects the subjective value placed on the outcome of care. Therefore, it is not possible to make general statements about the superiority of any given approach.

PREVENTION AND CONTROL OF DENTAL CARIES

Although many caries prevention strategies, notably community water fluoridation and use of a fluoride-containing dentifrice, benefit adults and children alike, most of our understanding of the effectiveness of these strategies comes from the study of children, during a life stage when caries incidence is high. Caries prevention programs have been designed and evaluated for children and have used a variety of fluoride and dental sealant strategies applied separately and together. Because these strategies are complementary, their use in combination has the potential of virtually eliminating dental caries in all children. However, dental caries is a problem for all ages. Although direct evidence of caries preventive strategies in adults is limited, the evidence that does exist is consistent with expected effects based on experience with children. The Centers for Disease Control and Prevention (CDC) recently convened an expert work group to develop recommendations for modalities to prevent and control dental caries based on a review of publications selected by the work group and other experts. The resulting recommendations are summarized in Table 7.2, where they are organized according to quality of evidence, strength of recommendation, and target population in accordance with criteria adapted from the U.S. Preventive Services Task Force (CDC in press).

Fluoride

Fluoride reduces the incidence of dental caries and slows or reverses the progression of existing lesions (i.e., helps prevent cavities). Today, all Americans are exposed to fluoride to some degree, and there is little doubt that widespread use of fluoride has been a major factor in the overall decline in recent decades in the prevalence and severity of dental caries in the United States and other economically developed countries (Bratthall et al. 1996).

Fluoride is the ionic form of the element fluorine, the thirteenth most abundant element in the crust of the Earth. Because of its high affinity for calcium, fluoride is mainly associated with calcified tissues (i.e., bones and teeth). The ability of fluoride to inhibit, and even reverse, the initiation and progression of dental caries is well known. Fluoride's mech-

anisms of action include incorporation of fluoride into enamel preeruptively, inhibition of demineralization, enhancement of remineralization, and inhibition of bacterial activity in dental plaque.

A variety of theories regarding fluoride's mechanisms of action account for the range of fluoride products available (Burt and Eklund 1999, Stookey and Beiswanger 1995). The initial theory of action was based on the belief that incorporation of fluoride into the hydroxyapatite of developing tooth enamel in the preeruptive phase reduced the mineral's solubility, thereby increasing enamel resistance. Because of the length of time the tooth is at risk of caries during the posteruptive phase, however, the topical effects of fluoride are considered to predominate (Clarkson et al. 1996). These effects are based on fluoride's role in the aqueous phase around the tooth, both in saliva and in dental biofilm (plaque). Fluoride in plaque contributes to the remineralization of demineralized enamel when bound fluoride is released during an acid challenge, resulting in a more acid-resistant enamel surface structure. Fluoride also has been shown to inhibit the process of glycolysis by which fermentable carbohydrates are metabolized by cariogenic bacteria to produce acid. All these effects occur after the tooth erupts, while it is functioning in the mouth, enabling fluoride to prevent caries over a lifetime in both children and adults.

The first use of fluoride for caries prevention was in 1945 in the United States and Canada, when the fluoride concentration was adjusted in the drinking water supplying four communities (Arnold et al. 1962, Ast and Fitzgerald 1962, Blayney and Hill 1967, Hutton et al. 1956). This public health approach followed a long period of epidemiologic studies of the effects of naturally occurring fluoride in drinking water (Burt and Eklund 1999).

The success of the community water fluoridation trials in reducing dental caries led to the development of other important fluoride-containing products, such as dietary supplements and, most notably, fluoride-containing dentifrices, in the early 1960s. Fluoride-containing gels, solutions, pastes, and varnishes were also developed for topical use, either applied by professionals or self-applied at home or in other settings. All of these products were tested for safety and effectiveness in reducing caries. Products designed for professional use generally have higher concentrations and are used at less frequent intervals than those designed for self-application.

Controlled clinical trials from the 1940s through the 1970s documented the benefits of professionally applied fluoride in reducing dental caries, and several excellent reviews are available (Horowitz and Ismail 1996, Johnston 1994, Ripa 1990, Stookey and Beiswanger 1995). Professional application of fluoride is inherently more expensive than self-applied methods, so the use of such an approach for groups and individuals at low risk of dental caries is unlikely to be cost-effective. For patients at high risk of dental caries, however, professionally applied fluoride is still considered cost-effective. It is not clear whether fluoride varnishes and

TABLE 7.2
Quality of evidence, strength of recommendation, and target population of recommendation for each modality to prevent and control dental caries

Modality[a]	Quality of Evidence (grade)	Strength of Recommendation (code)	Target Population[b]
Community water fluoridation	II-1	A	All areas
School water fluoridation	II-3	C	Rural, nonfluoridated areas
Fluoridated dentifrices	I	A	All persons
Fluoride mouthrinses	I	A	High risk[c]
Fluoride supplements			
Pregnant women	I	E	None
Children aged <6 years	II-3	C	High risk
Children aged 6 to 16 years	I	A	High risk
Persons aged >16 years	N.A.	C	High risk
Fluoride gels	I	A	High risk
Fluoride varnishes	I	A	High risk
Dental sealants	I	A	High risk[d]

Notes: Criteria for quality of evidence and strength of recommendation designations are adapted from USPSTF as Table 5.3.

N.A. = no published studies of effectiveness of fluoride supplements in controlling dental caries among persons aged >16 years.

[a] Assume that the modalities are used as directed in terms of dosage and age of user.

[b] The quality of evidence for targeting some modalities to persons at high risk is grade III, representing the opinion of respected experts, and is based on considerations of cost-effectiveness that were not included in the studies establishing efficacy or effectiveness.

[c] Groups believed to be at high risk for caries are members of families of low socioeconomic status (SES) or with low levels of parental education; those seeking dental care on an irregular basis; and persons without dental insurance or access to dental service. Individual factors contributing to increased risk are currently active dental caries; a history of high caries experience in older siblings or caregivers; exposed root surfaces; high levels of infection with cariogenic bacteria; impaired ability to maintain oral hygiene; reduced salivary flow due to medications, radiation treatment, or disease; and the wearing of orthodontic appliances or prostheses.

[d] Assessment of risk is based on both patient and tooth-specific factors.

Source: Modified from CDC in press, and ASTDD 1995.

gels would be most efficiently used in clinical programs targeting groups at high risk of dental caries or whether they should be reserved for individual high-risk patients.

The U.S. Preventive Services Task Force (Greene et al. 1989, USPSTF 1996) and the Canadian Task Force on Periodic Health Examination (Lewis and Ismail 1995) affirm that there is strong evidence to support the major methods for providing fluoride to prevent dental caries.

The safety of fluoride is well documented and has been reviewed comprehensively by several scientific and public health organizations (Institute of Medicine (IOM) 1997, National Research Council (NRC) 1993, Newbrun 1996, U.S. Department of Health and Human Services (USDHHS) 1991, World Health Organization (WHO) 1984). When used appropriately, fluoride has been demonstrated to be both safe and effective in preventing and controlling dental caries. The IOM (1997) classified fluoride as a micronutrient, citing it, along with calcium, phosphorus, magnesium, and vitamin D, as an important constituent in maintaining health.

Appropriate use of fluoride products can minimize the potential for enamel fluorosis, a broad term applied to certain visually detectable changes in the opacity of tooth enamel associated with areas of fluoride-related developmental hypomineralization. There are also many developmental changes in enamel that are not fluoride-related (Fejerskov et al. 1990). Most enamel fluorosis seen today is of the mildest form, which affects neither aesthetics nor dental function. Cosmetically objectionable enamel fluorosis can occur when young children ingest higher than optimal amounts of fluoride, from any source, while tooth enamel is forming (up to age 6). Its occurrence appears to be most strongly associated with the total cumulative fluoride intake during the period of enamel development, but the condition's severity depends on the dose, duration, and timing of fluoride intake. Specific recommendations have been made to control fluoride intake by children during the years of tooth development (USDHHS 1991).

Fluoridation of Drinking Water

For more than half a century, community water fluoridation has been the cornerstone of caries prevention in the United States; indeed, CDC has recognized water fluoridation as one of the great public health achievements of the twentieth century (CDC 1999). All water contains at least trace amounts of fluoride. Water fluoridation is the controlled addition of a fluoride compound to a public water supply to achieve a concentration optimal for dental caries prevention. In the 1940s, Dean et al. (1941) concluded that 1 ppm (part per million) fluoride was the optimal concentration for climates similar to that of the Chicago area; this concentration would significantly reduce the prevalence of dental caries with an acceptably low prevalence of enamel fluorosis. Current U.S. Public Health Service (USPHS) recommendations for fluoride use include an optimally adjusted concentration of fluoride in drinking water ranging from 0.7 to 1.2 ppm, depending on the mean maximum daily air temperature of the area (Galagan and Vermillion 1957, USDHEW 1962). A lower fluoride concentration is recommended for communities in warmer climates than cooler climates, because it is assumed that persons living in warmer climates drink more tap water.

Effectiveness

Numerous studies in naturally fluoridated areas preceded the field trials. There are no randomized, double-blind, controlled trials of water fluoridation because its community-wide nature does not permit randomization of people to study and control groups. Similar results have been derived from numerous well-conducted field studies by various investigators on thousands of subjects in different parts of the world. Conducting a study in which individuals are randomized to receive or not receive fluoridated water is unnecessary and is not feasible.

In 1945, Grand Rapids, Michigan, became the first city in the United States to fluoridate its water supply; the oral health of its schoolchildren was periodically compared with that of schoolchildren in the control city, Muskegon, Michigan. Dramatic declines in dental caries among children in Grand Rapids and three other cities conducting studies shortly thereafter led to fluoridation in many other cities. In an extensive review of 95 studies conducted between 1945 and 1978, Murray et al. (1991) reported the modal caries reduction following water fluoridation to be between 40 and 50 percent for primary teeth and 50 and 60 percent for permanent teeth. Newbrun (1989) reported on more than 60 studies conducted during the 1970s and early 1980s, limiting his review to those with concurrent control groups because of the continuing decline in dental caries in both fluoridated and nonfluoridated areas. Comparisons of fluoride-deficient and fluoridated communities in the United States, Australia, Britain, Canada, Ireland, and New Zealand have consistently demonstrated the

continued effectiveness of water fluoridation. Caries reductions ranged between 15 and 40 percent in fluoridated, as compared with fluoride-deficient, communities (USDHHS 1991).

Fluoridation also benefits middle-aged and older adults. Benefits to adults include reductions in both coronal and root caries. These benefits are important because older people typically experience gingival recession, which results in exposed root surfaces, which are susceptible to caries. In addition, tooth retention in older U.S. cohorts has increased in recent decades, so that the number of teeth at risk for caries in older age groups is also increasing. Finally, many medications used to treat chronic diseases common in aging have the side effect of diminished salivary flow, depriving teeth of the many protective factors in saliva.

Other evidence of the benefits of fluoridation comes from studies of populations where fluoridation has ceased. Examples in the United States, Germany, and Scotland have shown that when fluoridation is withdrawn and there are few other fluoride exposures, the prevalence of caries increases. In Wick, Scotland, which began water fluoridation in 1969 but stopped it in 1979, the caries prevalence in 5- to 6-year-olds with limited exposure to other sources of fluoride increased by 27 percent between 1979 and 1984. This was despite a national decline in caries and increased availability of fluoride-containing dentifrices (Kugel and Fischer 1997, Seppä et al. 1998, Stephen et al. 1987).

Costs and Cost-effectiveness

The increase in other fluoride exposures since water fluoridation was first introduced in 1945—particularly from fluoride-containing dentifrices, mouthrinses, and foods and beverages processed using fluoridated water—has led to smaller differences in the prevalence of dental caries between people in fluoridated and those in nonfluoridated communities than in the past. Most public health experts believe that water fluoridation continues to be a highly cost-effective strategy, even in areas where the overall caries level has declined and the cost of implementing water fluoridation has increased (Burt 1989, CDC 1999).

Compared to the cost of restorative treatment, water fluoridation actually provides cost savings, a rare characteristic for community-based disease prevention strategies (Garcia 1989). The mean annual per capita cost of fluoridation ranges from $0.68 for systems serving populations greater than 50,000 (large systems) and $0.98 for systems serving between 10,000 and 50,000 (medium systems), to $3.00 for systems serving less than 10,000 (small systems) (reported in 1999 dollars) (Ringelberg et al. 1992). In 1992, approximately 60 percent of the U.S. population receiving fluoridated water was served by large systems, 31 percent by medium systems, and 9 percent by small systems (USDHHS 1993).

Access to Optimally Fluoridated Water in the United States

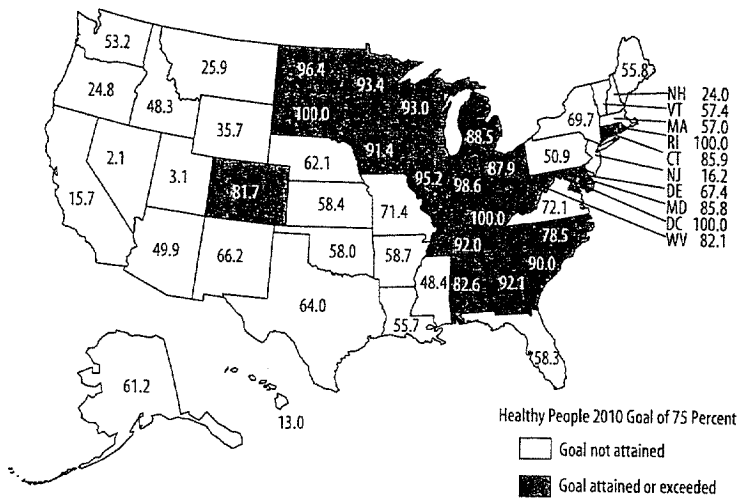
The most recent national data on the extent of community water fluoridation reflect the status of fluoridation in 1992 (see Figure 7.1 and Table 7.3). About 145 million people, or 62 percent of the population served by public water supplies, consume water with optimal fluoride levels. Of the 50 largest cities in the United States, 43 are fluoridated (Table 7.4). Residents of the seven unfluoridated cities in the group are among the almost 100 million persons in the United States who lack this method of caries prevention.

Although many states and large cities had been quick to implement fluoridation programs in the 1950s and 1960s, the trend then began to level off. In the absence of legislative mandates in most states and categorical federal funding, fluoridation decisions are left to the states, and frequently to local governments and city councils. Thus expansion of fluoridation in the United States is not simple and requires decisions at many levels. The national health promotion and disease prevention objectives in Healthy People 2010 (USDHHS 2000) call for increasing the percentage of Americans on public water supplies drinking fluoridated water from 62 to 75 percent—a 21 percent improvement (see Figure 7.1). This would mean adding 30 million people served by well over 1,000 community water systems to those who currently have access to fluoridated public water systems (USDHHS 1993).

Summary: Community Water Fluoridation

Epidemiological studies carried out during the last five decades provide strong evidence supporting the effectiveness of water fluoridation in preventing coronal and root caries in children and adults. Further support of effectiveness comes from studies that indicate that caries experience increases in communities that no longer fluoridate the water supply (and where there are few other exposures to fluorides). Given the modest cost of less than 1 dollar per person per year to fluoridate water systems serving most people, community water fluoridation is recommended as a very effective and cost-effective

FIGURE 7.1
Percentage of U.S. population by state served by fluoridated public water supply, 1992



Source: USDHHS 1993.

TABLE 7.3
Population served by fluoride-adjusted and naturally fluoridated water, United States, 1992

Type of Fluoridation	Population	Number of Systems	Number of Communities
Adjusted	134.6 million	10,567	8,572
Natural	10.0 million	3,784	1,924
Both	144.6 million	14,351	10,496

Source: USDHHS 1993.

method of preventing coronal and root caries in children and adults. Moreover, water fluoridation benefits all residents served by community water supplies regardless of socioeconomic status. Few barriers to its implementation exist, with the important exception of the political opposition that the measure often engenders and certain technical difficulties and costs involved in fluoridating very small water systems.

School Water Fluoridation

During the 1960s, 1970s, and 1980s, programs were initiated to bring the benefits of fluoride in drinking water to children living in homes supplied by well water and whose schools had independent water supplies. The idea was to adjust the fluoride content of the water supplies of the schools these children attended, especially consolidated rural schools, to levels higher than those that would be used for community water fluoridation, taking into account that the children were present for only portions of the day and year.

Although the strategy shares some of the advantages of community water fluoridation—serving rich and poor alike and requiring no action on the part of the children (other than drinking the water)—a number of disadvantages were evident from the outset. These included the limitations inherent in beginning exposure to fluoride only when children were of school age and then providing only intermittent exposure. Also, the possibility that the exposure would not confer benefits after the children left school was a concern. Practical considerations included the cost of operations, personnel, logistical difficulties, and mandatory water testing (CDC 1995). Moreover, the intervening decades have seen increased school consolidations, increased coverage of schools by community-wide water systems, declining numbers of children who could benefit from such programs, and a continuing general decline in dental caries in children. Another concern is that schools increasingly enroll preschoolers into daycare programs for which school water fluoridation at higher levels than for community water systems is not appropriate. Only four intervention studies evaluating the effectiveness of school water fluoridation have been published.

Summary: School Water Fluoridation

Given the limitations of the evidence for effectiveness, as well as the difficulties of implementation and operation, school water fluoridation has limited application. Decisions to initiate or continue school fluoridation programs should be based on an assessment of present caries risk in the target school(s), alternative preventive modalities that may be available, and periodic evaluation of program effectiveness.

Dietary Fluoride Supplements

Dietary fluoride supplements are available as tablets that are swallowed or chewed, drops that are swallowed, and lozenges that dissolve slowly in the

mouth. They can provide topical and systemic fluoride for children in the absence of optimally fluoridated drinking water. In the United States, supplements are available by prescription only, to be used once a day beginning at 6 months and ending at age 16. According to a 1986 National Health Interview Survey (NHIS), slightly more than 16 percent of children younger than 2 years used fluoride dietary supplements (Nourjah et al. 1994).

The fluoride supplement dosage schedule in use in the United States was last revised by the American Dental Association (ADA) in 1994 (Table 7.5) (ADA 1995). This schedule, based on the level of fluoride in the community water supply and on the age of the child, has also been endorsed by the American Academy of Pediatric Dentistry and the American Academy of Pediatrics. Fluoride supplements should not be prescribed for individuals living in optimally fluoridated communities.

Effectiveness of Home Use

The current fluoride supplement dosage schedule does not recommend prescribing fluoride for infants younger than 6 months. A double-blind study of fluoride supplements conducted to ascertain the effects of fluoride administered to the mother during the last 6 months of pregnancy followed by 5 years of supplements to the child after birth found no additional benefits from prenatal fluoride use (Leverett et al. 1997). In a randomized, double-blind, controlled trial in which supplements were administered from birth, Hennon et al. (1967) had found statistically significant 4-year reductions in caries in primary and permanent teeth of 65 and 41 percent, respectively. Beyond this study, which was conducted when other sources

TABLE 7.4
Water fluoridation status of top 50 U.S. cities

	Population Estimate (7/1/96)	Size Rank 1996	Fluoride/ No Fluoride[a]
New York, New York	7,380,906	1	F
Los Angeles, California	3,553,638	2	F
Chicago, Illinois	2,721,547	3	F
Houston, Texas	1,744,058	4	F
Philadelphia, Pennsylvania	1,478,002	5	F
San Diego, California[b]	1,171,121	6	NF
Phoenix, Arizona	1,159,014	7	F
San Antonio, Texas	1,067,816	8	NF
Dallas, Texas	1,053,292	9	F
Detroit, Michigan	1,000,272	10	F
San Jose, California	838,744	11	NF
Indianapolis, Indiana	746,737	12	F
San Francisco, California	735,315	13	F
Jacksonville, Florida	679,792	14	F-nat
Baltimore, Maryland	675,401	15	F
Columbus, Ohio	657,053	16	F
El Paso, Texas	599,865	17	F-nat
Memphis, Tennessee	596,725	18	F
Milwaukee, Wisconsin	590,503	19	F
Boston, Massachusetts	558,394	20	F
Washington, D.C.	543,213	21	F
Austin, Texas	541,278	22	F
Seattle, Washington	524,704	23	F
Nashville-Davidson (remainder), Tennessee	511,263	24	F
Cleveland, Ohio	498,246	25	F
Denver, Colorado	497,840	26	F
Portland, Oregon	480,824	27	NF
Fort Worth, Texas	479,716	28	F
New Orleans, Louisiana	476,625	29	F
Oklahoma City, Oklahoma	469,852	30	F
Tucson, Arizona[b]	449,002	31	NF
Charlotte, North Carolina	441,297	32	F
Kansas City, Missouri	441,259	33	F
Virginia Beach, Virginia	430,385	34	F
Honolulu, Hawaii	423,475	35	NF
Long Beach, California	421,904	36	F
Albuquerque, New Mexico	419,681	37	F
Atlanta, Georgia	401,907	38	F
Fresno, California	396,011	39	NF
Tulsa, Oklahoma	378,491	40	F
Las Vegas, Nevada	376,906	41	F
Sacramento, California	376,243	42	F
Oakland, California	367,230	43	F
Miami, Florida	365,127	44	F
Omaha, Nebraska	364,253	45	F
Minneapolis, Minnesota	358,785	46	F
St. Louis, Missouri	351,565	47	F
Pittsburgh, Pennsylvania	350,363	48	F
Cincinnati, Ohio	345,818	49	F
Colorado Springs, Colorado	345,127	50	F

[a] F = fluoride, NF = no fluoride, and F-nat = natural, nonadjusted fluoride in the water supply.
[b] Voted but not yet started.
Source: T. Reeves, CDC Division of Oral Health, personal communication, April 18, 2000.

of fluoride were not as widespread as today, there are no well-designed clinical trials of home-based administration of postnatal supplements. As Murray and Naylor (1996) noted, many studies are difficult to interpret, either because of small size, short experimental period, or inadequate reporting. The studies are further complicated by problems in self-selection bias, in choosing comparable control groups, and in compliance to the daily regimen.

Notwithstanding the paucity of true randomized controlled clinical trials to demonstrate efficacy of supplement use in children, at least 60 studies have reported on the effectiveness of fluoride tablets or drops in home- or school-based programs (Driscoll 1974, Murray and Naylor 1996, Stephen 1993). However, none used the current prescribing schedule. Altogether, the evidence for using fluoride supplements to prevent and control dental caries is mixed. Although many studies have reported that the use of fluoride supplements by infants and children before their permanent teeth erupt reduces caries in permanent teeth, many other studies have reported that it does not (CDC in press). For children aged 6 to 16 who take supplements after most teeth have erupted, the evidence is much clearer that fluoride reduces caries experience (DePaola and Lax 1968, Driscoll et al. 1978, Stephen and Campbell 1978).

Most of the supplements taken at home are prescribed by physicians and dentists in private practice, with physicians prescribing the larger share. Two difficulties are associated with home use. First, the provider may prescribe incorrectly; second, compliance with home-based tablet programs can be very poor. More public and professional education is needed to overcome the difficulties inherent in following recommended regimens for home use of fluoride supplements, which require motivation and adherence on the part of children, parents, and prescribers.

Effectiveness of School-based Programs

Most community fluoride supplement programs are school-based. Each school day, participating students receive a tablet, which they chew under supervision, swishing the resultant solution between the teeth for 30 seconds before swallowing.

Supplement programs in schools have been shown to be effective in preventing caries in permanent teeth when administration is tightly controlled and children are instructed to let the tablet dissolve slowly, to ensure as much topical fluoride exposure as possible. Under these conditions, randomized controlled trials in the United States reported caries reductions of 20 to 28 percent over periods of 3 to 6 years (DePaola and Lax 1968, Driscoll et al. 1978). In a randomized, double-blind, 3-year study of Scottish schoolchildren who were 5.5 years of age at the start of the study, a much higher percentage reduction in caries in permanent teeth was observed (Stephen and Campbell 1978). In this study, teachers were specifically requested to encourage children each school day to let the sodium fluoride tablet dissolve slowly. These children were from lower socioeconomic groups and may not have had access to fluoride-containing dentifrices and other sources of fluoride, factors that most likely put them at high risk for caries.

Costs of School-based Programs

The costs of a school-based tablet program are low because equipment is not necessary, the procedure does not take long, and an entire classroom of children can participate at once. A 1988 survey of five programs ranging from 7 to 49 schools and 657 to 10,751 children found an average direct cost of approximately $2.53 per child per school year (Garcia 1989). The costs ranged from $0.81 to $5.40, depending on whether paid personnel or volunteers supervised the procedure. The economic benefits of a fluoride supplement program were assessed in randomized controlled clinical trials in Manchester, England, and results showed overall health and cost benefits for the experimental group (O'Rourke et al. 1988).

Summary: Dietary Fluoride Supplements

For children not exposed to optimal fluoride concentration in their water supply, the evidence from studies conducted prior to the 1980s supporting the effectiveness of home use of daily dietary fluoride supplements in preventing dental caries in school-aged children is weak. However, the evidence of the effectiveness of school-based fluoride supplement programs is strong. Such programs require highly

TABLE 7.5
Dietary fluoride supplement dosage schedule

	Fluoride Dosage (milligrams per day) at Fluoride in Water Concentration of		
Age of Child	<0.3 ppm	0.3 to 0.6 ppm	>0.6 ppm
Birth to 6 months	None	None	None
6 months to 3 years	0.25	None	None
3 years to 6 years	0.50	0.25	None
6 years to 16 years	1.00	0.50	None

Source: ADA 1995.

motivated teachers and students, a requirement that likely has limited their widespread adoption. Experts recommend that school-based dietary fluoride supplement programs are likely to be effective in providing topical fluoride protection for children at high risk for dental caries in settings where supervising personnel are highly motivated (CDC in press, Clarkson 1992, Ismail 1994, WHO 1994). Under these conditions, such programs may also be cost-effective.

Fluoride Mouthrinses

Several different formulations of fluoride mouthrinses are available, differing in the amount of fluoride and suggested frequency of use. Rinses with low fluoride concentrations (0.05 percent neutral sodium fluoride or 0.1 percent stannous fluoride) are designed for daily use and are available over-the-counter. Higher-concentration rinses (0.2 percent sodium fluoride) are designed for weekly use and are available only by prescription or in public programs.

School-based Programs

Fluoride mouthrinses were developed in the 1960s as a public health measure for use primarily in schools. They were conceived as a way of avoiding the high costs associated with professional applications of gels and other topical fluoride products in school settings and the poor acceptance by children of brush-on fluoride pastes.

For children in the first grade and up, the procedure consists of vigorously rinsing with 10 milliliters (ml) of solution for 60 seconds. After the rinsing, the fluoride solution is expectorated into a cup, a napkin is inserted to absorb the solution, and both are disposed. Kindergarten children rinse with only 5 ml of solution.

Effectiveness

School-based fluoride mouthrinse programs have been evaluated extensively during the past three decades and have been the subject of numerous reviews (Adair 1998, Birkland and Torell 1978, Bohannan et al. 1985, Petersson 1993, Ripa 1991, Stamm et al. 1984, Torell and Ericsson 1974). Of the many studies during the 1970s and 1980s, 13 satisfied the strict criteria of randomized controlled clinical trials. Caries reductions ranging from 20 to 50 percent were observed, firmly establishing their efficacy. No recent controlled trials have been done. After the efficacy of fluoride mouthrinses was established, a 17-site national school-based demonstration program showed that a protocol involving weekly rinsing with 0.2 percent sodium fluoride was eminently practical. Most studies done after efficacy was established used a before-and-after design with no concurrent comparison group. This design might overestimate the caries reduction effects. On the whole, however, the programs appear to have been effective.

A survey conducted in 1984 found fluoride mouthrinsing programs in 48 states, with 3.2 million children participating (Bednarsh and Connolly 1984). A later study by CDC reported that 3.25 million schoolchildren were participating in mouthrinsing programs at 11,683 sites in 1988 (Burt 1989), although there are reports that some states have recently curtailed use of these programs (R. Kuthy, personal communication, 2000).

Cost-effectiveness

The cost of the procedure in 1988 ranged between $0.52 and $1.78 per child per school year, depending on whether paid or volunteer adult supervisors were used (Garcia 1989). An extensive study during the late 1970s, when downward trends of caries rates were noted, questioned the cost-effectiveness of rinse programs (Klein et al. 1985). Fluoride mouthrinses may be more cost-effective when targeted to schoolchildren with high caries activity (Bawden et al. 1980, Leverett 1989, Torell and Ericsson 1965).

Summary: School-based Fluoride Mouthrinse Programs

Sufficient evidence exists from studies conducted before 1985 to support the effectiveness of 0.2 percent sodium fluoride mouthrinses in preventing coronal caries in school populations. There is evidence that with a declining prevalence of dental caries, the cost-effectiveness of these procedures is reduced. Experts recommend that school-based rinsing once a week with 0.2 percent sodium fluoride is likely to be effective if used in schools and classrooms where students are at high risk for caries and if applied consistently over time (CDC in press). Fluoride mouthrinse programs are not recommended for preschool children in the United States, and programs for kindergarten children should use only 5 ml of solution.

Fluoride Varnishes

Fluoride varnishes have not been approved for use in the United States with an anticaries indication. However, the U.S. public health community has begun to investigate the use of fluoride varnishes,

which became available in this country in 1994. The varnishes are viscous, resinous lacquers painted onto teeth. Because the varnish adheres to enamel surfaces for up to 12 hours or more, fluoride retention in the mouth is greater than with solutions or gels. Varnishes have been used in Europe for 30 years.

No data are available on the use of varnishes in children under 3 years, and, although the results were positive, only two randomized clinical trials have been conducted abroad using preschoolers (Holm 1979, Peyron et al. 1992). Many fluoride rinsing programs in Finland have been replaced with fluoride varnish application programs (Seppä 1991, Sundberg et al. 1996). Studies conducted in Canada (Clark et al. 1987) and Europe (de Bruyn and Arends 1987, Helfenstein and Steiner 1994, Twetman et al. 1996) have found that fluoride varnish is efficacious in preventing dental caries. Applied semiannually, this modality is as effective as professionally applied fluoride gel (Seppä et al. 1995). Some researchers advocate application of fluoride varnish up to 4 times per year to achieve maximum effect, but the evidence of benefits from more than two applications per year remains inconclusive (Mandel 1994, Seppä 1991, Seppä and Tolonen 1990). Other studies have shown that three applications in 1 week, once a year, may be more effective than the more conventional biannual regimen (Petersson et al. 1991, Skold et al. 1994). European studies have shown that fluoride varnishes prevent decalcification (a very early stage of dental caries) beneath orthodontic bands (Adriaens et al. 1990) and slow the progression of existing enamel lesions (Peyron et al. 1992). Findings on cost-effectiveness are mixed (Kirkegaard et al. 1986, Koch et al. 1979, Seppä and Pollanen 1987, Vehmanen 1993).

Dental Sealants

The pits and fissures that characterize the biting surfaces of posterior teeth provide a haven for food debris and decay-causing bacteria. Not surprisingly, these sites are often the first and most frequent to be affected by decay in children and adolescents. The width of most pits and fissures is narrower than a single toothbrush bristle, making cleaning of their deepest recesses almost impossible. According to national estimates, as much as 90 percent of all dental caries in schoolchildren occurs in pits and fissures (Kaste et al. 1996). The teeth at highest risk by far are permanent first and second molars.

Enamel bonding, a technology introduced in the mid-1950s, led to the development of sealants. These are clear or opaque plastic resinous materials designed for professional application to the pit-and-fissure surfaces of teeth. The material hardens within 60 seconds or so into a thin, hard, protective coating. Sealants were introduced in the late 1960s and received the American Dental Association Seal of Approval in 1976 (ADA 1976). Most of the dozen products approved by the ADA do not contain a therapeutic agent, but work by providing a physical barrier that prevents microorganisms and food particles from collecting in the pits and fissures (ADA 1997). First-generation sealants used ultraviolet light to harden or "cure" the material; improved second- and third-generation sealants cure by chemical or visible light activation, respectively.

Sealant placement requires meticulous attention to technique, but they can be successfully provided in "field" settings using portable dental equipment. To be most effective, sealants should be placed on teeth soon after they erupt, but they can be applied across a wide age range. Not only does the risk for caries continue across the life span, but an individual's risk can increase for any number of reasons. Sealants are particularly helpful for persons with medical conditions associated with higher caries rates, children who have experienced extensive caries in their primary teeth, and children who already have incipient caries in a permanent molar tooth.

Efficacy

Initial clinical trials using a random half-mouth design and first- or second-generation sealant materials established their efficacy. Several comprehensive reviews and a meta-analysis of the amount of caries prevented testify to the utility of these materials (Llodra et al. 1993, Ripa 1993, Weintraub 1989). Llodra et al. (1993) used a systematic process to select and review studies of one-time sealant placement on permanent teeth in subjects unexposed to other preventive measures. Pooled results from 17 studies meeting their selection criteria found that second-generation sealants reduced caries over 70 percent.

These early trials firmly established retention as essential to preventing caries; a sealant is virtually 100 percent effective if it is fully retained on the tooth (NIH 1984). Mertz-Fairhurst (1984) reported 92 to 96 percent retention rates in second-generation sealants after 1 year, with 67 to 82 percent retention after 5 years. A review of studies of long-term retention of second-generation sealants showed 41 to 57 percent intact after 10 years (Ripa 1993). The longest-running study of a one-time application of a first-generation sealant indicated a reduction in pit-and-fissure caries by 52 percent after 15 years

(Simonsen 1991). Retention results for third-generation sealants are similar to those for second-generation systems (Ripa 1993).

Effectiveness

Administrators of school-linked sealant programs (Collins et al. 1985, Sterritt and Frew 1988) and of school-based programs with either fixed clinics (Ismail et al. 1989, Messer et al. 1997, Whyte et al. 1987) or portable equipment (Bravo et al. 1996, Calderone and Davis 1987, Calderone and Mueller 1983, Hardison 1983, Kumar et al. 1997, Morgan et al. 1998) have reported on their experiences with these programs. These studies, using second-generation sealants, have shown effectiveness results comparable to those of clinical trials, regardless of the physical delivery site or personnel used for sealant application. Complete retention after approximately 1 year varied from 83 to 94 percent (Calderone and Mueller 1983, Hardison 1983, Ismail et al. 1989, Sterritt and Frew 1988, Whyte et al. 1987).

A Consensus Development Conference sponsored by the National Institutes of Health concluded that "an extensive body of knowledge has firmly established the scientific basis for the use of sealants" (NIH 1984). The panel urged the development of educational materials to enhance public and professional acceptance as well as third-party reimbursement. Consensus on the value of sealants is reflected by the inclusion of sealant objectives in Healthy People 2000 and Healthy People 2010 (see Table 7.6). In addition, sealant placement is supported in federally funded programs for women and children, and sealants are covered services in all state Medicaid programs. A Workshop on Guidelines for Sealant Use has made recommendations for sealant use in both community and individual care programs (ASTDD 1995).

Community Dental Sealant Programs

Several community-based public health initiatives have arisen to promote sealant use among private practitioners and through community-based programs. These activities include reaching dentists through continuing education courses (Bader et al. 1987, Callanen et al. 1986, Siegal et al. 1996); directing large-scale promotional activities to consumers, community leaders, and third-party payers (Siegal et al. 1997a); and providing sealants directly to children in school programs.

Community programs that provide sealants directly to schoolchildren generally target vulnerable populations less likely to receive private dental care, such as children eligible for free or reduced-cost lunch programs. School-based programs are usually conducted entirely on site. School-linked programs conduct some portion of the program in schools, such as patient selection and parental permission, but generally provide the sealants at an off-site private practice or clinic. Nationally, 88 community-based sealant placement programs were in operation in the 1992-93 school year. These programs served children in 1,636 schools (Siegal et al. 1997b).

Combining Sealants with a Fluoride Program

Dramatic evidence of the impact of a combined fluoride and sealant program is provided by a program in Guam (Sterritt et al. 1990). For many years the children on this island had experienced dental caries rates more than double those of their U.S. mainland counterparts. In 1984 a school-linked pit-and-fissure sealant program was added to an existing school-based fluoride mouthrinse program. More than 15,000 children participated annually in the sealant program. After 8 years of fluoride mouthrinsing (from 1976 to 1984), mean decayed, missing, and filled surface (DMFS) scores declined by 1.79 surfaces per child. Only 7 percent of that decline was due to prevention of caries on surfaces that can benefit from sealants. With the addition of the sealant program to mouthrinsing, overall DMFS scores decreased an additional 2.34 surfaces per child in only 2 years. Most of this decline took place on pit-and-fissure surfaces. For the 10-year period a reduction of 4.13 DMFS per child was seen—a decline from 7.06 DMFS per child at baseline to 2.93 DMFS in 1986. At the end of the 10 years, participating children on Guam had caries rates close to those of mainland schoolchildren.

The National Preventive Dentistry Demonstration Program, a large project conducted in 10 U.S. cities between 1976 and 1981 to compare the costs and effectiveness of combinations of caries prevention procedures, found that the inclusion of sealants was critical to the cost-effectiveness of prevention strategies (Disney et al. 1989, Klein et al. 1985). In another combined program, Morgan et al. (1998) found that a 3-year sealant program and a fluoride mouthrinse program for secondary schoolchildren incurred a low cost for each tooth surface saved from caries. The incremental cost-effectiveness ratios comparing the intervention to the control group varied from a cost of $35.60 per tooth surface spared to a net savings of $7.00, depending on the assumptions used in the analysis.

Sealing Incipient Caries

Heller et al. (1995) evaluated the effect of sealants placed as part of a school-based program on permanent first molar teeth after 5 years. Sealants were applied to both sound teeth and those with incipient carious lesions (where the fissure is stained but not yet cavitated). For the initially incipient carious surfaces, the 5-year decay rate was 10.8 percent for sealed surfaces and 51.8 percent for unsealed surfaces. Initially sound surfaces had a decay rate of 8.1 percent for sealed surfaces and 12.5 percent for unsealed surfaces. Initially sound tooth surfaces were unlikely to become decayed in 5 years and did not benefit greatly from the application of sealants. The study showed potential efficiencies in targeting teeth with incipient caries for sealants.

Cost-effectiveness of Sealant Programs

Studies suggest that sealants are an efficient use of resources when used in populations with higher-than-average disease incidence rates and when selection methods limit sealants to teeth at highest risk of disease. Weintraub et al. (1993) demonstrated cost savings or improving cost-effectiveness with time in a sealant study at a children's dental clinic for low-income families. A strategy of identifying children with prior molar restorations (an indicator of high risk) and sealing the remaining molars showed cost savings within 4 to 6 years.

Summary: Dental Sealant Programs

Studies carried out during the last 20 years provide strong evidence to support the effectiveness of sealants in preventing the development of caries in tooth pits and fissures. Economic analyses suggest that community sealant programs are cost-effective and may even provide cost savings when used in high-risk populations. Experts recommend that programs should be limited to high-risk children and high-risk teeth.

TABLE 7.6
Baseline data for Healthy People 2010 objective 21-8a & b: increase the proportion of children who have received dental sealants on their molar teeth

	Percentage of Children Who Have Received Sealants[a]	
	Aged 8 Years	Aged 14 Years
2010 target	50	50
Total, 1988–94 baseline	23	15
Race and ethnicity		
American Indian or Alaska Native (1999)[b]	37	26
Asian or Pacific Islander	DSU	DSU
Asian	DNC	DNC
Native Hawaiian and other Pacific Islander	DNC	DNC
Black or African American	11	5
White	26	19
Hispanic or Latino	DSU	DSU
Mexican American	10	7
Not Hispanic or Latino	25	DNA
Black or African American	11	5
White	29	18
Gender		
Female	24	14
Male	22	16
Education level (head of household)		
Less than high school	17	4
High school graduate	12	6
At least some college	35	28
Disability status		
Persons with disabilities	DNC	DNC
Persons without disabilities	DNC	DNC
Selected populations		
Third-grade students	26	NA

[a] DNA = data have not been analyzed. DNC = data are not collected. DSU = data are statistically unreliable. NA = not applicable.
[b] Data are for IHS service areas.
Data sources: National Health and Nutrition Examination Survey (NHANES), NCHS, CDC; Oral Health Survey of Native Americans, 1999, IHS.
Source: USDHHS 2000.

PREVENTION AND CONTROL OF PERIODONTAL DISEASES

Periodontal diseases, caused by specific bacteria in dental plaque, affect most adults at some point in their lives. The mildest and most common form of periodontal disease is gingivitis. Over time, periodontitis, the more severe form of periodontal disease, can lead to the destruction of the soft tissue and bone that anchor the teeth into the jaw. Lacking support, teeth can loosen and be lost.

Periodontal diseases can be prevented and controlled through an array of mechanical and chemical means (Ismail and Lewis 1993, AAP 1996). Conscientious oral hygiene and professional oral cleanings to reduce plaque can reverse gingivitis (Löe et al. 1965).

Methods for personal oral hygiene include toothbrushing and flossing, which may be augmented by over-the-counter and prescription mouthrinses with antimicrobial action.

Community Programs to Prevent Gingivitis

With the confirmation of specific bacteria in dental plaque as the cause of gingivitis, public health officials began to seek ways to educate the public about plaque control in community settings, primarily in schools. These efforts have had equivocal results. Although knowledge and attitudes were enhanced in demonstration programs, improvements in plaque levels and gingivitis were short-lived in clinical trials (Horowitz et al. 1980).

Prevention of Periodontitis

Tobacco use is a major risk factor for the development and progression of periodontal diseases, and proven strategies aimed at reducing tobacco use should aid in the prevention of periodontitis. The following section on oral and pharyngeal cancers includes a discussion of such intervention strategies. Until recently, most interest in controlling tobacco use reflected concerns about oral cancers. As appreciation of the role of tobacco in the progression of periodontal diseases and tooth loss increases, attention to these oral health effects may increase attention to tobacco cessation in primary oral health care. Periodontitis can also be a complication of poorly controlled diabetes. (See Chapters 3 and 5 for a discussion of other periodontal risk factors; Chapter 5 discusses the connection between periodontal disease and diabetes.)

Some efforts have been directed at alerting dental practitioners to the need to educate patients about diseases affecting the periodontal tissues (Bader et al. 1990, Brown and Spencer 1989). These efforts have met with some success, but they tend to reach only those people who already use dental services. Currently, there are no broad community-based intervention programs that address periodontal diseases.

Summary

Gingivitis can be controlled with available methods, and its control is the principal way to prevent periodontitis. However, the currently available methods are individually or professionally based and require conscientious oral hygiene practices and regular dental visits. Although some schools instruct children in proper methods of oral hygiene, no community methods, other than programs designed to discourage tobacco use, are available for preventing gingivitis or periodontitis in the general population.

PREVENTION AND CONTROL OF ORAL AND PHARYNGEAL CANCERS

The term *oral and pharyngeal cancers* refers to a diverse group of tumors affecting the oral cavity and pharynx, the majority of which are squamous cell carcinomas. Usually included are cancers of the lips, tongue, pharynx, and oral cavity. These malignancies are among the most debilitating and disfiguring of all cancers. More than 30,000 new cases of oral and pharyngeal cancers are diagnosed each year, and more than 8,000 people die annually from these diseases. The overall 5-year survival rate (52 percent) has not changed in the past four decades (Murphy et al. 1995, Silverman 1998).

Primary risk factors for oral cancers in the United States are the use of tobacco and alcohol products and, for lip cancer, exposure to sun. Tobacco and alcohol independently increase the risk of oral and pharyngeal cancers and also act synergistically, so that persons who use both are at much higher risk than those who use only one. Other risk factors include insufficient fruits and vegetables in the diet, failure to use ultraviolet protection, and infection with certain viruses (Winn et al. 1998).

In 1996 CDC convened the National Oral Cancer Strategic Planning Conference to develop strategies for preventing and controlling oral and pharyngeal cancers in the United States. The conference, which was co-sponsored by the National Institute of Dental and Craniofacial Research and the ADA, included over 125 experts in oral and pharyngeal cancer prevention and control, treatment, and research (CDC 1998). These experts developed recommendations concerning public advocacy, collaboration, and coalition building; public education; professional education and practice; and data collection, evaluation, and research. An ongoing multidisciplinary subgroup from that conference, the Oral Cancer Working Group, met in 1997 and again in 1999 to share information on progress made and to discuss steps to implement a national plan. This group's work will augment existing interventions directed at the reduction of tobacco use, for which several community-based interventions have already been shown to be effective. The group is also developing several statewide models for the prevention and early detection of oral and pharyngeal cancers.

Many recommendations from the 1996 Strategic Planning Conference relate to the inclusion of primary prevention (i.e., reducing risk factors) and early detection. These include a recommendation that because people at high risk for oral cancers are more likely to visit a physician than a dentist, and because physicians may be less likely than dentists to perform an oral cancer examination on such patients, all primary care providers should assume more responsibility for counseling patients about behaviors that put them at risk for developing these cancers; should perform oral cancer examinations on all patients who are at high risk for developing the disease because of tobacco use or excessive alcohol consumption; and should refer patients to the appropriate specialist for management of suspicious oral lesions (CDC 1994c, Elwood and Gallagher 1985, Lynch and Prout 1986, Prout et al. 1990, Yellowitz and Goodman 1995). Further research is needed to better define screening parameters. Comprehensive education of medical and dental practitioners in diagnosing and promptly managing early lesions was recommended to facilitate the multidisciplinary collaboration needed to detect oral cancers in their earliest stages. Furthermore, because of the public's lack of knowledge about the risk factors for oral cancers and because these diseases can often be detected in the early stages, it is also recommended that programs to raise the public's awareness of oral cancers (including their risk factors, signs, and symptoms) be increased.

Community-based Interventions

Community-based interventions for oral and pharyngeal cancer prevention have depended on tobacco control programs.

School-based Prevention Programs

On average, more than 3,000 children and teenagers become regular smokers each day (USDHHS 1994). Prevention efforts aimed at young people are extremely important because nearly all initiation of tobacco use in the United States occurs by age 18. Moreover, the finding that the earlier that smoking begins the more likely it is to lead to heavy use in adulthood makes preventing tobacco use among school-age youth all the more critical (CDC 1994a).

Programs identifying the social influences that foster tobacco use in schoolchildren and teaching skills to resist such influences have yielded consistent and significant results. Reductions or delays in adolescent smoking have been documented, ranging from 25 to 60 percent and persisting from 1 to 4 years (CDC 1994b). The interventions were based on a CDC review of published research, including the conclusions of the National Cancer Institute's (NCI) Expert Advisory Panel on School-based Smoking Prevention Programs and findings from the 1994 Surgeon General's report, *Preventing Tobacco Use Among Young People* (CDC 1994b). The *Guidelines for School Health Programs to Prevent Tobacco Use and Addiction* cites seven recommendations (CDC 1994a,b):

1. Develop and enforce a school policy on tobacco use.
2. Provide instruction about the short- and long-term negative physiologic and social consequences of tobacco use, social influences on tobacco use, peer norms regarding tobacco use, and refusal skills.
3. Provide tobacco-use-prevention education in kindergarten through 12th grade; this instruction should be especially intensive in junior high or middle school and reinforced in high school.
4. Provide program-specific training for teachers.
5. Involve parents or families in support of school-based programs to prevent tobacco use.
6. Support cessation efforts among students and all school staff who use tobacco.
7. Assess the tobacco-use-prevention program at regular intervals.

A major part of most successful interventions has been the decrease of illegal sales to minors. This strategy has been accomplished by increasing merchant education and enforcement of laws prohibiting tobacco sales to minors under 18 and increasing the cost of cigarettes (CDC 1994a,b, Lewit et al. 1997, Lynch and Bonnie 1994). All 50 states and the District of Columbia have laws prohibiting the sale of tobacco, including smokeless (spit) tobacco, to minors.

In recent years, attempts to prevent and reduce the use of spit tobacco have increased. These informational and educational efforts have largely targeted baseball clubs, Little League baseball teams, and 4-H Club members. A major new initiative, the National Spit Tobacco Education Program, has been launched by Oral Health America, with support from NIH and CDC and funding largely from the Robert Wood Johnson Foundation in collaboration with the Major League Baseball Players Association, to help break the link between spit tobacco and Major League Baseball.

Other Program Models

The majority of community programs designed to prevent or reduce the use of tobacco products have focused on cigarette smoking. Initially, NCI funded randomized trials of interventions to prevent smoking in adolescents and promote cessation in adults. The value of multiple interventions delivered through multiple channels was confirmed in NCI's Community Intervention Trial for Smoking Cessation (COMMIT 1995a,b).

Findings from more than 100 intervention trials continue to provide important information about how to reach smokers and potential smokers. A major conclusion from these studies is that large-scale reductions in smoking prevalence are unlikely when interventions focus on the individual, but that interventions can be effective when community-based. Further, researchers found a statistically significant difference in the proportion of light-to-moderate (but not heavy) smokers who quit in the intervention communities compared with control communities (COMMIT 1995a,b, Klausner 1997, NCI 1995).

Findings from COMMIT and other studies in the United States and abroad led to planning for ASSIST (American Stop Smoking Intervention Study for Cancer Prevention). In 1990, California adopted the ASSIST model, and early success in the California Statewide Tobacco Control Program clearly showed an impact on per capita cigarette consumption in that state compared with consumption in the United States as a whole (Manley et al. 1997a,b, Shopland 1993). The ASSIST model uses surveillance systems that allow for time-series analysis designs comparing intervention and control communities. Media-led tobacco control campaigns, as well as efforts to increase state excise taxes on cigarettes and thereby discourage teenagers from smoking, are included in the model.

There are now dedicated tobacco-control coalitions in all 50 states, and the Agency for Healthcare Research and Quality (formerly Agency for Healthcare Policy and Research) has developed clinical practice guidelines on smoking cessation to aid health professionals in interventions with patients (Fiore 1997).

Although the major focus in reducing the risk for oral and pharyngeal cancers has been on tobacco cessation programs, reduction in alcohol use is clearly indicated. Currently, alcoholic beverages carry the Surgeon General's warning label stating that pregnant women should not drink because of the risk of birth defects and admonishing that alcohol impairs the ability to drive and operate machinery and may cause other health problems. Many communities have programs that stress responsible drinking by adults related to the use of motor vehicles and completely discourage drinking among young drivers. Community approaches have also been developed to discourage drinking among young people. Targets are youth and adults who are at risk for alcohol-related problems, such as college students who may need to develop skills to avoid binge drinking, or women attending women's clinics who might not know the risk of fetal alcohol syndrome. Because alcohol use, like tobacco use, usually begins in adolescence, development and testing of community- and school-based programs that provide youth with the skills to avoid alcohol use are warranted.

Early Diagnosis of Oral and Pharyngeal Cancers

Primary care providers can counsel patients about lifestyle behaviors that increase the risk for oral cancers. Dental as well as medical personnel have provided successful tobacco control programs in their offices (see Chapter 8). Generally, Americans are ill-informed about the risk factors as well as the signs and symptoms of oral cancers (Horowitz and Nourjah 1996, Horowitz et al. 1995). The mass media have paid little attention to the topic, and health education textbooks are nearly devoid of discussion (Canto et al. 1998b, Chung et al. 2000, Gold and Horowitz 1993, Horowitz et al. 1998). The scant attention that has been paid to oral cancers has focused on the role of spit tobacco.

At present, the principal test for oral and pharyngeal cancers is a comprehensive clinical examination that includes a visual/tactile examination of the mouth, full protrusion of the tongue with the aid of a gauze wipe, and palpation of the tongue, floor of the mouth, and lymph nodes in the neck. The U.S. Preventive Services Task Force concluded that there was insufficient evidence to recommend for or against routine screening for oral cancers, but noted that clinicians should remain vigilant for signs and symptoms of oral cancers and premalignancy in people who use tobacco or regularly use alcohol (USPSTF 1996). The Canadian Task Force on Periodic Health Examination (1997) states that although there is insufficient evidence to include or exclude screening for oral cancers from the periodic health examination for the general public, those at high risk (smokers and heavy drinkers) over 60 warrant an annual oral cancer exam by a physician or dentist (Lewis and

Ismail 1995). The American Cancer Society recommends annual examinations for individuals 40 and older and for individuals who are exposed to known risks. Nevertheless, a 1992 national survey showed that only 15 percent of U.S. adults reported ever having had an oral cancer examination (Horowitz and Nourjah 1996).

There are large gaps in knowledge of the efficacy of oral cancer examinations and the effectiveness and cost-effectiveness of community approaches to early detection of oral cancers. Methodologies and settings differ across studies. Moreover, these studies do not provide definitive evidence supporting the oral cancer exam, and there have been no controlled clinical trials for defining the effectiveness of screening programs. Further research is thus needed.

Summary

Although no school- or community-based interventions specifically designed for the prevention or early detection of oral and pharyngeal cancers are now in place, scientists representing the agencies in the newly formed oral cancer consortium have begun to develop statewide model protocols, beginning with the state of Maryland. In the meantime, any program that aims at eliminating tobacco use will reduce the primary risk factor for oral and pharyngeal cancers, along with other tobacco-related diseases. The evidence on the effectiveness of school-based programs to prevent tobacco use and addiction among children and adolescents provides strong support for their use as part of the school health education curriculum. Further, other community-based interventions such as COMMIT and ASSIST are recommended because they have demonstrated effectiveness in getting light-to-moderate smokers to quit. After reviewing the evidence, an expert panel convened by AHCPR (now the Agency for Healthcare Research and Quality) recommended that all primary care clinicians be trained to provide smoking cessation activities (see Chapter 8). In addition, providers should perform oral cancer examinations on high-risk persons regularly. The recommendation to use all of these interventions to prevent or cease tobacco use in communities is based on expert opinion.

Oral cancers occur in sites that lend themselves to early detection by most primary health care providers and, to a lesser extent, by self-examination. Heightened awareness in the general population could help with early detection and could stimulate dialogue between patients and their primary health care providers about behaviors that may increase their risk. Recent advances in understanding the molecular events involved in developing cancer might provide the tools needed to design novel preventive, diagnostic, prognostic, and therapeutic regimens to combat oral cancers. Acquiring greater knowledge of the biology, immunology, and pathology of the oral mucosa may also help reduce the morbidity and mortality from these cancers.

PREVENTION AND CONTROL OF CRANIOFACIAL BIRTH DEFECTS

The causes of craniofacial birth defects are often complex and multifactorial—the result of gene-environment interactions occurring from the time of conception to birth. Even when a mutation in a single gene has been discovered as the cause of a particular syndrome, there can be considerable variation in susceptibility, with some infants showing little or no sign of a problem and others experiencing multiple organ defects.

The work to complete the mapping and sequencing of the human genome will undoubtedly shed light on the hundreds of genes involved in craniofacial development and provide details on when and how they function in development. This knowledge may in turn lead to gene therapies that restore or "rescue" the function of a defective gene and thus prevent the anomaly.

Craniofacial defects also may occur because the susceptible embryo or fetus was exposed to an environmental teratogen, a diminished oxygen supply, or a deficit in an essential nutrient. Chapter 5 reports an association between low-birth-weight, premature babies who may show other subtle craniofacial anomalies and mothers with chronic oral infectious disease. In addition, diets poor in folic acid increase the risk of spina bifida and possibly clefting syndromes. Clinical trials using vitamin supplementation with varying levels of folic acid are under development to determine if they can lower the risk of clefts in high-risk pregnancies. Outcomes of clinical trials of nutrient supplementation in pregnancy may lead to new nutritional guidelines and the development of enriched food products, which can form the basis for community-wide health promotion and disease prevention programs.

Given the array of variables affecting prenatal growth and development, the key to public health programs aimed at preventing birth defects lies primarily in health promotion and education campaigns. Individuals need to be made aware of known risk and protective factors in pregnancy. Such programs should emphasize the importance of good nutrition, avoidance of tobacco and alcohol use, and

prenatal care. Education includes knowledge about the teratogenic effects of prescription drugs, such as the antiepileptic drug phenytoin and the retinoic acid drugs used to treat cystic acne.

Summary

As information from developmental biology, genetics, and epidemiologic and clinical studies accrues, dental care providers are better positioned to provide counseling. The public is best served by health promotion and disease prevention campaigns that communicate findings about risk and protective factors in pregnancy.

PREVENTION AND CONTROL OF INTENTIONAL AND UNINTENTIONAL INJURY

Intentional and unintentional injuries are related to behaviors and are thus amenable to prevention. As studies of motor vehicle and sports injuries have demonstrated, injuries are frequently due to a sequence of predictable events, and a public health approach can be successful in injury prevention and control.

The interventions that have proved to be most effective in controlling injuries have been passive; that is, they do not require the individual to participate. Examples include the use of environmental controls such as vehicle and roadway design, speed limits, passenger restraints, and airbags to prevent injuries from motor vehicle collisions (Karlson 1992, Smith and Falk 1987). Passive measures such as these are more easily implemented at the state or federal level. However, many preventive measures for oral-facial injuries have been directed at the individual and professional health service levels, rather than at the population at large (see Table 7.7).

Craniofacial Injuries

The principal causes of craniofacial injuries are motor vehicle collisions, falls, assaults, and sporting activities. Except in relation to sports, injuries to the craniofacial region have received little attention. These injuries are hardly insignificant, however, and efforts to prevent them are gaining acceptance. For example, to increase public awareness of the importance of facial protection, the inaugural National Facial Protection Month was celebrated in April 2000. This national campaign, providing information to the media and the public, was sponsored by the American Association of Oral and Maxillofacial Surgeons (AAOMS 2000).

Motor vehicle collisions are the leading cause of death during the first three decades of life in the United States and the leading cause of death from injury over most of the life span (Baker et al. 1992). Data from multiple sources indicate that craniofacial injuries account for a substantial subset of these injuries annually (USDOT 1998). Even though it is likely that passive measures enacted to reduce fatalities have reduced nonfatal craniofacial injuries, no supporting data exist.

Various sources report the number of motorcycle- and pedal-cycle-related craniofacial injuries. Data from the National Electronic Injury Surveillance System indicate that head injuries account for 50 percent of all pedal-cycle-related injuries; of those, bicycle-related events accounted for 19 percent of all facial injuries within the study period (McDonald 1994). In similar studies, tricycle-related incidents were found to be responsible for up to 61 percent of injuries to the head, face, or mouth (CDC 1987, USCPSC 1986). Motorcycle injuries are a major source of fatal and nonfatal head trauma in the United States (Rivara et al. 1988).

Helmet use reduces head and facial injuries among bicyclists (Acton et al. 1995, Grimard et al. 1995, Rivara et al. 1997) and motorcyclists (Bachulis et al. 1988, Johnson et al. 1995, Lee et al. 1995) by up to 50 percent. Health promotion efforts have increased acceptance at the community level for helmet use by bicyclists; however, helmet use regulations vary by state (Sacks et al. 1996) and with the public whim (Sosin et al. 1990). Over a dozen states currently have bicycle helmet laws, and half of the states have motorcycle helmet laws (NCHS 1992).

Many authors have described craniofacial injuries related to sports. Information is usually obtained from community or regional surveys of injuries or mouthguard use and effectiveness. Craniofacial injuries sustained during sporting activities are a major source of nonfatal injury and disability (Baker et al. 1992), possibly accounting for up to one third of all sports injuries (Cathcart 1982, Meadow et al. 1984). The increasing participation of women in competitive sports means that young women should be alerted to the risks and advised of the need for additional protective gear as appropriate. The most comprehensive data on the effectiveness of protective equipment have been collected by agencies such as the National Alliance of Football Rules Committee, the National Collegiate Athletic Association, and the U.S. Consumer Product Safety Commission. Data on craniofacial injuries from participation in football before and after the enactment of mandatory mouthguard regulations indicate a

TABLE 7.7
Community-based interventions for the prevention and control of craniofacial injuries

	Restraints and Airbags	Helmets	Mouthguards
Guidelines for use	Combination of manual lap and automatic shoulder restraints plus airbag; emphasis on passive systems to overcome noncompliance	Cyclists, both motorized and nonmotorized, wear approved protective helmets, preferably with a full face mask for motorcyclists	**Football:** Wear helmet with face mask and use mouthguard **Hockey:** Wear helmet with face mask and use mouthguard because face shields do not prevent injury to lower face
Public policies	**Restraints:** Mandatory use required by law in 48 states **Airbags:** All late model vehicles required to have driver-side airbags, and future models to add passenger-side airbags; National Traffic and Motor Vehicle Safety Act legislates policies	• 13 states have bicycle helmet laws; 25 have motorcycle helmet laws • Post-law bicycle helmet use rates increase by up to 50 percent among children (National Center for Injury Prevention and Control 1995) • States with helmet use laws have higher rates of helmet use	**Football:** Requirement since 1962 for mandatory mouthguard use in football accompanied by significant decline in incidence of oral-facial injuries **Hockey:** Mandatory requirement for full facial protection in Canada has reduced facial injuries among youth (Rampton et al. 1997)
Utilization rates	**Restraints:** Compliance with seatbelt laws ranges from 29 to 74 percent (Reinfurt et al. 1991); current use may be as high as 67 percent (NCHS 1992) **Airbags:** Utilization may become an issue if on-off switch is implemented	**Bicycle:** Approximately half of bicyclists own a helmet, and half of those consistently wear it (Sacks et al. 1996); 62 percent of motorcyclists and 17.6 percent of bicyclists wear helmets (NCHS 1992)	**Football:** 72 percent of children wear headgear and mouthguards **Baseball/softball:** 35 percent of children wear headgear; 7 percent consistently wear mouthguards **Soccer:** 4 percent of children wear headgear; 7 percent of children wear mouthguards (Nowjack-Raymer and Gift 1996) **Basketball:** 4 percent of respondents reported wearing mouthguards (Maestrello-deMoya and Primosch 1989)
Type of evidence for effectiveness and PHS ratings	• **Hospital and trauma registry studies** (Sutyak et al. 1997, Orsay et al. 1990) • **Modeling** from insurance studies (Sorenson 1993) • **Case-control study** (Marine et al. 1994)	• **Hospital and trauma registry studies** (Bachulis et al. 1988, Johnson et al. 1995) • **National survey** (Sacks et al. 1996) • **Case-control study** (Thompson et al. 1996)	• **Hospital and trauma registry studies** • **Questionnaire (baseball and basketball)** • **Before and after** NFA rule in 1962 • **Descriptive survey** (Maestrello-deMoya and Primosch 1989)
Evidence for effectiveness	**Restraints:** Use reduces facial injuries by 30 percent (Orsay et al. 1990) **Airbags:** Projected facial injury harm reduction of up to 90 percent for airbag added to restraint (Sorenson 1993); report of facial injuries may increase with airbags due to a decrease in fatalities and more severe injuries (Blacksin 1993)	**Motorcycle:** A twofold decrease in incidence of maxillofacial trauma in helmeted versus nonhelmeted motorcyclists (Bachulis et al. 1988); nonhelmeted 3 times more likely to have facial fractures than those with helmets (Johnson et al. 1995) **Bicycle:** Helmet wearers have a 65 percent reduction in upper- and mid-face injuries (Thompson et al. 1996); head injuries decreased 67 percent in children concomitant with rate of helmet use increase of 35 percent following educational campaign (Rivara et al. 1994); helmets with face protection decrease facial injuries by a factor of 3 (Vaughan 1977); helmet wearing alone is not sufficient to prevent serious injury and fatality (Rivara et al. 1997)	**Football:** Face mask reduces oral-facial injury by 50 percent; addition of a mouthguard reduces risk to less than 1 percent (AAHPER 1960) **Hockey:** Full-face protection reduced chance of upper facial injury; half visor same as no face protection (Rampton et al. 1997) **Baseball and basketball:** 60 times more likely to sustain oral injury without mouthguard (McNutt et al. 1989); 30 percent reduced risk of oral-facial injury for those wearing mouthguards (Powers et al. 1984)

	Restraints and Airbags	Helmets	Mouthguards
Risks	**Restraints:** • Improper car seat design and use for infants **Airbags:** • Concern regarding higher risk for death in children and small women • Case report of facial desquamation from ruptured airbag	• No injuries have been documented secondary to the helmet itself; helmets do not decrease risk of injury to lower face, mandible, and mouth	Costs are high because mouthguards should be fabricated for each individual by a health professional
Costs and effectiveness	**Airbags and restraints:** U.S. costs are calculated for all injuries or fatalities, not craniofacial injuries; Australian report estimated savings of 108 million (Australian) dollars per year due to facial injury reduction (Sorenson 1993)	**Bicycle:** Hospital treatment costs for bicyclists estimated at $1 billion annually—includes mortality and morbidity (Sacks et al. 1996)	**Hockey:** Direct costs: 3 million (Canadian) dollars annually (Rampton et al. 1997)
Recommendations (abstracted from CDC 1987, USDHHS 2000)	• Extend safety belt laws to all 50 states • Increase airbag efficacy and safety research for craniofacial injuries	• Helmets should meet recommended industry manufacturing standards • Implement national mandatory helmet requirement law for motorcyclists in all states • Implement national mandatory helmet requirement law for child bicyclists in all states—strongly recommend helmet use for adult bicyclists • Combine helmet use with education and health promotion and environmental controls (e.g., separation of cyclists and motor vehicles, features to make cyclist more visible) • State and local health departments should engage in health promotion for helmet use, develop and work for legislation for mandatory helmet use, and evaluate programs	• Extend mandatory mouthguard use for all team sports sponsored by organizations, agencies, and institutions • Utilize health promotion and education of trainers, athletes, and parents to increase use of protective sporting equipment

significant decline in craniofacial injuries (Sane 1988). Further, the U.S. Consumer Product Safety Commission's review of National Electronic Injury Surveillance System data showed that mouth injuries were more frequent in baseball than in any other sport monitored (USCPSC 1981). These combined reports were instrumental in implementing policies for protective equipment use in these two sports. (See Box 7.2, Sports Injuries and Oral-Facial Trauma.)

Research on elderly and disabled individuals has led to the development of safety measures to prevent unintentional injuries from falls in the home. These include installing adequate lighting and handrails, using nonskid materials on floors and in bathrooms, and positioning furniture to reduce the risk of tripping. Wider distribution and adoption of such safety measures should lower the risk of oral and craniofacial injuries due to falls for the general population as well, not only in the home but also in the workplace and other settings.

Summary: Prevention of Craniofacial Injuries

Health education and injury prevention campaigns addressing the need for protective gear in sports and cycling activities can increase awareness and use. More rapid adoption can occur through legislation or regulation. Greater dissemination of safety measures for home and workplace can similarly lower the risk of falls and other unintentional injuries. With regard to reducing intentional injuries in the United States, current and ongoing policy discussions, legislative proposals, and research efforts are necessary first steps toward appropriate programs.

ORAL HEALTH PROMOTION AND DISEASE PREVENTION KNOWLEDGE AND PRACTICES

To take full advantage of emerging science-based health and health care practices, individuals, health care providers, and policymakers need to be sufficiently informed that they can take appropriate actions for themselves, for those for whom they have responsibility, and for the community at large. For the individual, these actions include brushing with a fluoride-containing dentifrice for caries prevention, brushing and flossing to prevent gingivitis and periodontal diseases, and avoiding tobacco and other substances that are detrimental to health.

Lack of knowledge can affect care. If parents are not familiar with the importance and care of their child's primary teeth or if they do not know that dental sealants exist, they are unlikely to take appropriate action or seek professional services. If the public is not aware of the benefits of community water fluoridation, public referenda and funding for such interventions are not likely to be supported. Similarly, if individuals do not know that an oral cancer examination exists, they may not ask about the need for one. However, it is well established that

BOX 7.2
Sports Injuries and Oral-Facial Trauma

The national concern regarding oral-facial injury is addressed in the Healthy People 2010 objective 15-31, which is to increase the proportion of public and private schools that require use of appropriate head, face, eye, and mouth protection for students participating in school-sponsored physical activities. The National Youth Sports Safety Foundation estimates that more than 3 million teeth will be knocked out in youth sporting activities this year, an injury almost completely preventable by wearing a mouthguard. Even more significant, oral-facial trauma from sports injuries will result in facial bone fractures, concussion, permanent brain injury, temporomandibular dysfunction, blinding eye injuries, and even death.

Currently, no systematic monitoring for oral-facial injuries exists in the United States. Progress toward a more broadly targeted Healthy People 2000 objective proved to be difficult to track because of the data requirements of monitoring all organizations, agencies, and institutions sponsoring sporting and recreational events that pose risk of injury. By focusing on schools, not only should the monitoring of progress be feasible, but healthy habits will be formed early. The hope is that by the time the athletes reach young adulthood they will recognize the hazards posed by their athletic interests and, perhaps, be more comfortable using protective devices than they would be without them.

It is estimated that as many as one third of all dental injuries are sports-related. A particularly high proportion of all baseball injuries (41 percent) is estimated to occur to the head, face, mouth, or eyes. Nowjack-Raymer and Gift (1996) reported that in 1991 more than 14 million U.S. school-aged youngsters participated in at least one sport that was listed on the 1991 National Health Interview Survey questionnaire, with more than 9 million of these children in organized baseball or softball.

Baseball and softball are the most popular organized sports, with nearly one quarter of the school-aged population playing. Unlike football, not all baseball/softball leagues or teams require the use of safety equipment. In many cases, only selected positions such as catchers and batters are covered by rules. Thus only 35 percent of players reported that they wore headgear all or most of the time, and only 7 percent wore mouthguards all or most of the time.

Further analysis of the interview data revealed a variety of socioenvironmental differences in the wearing of headgear and mouthguards. Forty percent of males who played baseball or softball reported wearing protective headgear "all or most of the time," compared with only 25 percent of females. Differences were also found by poverty level, with 36 percent of those at or above poverty level wearing headgear, compared with 24 percent of those below. Better educated parents were somewhat more likely than less educated parents to have responded that their child wore headgear "sometimes" (45 percent versus 38 percent) and non-Hispanics reported occasional use more than Hispanics (43 percent versus 30 percent). Parents of a greater percentage of baseball or softball players of high school age (12 percent) than elementary school-aged players (6 percent) reported that their child wore a mouthguard "all or most of the time." Also, more black (17 percent) than white (6 percent) children reported the use of mouthguards.

These socioeconomic differences might be greater were it not for the safety efforts of school athletic programs. Still, many parents and coaches are not as proactive as they could be and are not aware that facial injuries also occur in sports that are not considered high contact. For example, basketball players typically do not wear mouthguards. Yet approximately 34 percent of all injuries to basketball players involve teeth and/or the oral cavity.

Examples of community-based interventions to prevent sports-related, oral-facial trauma include the development of rules and regulations for the use of headgear and mouthguards in sports where craniofacial injury is a risk; efforts to alert players, parents, sports officials, and organizers to the potential for injury; better product design; and the creation of supportive environments for sports-related equipment and recreation areas.

knowledge alone will not necessarily lead to appropriate practices. For example, even if individuals know that tobacco use is unhealthful and that it contributes to multiple life-threatening illnesses, some continue to smoke. The majority of people who need such information most—those in low-income groups and those with lower levels of education—also are the ones who lack the information and skills (oral health literacy) to ask for and obtain specific preventive services or treatment options. Health professionals are in an ideal position to provide up-to-date health information and care to their patients. They also have an opportunity to enhance their knowledge and practices as well as increase their communication to patients about the procedures they provide and the reasons for these procedures.

Few national studies of public and professional knowledge, attitudes, and practices exist. Highlights from these as well as from state and local studies that evaluated the prevention of dental caries, periodontal diseases, and oral cancers are provided below. Generally, the public is unable to discriminate between methods that prevent dental caries and those that prevent periodontal diseases (Corbin et al. 1985, Gift et al. 1994). This confusion has been attributed to the prevailing marketing message that refers to them as "plaque diseases" preventable by thorough tooth cleaning with a toothbrush and floss. In addition, the general public and health care providers are not fully informed about the relative value of fluoride and the appropriate recommended applications of regimens to prevent dental caries (Corbin et al. 1985, Gallup 1992, Gift et al. 1994, O'Neil 1984). More work is needed to improve knowledge and practices related to oral cancer prevention as well. As with other areas of investigation, additional survey research is needed to better understand findings to date and to develop tailored interventions. Research is ongoing to improve the design of survey instruments and the wording of questions to address cultural and ethnic differences and interpretations.

Dental Caries Prevention

The Public

Most members of the general public, regardless of socioeconomic level, tend to believe that the best way to prevent dental caries is by brushing their teeth (Corbin 1985, Gift et al. 1994, O'Neil 1984). In the 1990 National Health Interview Survey (NHIS), respondents were asked the purpose of adding fluoride to public drinking water. About two thirds of the respondents 25 to 65 years of age knew that water fluoridation helps prevent caries, compared with only 51 percent and 49 percent of those 65 and older and 18 to 24 years of age, respectively. Blacks and Hispanics were less likely to know the value of this preventive procedure than whites. In the same survey, when asked to indicate the one best way to prevent tooth decay from five answers (limiting sugary snacks, using fluorides, chewing sugarless gum, brushing and flossing the teeth, and visiting the dentist every 6 months), only 7 percent of the respondents answered correctly that fluoride was the most effective (Gift et al. 1994). More than two thirds said tooth brushing and flossing were the most effective. These results paralleled those of earlier studies (Gift et al. 1994, O'Neil 1984). A lower perceived value of fluorides by the public in preventing dental caries also was seen in the 1985 NHIS (Corbin et al. 1985). In a survey of knowledge and beliefs of the public, dentists, and dental researchers about the best way to prevent dental caries, the public and the dentists identified tooth brushing, whereas dental researchers unanimously ranked fluorides, as most important (O'Neil 1984). A small study among Latina mothers showed that they believed that brushing with baking soda is a good way to prevent dental caries; they knew little about brushing with a fluoride-containing dentifrice (Watson et al. 1999).

Dental sealants and appropriate use of fluoride are critical for caries prevention. In the 1990 NHIS, about 32 percent of the public had heard of dental sealants, but among those only three fourths knew the purpose of this preventive measure (Gift et al. 1994). In 1991 the Gallup Organization conducted a poll for the American Academy of Pediatric Dentistry among a national sample of 1,200 parents of children 16 years and younger. The results indicated that only 58 percent believed fluoride to be very important to a child's oral health; another 36 percent considered it to be somewhat important. Eight of 10 parents did not know when a child should be prescribed fluoride supplements, and virtually no one knew when supplements should be stopped. Only 25 percent of parents in nonfluoridated communities reportedly give their children fluoride supplements (Gallup 1992).

Health Care Providers

In a national survey of U.S. dental hygienists' knowledge, opinions, and practices regarding dental caries etiology and prevention, over 90 percent agreed that "adults benefit from the use of fluorides" and that "root surface caries is an emerging problem." A little

less than one third did not provide fluoride treatments to adults. This same survey found that only 57 percent of the respondents recognized remineralization as fluoride's most important mechanism of action; rather, flossing was selected as the most effective procedure for preventing caries in adults. Also, only 18 percent reported providing the recommended time for acidulated phosphate fluoride (APF) gel treatment (Forrest 1998). A city-based survey of dentists and dental hygienists found that nearly 70 percent of the offices used lower than recommended topical fluoride application times and that some of the fluoride products reportedly used had not been clinically tested (Warren et al. 1996).

Periodontal Disease Prevention

The Public

In the 1990 NHIS the majority of household respondents (79 percent) could identify one common sign of "gum" disease. Level of education was directly related to knowledge of gum disease. Eighty-nine percent of those with more than a high school level of education were able to name a common sign of gum disease, compared with 79 percent of those with a high school education and 60 percent of those with less than a high school education (Gift et al. 1994).

A Roper report on oral health surveyed more than 1,000 adults 18 and older. Eighty percent reported that they did not believe they have had periodontal disease. However, 70 percent reported having experienced at least one symptom of gum disease—bleeding gums; swollen, painful, or receding gums; a change in bite; or loose teeth. Although 41 percent of the respondents said that losing their teeth was their greatest fear regarding oral health, only 38 percent who had bleeding gums said they told their dentists about the problem. Further, only 30 percent of the respondents who had experienced warning signs of gum disease were worried about developing periodontal problems in the future. Fifty-eight percent knew that plaque is the main cause of gum disease and that flossing alone will not prevent gum disease, whereas 77 percent knew that brushing alone would not prevent gum disease. The majority (90 percent) knew that gum disease could strike anyone at any age (Roper Report 1994).

In a recently reported study on the oral hygiene practices of a convenience sample of 34,897 users and nonusers of tobacco products who obtained dental care in 75 dental practices, 74 percent reported brushing twice a day and 36 percent reported flossing once daily (Andrews 1998). Tobacco users brushed and flossed much less frequently than nonusers. Patients with more than a high school education were less likely to use tobacco products and more likely to brush at least 2 times a day and floss daily than were those with less education.

A 1996 study of 1,000 U.S. adults showed that nearly one third (29 percent) of respondents were extremely or very concerned about getting gum disease. Concern was highest among younger respondents 18 to 49 years of age and those who very or somewhat frequently experienced bleeding gums. Only 6 percent said they frequently suffered from bleeding gums (2 percent very frequently and 4 percent somewhat frequently). Only 13 percent said a dental professional had diagnosed them with any kind of periodontal disease (gingivitis, pyorrhea, and periodontitis). Older respondents were somewhat more likely than younger ones to have been diagnosed with gum disease, and 17 percent reported experiencing gingival bleeding occasionally (Andrews 1998).

Health Care Providers

Studies of dental professionals regarding periodontal disease prevention practices are limited. In 1989, Dental Products Report launched a study to determine the involvement of general practitioners in periodontal care. Overall, general dentists and their hygienists have become more involved in the periodontal exam phase of patient treatment. This positive trend suggests that periodontal diagnosis and treatment are well integrated into general practice. For example, when asked "what phases of periodontal treatment are you providing at present?" 100 percent reported gingival exam and evaluation, 97 percent reported pocket probing, and 88 percent reported providing patient education. The majority of dentists (67 percent) used as many as six measurement sites per tooth. Nearly all (93 percent) reported having a referral relationship with a periodontist (Dental Products Report 1996).

Oral Cancer Prevention and Early Detection

The Public

U.S. adults generally are ill-informed regarding risk factors for and signs and symptoms of oral cancers. Further, a 1990 national survey found that only 14 percent of adults 40 and older reported that they had ever had an oral cancer examination. Of those, only 7 percent had had an exam within the last year

(Horowitz et al. 1995). In a statewide survey in Maryland, 85 percent of the adults claimed to have heard of oral or mouth cancer, but only 28 percent reported ever having an oral cancer examination (Horowitz et al. 1996). A state-based study of veterans—a population at high risk for oral cancers—found that they were ill-informed and misinformed about these cancers (Canto et al. 1998a). Finally, a study among Latino youths who reported use of tobacco and alcohol found that they, too, were not knowledgeable regarding risk factors for oral cancers (Canto et al. 1998b).

Health Care Providers

A recent national pilot survey of U.S. dentists found that the respondents' knowledge regarding risk factors for and signs and symptoms of oral cancers and their reported practice of examination procedures were limited (Yellowitz et al. 1998). Most respondents believed they were adequately trained to provide oral cancer examinations, and 70 percent provided annual oral cancer exams to patients 40 and older. Seventy-four percent reported their knowledge of oral cancers to be current, yet only 30 percent correctly identified the age cohort most frequently diagnosed with oral cancers. Further, less than 50 percent correctly identified the stage at which most oral cancer lesions are diagnosed, and nearly one third of respondents could not identify the two most common sites of these lesions. Although 86 percent claimed to assess their patients' current tobacco use, only 50 percent assessed current alcohol use; relatively few dentists assessed past alcohol or tobacco use. There was a modest amount of misinformation as well. For example, 65 percent believed, incorrectly, that ill-fitting dentures and partials were a risk factor for oral cancers, and 47 percent believed, also incorrectly, that poor oral hygiene was a risk factor. Further, although the majority of dentists claimed to provide oral cancer examinations to the majority of their patients, a large proportion did not palpate the lymph nodes—part of a comprehensive oral cancer examination. These results confirm an earlier study conducted among a convenience sample of Maryland dentists and physicians in that both groups believed their knowledge and skills related to oral cancer prevention and early detection to be wanting (Yellowitz and Goodman 1995).

A recent national survey among U.S. dental hygienists found that although 98 percent agreed that oral cancer examinations should be provided annually for adults 40 and older, only 64 percent reported performing such an exam 100 percent of the time, and nearly 17 percent reported not performing an exam at any time (Forrest 1998). Further inconsistencies were found between knowledge of risk factors and performance. For example, although 94 percent correctly identified alcohol use as a risk factor for oral cancer, only 49 percent asked about alcohol use. Less than a majority (45 percent) reported their knowledge of oral cancers to be current. A majority (61 percent) believed they were adequately trained to palpate lymph nodes; still, only 24 percent reported routine palpating of lymph nodes, while 51 percent indicated they did not do so at any time.

Summary

Findings from national surveys, together with those from local studies, suggest that there are opportunities for enhanced educational efforts for both the public and health professionals to improve oral health. These studies focus on the public and the dental profession for selected diseases. New research is needed to assess knowledge, attitudes, and practices of all health professionals and for other conditions and risk factors related to oral health as well.

BUILDING UPON SUCCESS

As research and technology advance our understanding of the causes of major craniofacial diseases and disorders and lead to improved methods of diagnosis, treatment, and prevention, opportunities for new community-based prevention programs will grow. Ultimately, the application of any preventive intervention is driven by a combination of individual behaviors, community interventions, and professional practice. Only a few studies have taken into account all three spheres of action in determining health outcomes in a community (Arnljot et al. 1985, Chen et al. 1997). Our knowledge of the effects of multiple interventions is limited because most interventions were developed and tested singly.

In the past half century, however, advances in our understanding of oral diseases and the application of multiple preventive measures have resulted in continuing declines in the prevalence and severity of both dental caries and periodontal diseases for a sizeable majority of Americans. For dental caries, for example, experts now believe that most people can maintain a low risk of the disease by a combination of drinking fluoridated water and brushing daily with a fluoride dentifrice. They recommend that additional provider- and community-based dental prevention programs be targeted to high-risk individuals and groups.

Many of the studies reviewed in this chapter were conducted when higher rates of caries prevailed, community water fluoridation was less widespread, and use of fluoride dentifrices and supplements was not as common as today. These facts must be taken into consideration in contemporary decision making by public health professionals and policymakers. The validity and reliability of recommendations will benefit from the systematic reviews of the scientific evidence by the Task Force on Community Preventive Services (2000) to be included in a *Guide to Community Preventive Services*. Oral health promotion strategies are among those currently being evaluated.

Future innovations include implementing programs in new settings, such as workplaces, senior centers, and nursing homes, where individuals at high risk can be reached. Even if these programs are more expensive, the yield may be worth it if they reach those at high risk for disease. Similarly, focusing community-based interventions on populations at greatest risk will make optimal use of available resources. However, continued research to understand risk and improve ways to measure it is equally important for the success of these ventures.

A review of progress in reaching the Healthy People 2000 oral health objectives reveals relatively little gain across many of the objectives (Table 7.8). Progress in the next decade will require diligent efforts to identify public health problems, mobilize resources, and ensure that the necessary conditions are in place and crucial services received. Public health agencies will be instrumental in carrying out these functions, and state and local dental directors can perform a leadership role. Box 7.3 describes the public health services that are essential if a community is to realize fully the benefits of available disease prevention and health promotion interventions.

TABLE 7.8
Progress in meeting Healthy People 2000 oral health objectives

		Age	Baseline Data	HP 2000 Goal	Final Data	Summary
13.1	Reduce dental caries in children	6-8	54%	35%	52%	Prog
	Reduce dental caries in adolescents	15	78%	60%	61%	Prog +++
13.2	Reduce untreated dental decay in children	6-8	28%	20%	29%	Reversed
	Reduce untreated dental decay in adolescents	15	24%	15%	20%	Prog ++
13.3	Increase adults who have never lost a permanent tooth	35-44	31%	45%	31%	No Change
13.4	Reduce adults who have lost all their teeth	65+	36%	20%	30%	Prog ++
13.5	Reduce gingivitis among adults	35-44	41%	30%	48%	Reversed
13.6	Reduce destructive periodontal disease	35-44	25%	15%	22%	Prog +
13.7	Reduce oral and pharyngeal deaths in males	45-74	13.6%	10.5%	10.3%	Met
	Reduce oral and pharyngeal deaths in females	45-74	4.8%	4.1%	3.5%	Met
13.8	Increase sealants in children	8	11%	50%	23%	Prog ++
	Increase sealants in adolescents	14	8%	50%	24%	Prog ++
13.9	Increase persons on public water receiving fluoridated water		61%	75%	62%	Prog
13.10	Increase topical/systemic fluorides among nonfluoridated		50%	85%	No data	No data
13.11	Increase caregivers using feeding practices that prevent early childhood caries		55%	75%	No data	No data
13.12	Increase oral health screening, referral, follow-up, first time school attendee		66%	90%	75%	Prog ++
13.13	For long-term care, oral exam and services provided within 90 days		No data	100%	No data	No data
13.14	Increase use of oral health care system (adults)	35+	54%	70%	63%	Prog ++
13.15	Increase states with system for recording and referring orofacial clefts		11 states	40 states	23 states	Prog ++
13.16	Extend use of protective head, face, eye, and mouth equipment		No data	No data	No data	No data
13.17	Reduce smokeless tobacco use among males	12-17	6.6%	4%	3.7%	Met
		18-24	8.9%	4%	6.9%	Prog ++

Source: Adapted from NCHS 1999.

BOX 7.3
Essential Public Health Services for Oral Health

The Association of State and Territorial Dental Directors' *Guidelines for State and Territorial Oral Health Programs* (ASTDD 1997) identifies the following essential public health services to improve oral health:

I. Assessment
   A. Assess *oral health status and needs* so that problems can be identified and addressed.
   B. Analyze *determinants* of identified oral health needs, including resources.
   C. Assess the *fluoridation status* of water systems, and other sources of fluoride.
   D. Implement an *oral heath surveillance system* to identify, investigate, and monitor oral health problems and health hazards.

II. Policy Development
   A. Develop *plans and policies* through a collaborative process that support individual and community oral health efforts to address oral health needs.
   B. Provide *leadership* to address oral health problems by maintaining a strong oral health unit within the health agency.
   C. Mobilize *community partnerships* between and among policymakers, professionals, organizations, groups, the public, and others to identify and implement solutions to oral health problems.

III. Assurance
   A. Inform, educate, and empower *the public* regarding oral health problems and solutions.
   B. Promote and enforce *laws and regulations* that protect and improve oral health, ensure safety, and assure accountability for the public's well-being.
   C. *Link people* to needed population-based oral health services, personal oral health services, and support services and assure the availability, access, and acceptability of these services by enhancing system capacity, including directly supporting or providing services when necessary.
   D. Support services and implementation of programs that focus on *primary and secondary prevention*.
   E. Assure that the *public health and personal health workforce* has the capacity and expertise to effectively address oral health needs.
   F. Evaluate *effectiveness, accessibility, and quality* of population-based and personal oral health services.
   G. Conduct *research and support demonstration projects* to gain new insights and applications of innovative solutions to oral health problems.

FINDINGS

- Community water fluoridation, an effective, safe, and ideal public health measure, benefits individuals of all ages and socioeconomic strata. Unfortunately, over one third of the U.S. population (100 million persons) are without this critical public health measure.
- Effective disease prevention measures exist for use by individuals, practitioners, and communities. Most of these focus on dental caries prevention, such as fluorides and dental sealants, where a combination of services is required to achieve optimal disease prevention. Daily oral hygiene practices such as brushing and flossing can prevent gingivitis.
- Community-based approaches for the prevention of other oral diseases and conditions, such as oral and pharyngeal cancers and oral-facial trauma, require intensified developmental efforts.
- Community-based preventive programs are unavailable to substantial portions of the underserved population.
- There is a gap between research findings and the oral disease prevention and health promotion practices and knowledge of the public and the health professions.
- Disease prevention and health promotion approaches, such as tobacco control, appropriate use of fluorides for caries prevention, and folate supplementation for neural tube defect prevention, highlight opportunities for partnerships between community-based programs and practitioners, as well as collaborations among health professionals.
- Many community-based programs require a combined effort among social service, health care, and education services at the local or state level.

REFERENCES

Acton CH, Thomas S, Nixon JW, Clark R, Pitt WR, Battistutta D. Children and bicycles: what is really happening? Studies of fatal and non-fatal bicycle injury. Inj Prev 1995 Jun;1:86-91.

Adair SM. The role of fluoride mouthrinses in the control of dental caries: a brief review. Pediatr Dent 1998 Mar-Apr;20(2):101-14.

Adriaens ML, Dermaut LR, Verbeeck RM. The use of 'fluor protector', a fluoride varnish, as a caries prevention method under orthodontic molar bands. Eur J Orthod 1990;12:316-9.

American Academy of Periodontology (AAP). Proceedings of the 1996 World Workshop in Periodontics. Ann Periodontol 1996:1(1):223-55.

American Association for Health, Physical Education and Recreation, and American Dental Association (ADA). Report of the Joint Commission on Mouth Protectors. 1960.

American Association of Oral and Maxillofacial Surgeons (AAOMS). National Facial Protection Month. Available from: http://www.aaoms.org/facpromonth.htm. [accessed 2000 Apr 6].

American Dental Association (ADA). Caries diagnosis and risk assessment. A review of preventive strategies and management. J Am Dent Assoc 1995 Jun;126(Suppl):1S-4S.

American Dental Association (ADA) Council on Access, Prevention and Interprofessional Relations and Council on Scientific Affairs. Dental sealants. J Am Dent Assoc 1997 Apr;128(4):485-8.

American Dental Association (ADA) Council on Dental Materials and Devices. Pit and fissure sealants. J Am Dent Assoc 1976 Jul;93(1):134.

Andrews JA, Severson HH, Lichtenstein E, Gordon JS. Relationship between tobacco use and self-reported oral hygiene habits. J Am Dent Assoc 1998;129:313-20.

Arnljot H, et al., editors. Oral health care systems: an international collaborative study coordinated by the World Health Organization. London: Quintessence; 1985.

Arnold FA Jr, Likins RC, Russell AL, Scott DB. Fifteenth year of the Grand Rapids fluoridation study. J Am Dent Assoc 1962;65:780-5.

Association of State and Territorial Dental Directors (ASTDD), the New York State Health Department, the Ohio Department of Health and the School of Public Health, University of Albany, State University of New York. Workshop on guidelines for sealant use: recommendations. J Public Health Dent 1995;55(5 Spec No):263-73.

Association of State and Territorial Dental Directors (ASTDD). Guidelines for state and territorial oral health programs. 1997 Jul.

Ast DB, Fitzgerald B. Effectiveness of water fluoridation. J Am Dent Assoc 1962;65:581-7.

Bachulis BL, Sangster W, Gorrell GW, Long WB. Patterns of injury in helmeted and nonhelmeted motorcyclists. Am J Surg 1988 May;155(5):708-11.

Bader JD, Sams DH, O'Neil EH. Estimates of the effects of a statewide sealant initiative on dentists' knowledge and attitudes. J Public Health Dent 1987 Fall;47(4):186-92.

Bader JD, Rozier RG, McFall WT, Sams DH, Graves RC, Slome BA, Ramsey DL. Evaluating and influencing periodontal diagnostic and treatment behaviors in general practice. J Am Dent Assoc 1990 Dec;121(6):720-4.

Baker SP, O'Neill B, Ginsburg MJ, Guohua L, editors. The injury fact book. 2nd ed. New York: Oxford University Press; 1992. p. 211-2.

Bawden JW, Granath L, Holst K, Koch G, Krasse P, Rootzen H. Effect of mouthrinsing with a sodium fluoride solution in children with different caries experience. Swed Dent J 1980;4(3):111-7.

Bednarsh H, Connolly GN. A report on fluoride mouthrinsing programs among states. Presented at the 112th annual meeting of the American Public Health Association; 1984; Anaheim, CA.

Birkland JM, Torell P. Caries-preventive fluoride mouthrinses. Caries Res 1978;12(Suppl):38-51.

Blacksin MF. Patterns of fracture after air bag deployment. J Trauma 1993 Dec;35(6):840-3.

Blayney JR, Hill IN. Fluorine and dental caries. J Am Dent Assoc 1967:74(SI):233-302.

Bohannan HM, Stamm JW, Graves R, Disney JA, Bader JD. Fluoride mouthrinse programs in fluoridated communities. J Am Dent Assoc 1985 Nov;111(5):783-9.

Bratthall D, Hansel Petersson G, Sundberg H. Reasons for the caries decline: what do the experts believe? Eur J Oral Sci 1996;104:416-22.

Bravo M, Llodra JC, Baca P, Osorio E. Effectiveness of visible light fissure sealant (Delton) versus fluoride varnish (Duraphat): 24-month clinical trial. Community Dent Oral Epidemiol 1996 Feb;24(1):42-6.

Brown LF, Spencer AJ. Special report—continuing education in periodontology—the Adelaide study. Periodontol 1989;10:12-13.

Burt BA, editor. Proceedings for the workshop: cost-effectiveness of caries prevention in dental public health. J Public Health Dent 1989;49(SI)352:251-352.

Burt BA, Eklund SA. Dentistry, dental practice, and the community, 5th ed. Philadelphia: W.B. Saunders; 1999.

Calderone JJ, Davis JM. The New Mexico sealant program: a progress report. J Public Health Dent 1987 Summer;47(3):145-9.

Calderone JJ, Mueller LA. The cost of sealant application in a state dental disease prevention program. J Public Health Dent 1983 Summer;43(3):249-54.

Callanen VA, Weintraub JA, French DP, Connolly GN. Developing a sealant program: the Massachusetts approach. J Public Health Dent 1986 Summer;46(3):141-6.

Canadian Task Force on the Periodic Health Examination. The periodic health examination. Can Med Assoc J 1979 Nov 3;121(9):1193-254.

Canto MT, Horowitz AM, Goodman HS, Watson MR, Cohen LA, Fedele DJ. Maryland veterans' knowledge of risk factors for and signs of oral cancers and their use of dental services. Gerodontology 1998a;15(2):79-86.

Canto MT, Kawaguchi Y, Horowitz AM. Coverage and quality of oral cancer information in the popular press: 1987-98. J Public Health Dent 1998b Summer;58(3):241-7.

Cathcart JF. Mouth protectors for contact sports. Dent Digest 1982;57:348.

Centers for Disease Control (CDC). Bicycle-related injuries: data from the National Electronic Injury Surveillance System. MMWR Morb Mortal Wkly Rep 1987 May;36(17):269-71.

Centers for Disease Control (CDC). Guidelines for school health programs to prevent tobacco use and addiction. MMWR Morb Mortal Wkly Rep 1994a Feb 25;43(RR-2):1-18.

Centers for Disease Control (CDC). Preventing tobacco use among young people: a report of the Surgeon General. Executive summary. MMWR Morb Mortal Wkly Rep 1994b Mar 11;(RR-4):1-10.

Centers for Disease Control and Prevention (CDC). Examinations for oral cancer—United States, 1992. MMWR Morb Mortal Wkly Rep 1994c;43:198-200.

Centers for Disease Control and Prevention (CDC). Engineering and administrative recommendations for water fluoridation, 1995. MMWR Morb Mortal Wkly Rep 1995 Sep 29;44(RR-13):1-40.

Centers for Disease Control and Prevention (CDC). Preventing and controlling oral and pharyngeal cancer. Recommendations from a National Strategic Planning Conference. MMWR Morb Mortal Wkly Rep 1998 Aug 28;47(RR-14):1-12.

Centers for Disease Control and Prevention (CDC). Fluoridation of drinking water to prevent dental caries. MMWR Morb Mortal Wkly Rep 1999;48:933-940.

Centers for Disease Control and Prevention (CDC). Recommendations for using fluoride to prevent and control dental caries in the United States. MMWR Morb Mortal Wkly Rep (in press).

Chen MS, Andersen RM, Barmes DE, Leclercq MH, Lyttle CS. Comparing oral health care systems: A second international collaborative study. Geneva: World Health Organization; 1997.

Chung V, Horowitz AM, Canto MT. Siriphant P. Oral cancer educational materials for the general public: 1998. J Public Health Dent 2000;60:49-52.

Clark DC, Stamm JW, Tessier C, Robert G. The final results of the Sherbrooke-Lac Megantic fluoride varnish study. J Can Dent Assoc 1987;53:919-22.

Clarkson J. A European view of fluoride supplementation. Br Dent J 1992 May 9;172(9):357.

Clarkson HB, Fejerskov O, Ekstrand J, Burt BA. Rational use of fluorides in caries control. In: Fejerskov O, Ekstrand J, Burt BA, editors. Fluorides in dentistry. 2nd ed. Copenhagen: Munksgaard; 1996. p. 347-57.

Collins WJ, McCall DR, Strang R, Main C, Campbell D, Stephen KW, McKenzie R. Experience with a mobile fissure sealing unit in the Greater Glasgow area: results after three years. Community Dent Health 1985 Sep;2(3):195-202.

Community Intervention Trial for Smoking Cessation (COMMIT): I. Cohort results from a four-year community intervention. Am J Public Health 1995a; 85(2):183-92.

Community Intervention Trial for Smoking Cessation (COMMIT): II. Changes in adult cigarette smoking prevalence. Am J Public Health 1995b;85(2):193-200.

Corbin SB, Maas WR, Kleinman DV, Backinger CL. NHIS findings on public knowledge and attitudes about oral diseases and preventive measures. Public Health Rep 1985;102:53-60.

Dean HT, Jay P, Arnold FA Jr, Elvove E. Domestic water and dental caries II. A study of 2,832 white children aged 12-14 years, of eight suburban Chicago communities, including *L. acidophilus* studies of 1,761 children. Public Health Rep 1941;56:761-92.

Dean HT, Arnold FA Jr, Jay P, Knutson JW. Studies on mass control of dental caries through fluoridation of the public water supply. Public Health Rep 1950;65:1403-8.

de Bruyn H, Arends J. Fluoride varnishes—a review. J Biol Buccale 1987;15:71-82.

Dental Products Report. Periodontal care report. Periodontal care in general practice: overview & update. 1996 Aug; p. 46-51.

DePaola PF, Lax M. The caries-inhibiting effect of acidulated phosphate-fluoride chewable tablets: a two-year double-blind study. J Am Dent Assoc 1968 Mar;76(3):554-7.

Disney JA, Graves RJ, Stamm JW, Bohannan HM, Abernathy JR. Comparative effects of a 4-year fluoride mouthrinse program on high and low caries forming grade 1 children. Community Dent Oral Epidemiol 1989;17:139-43.

Driscoll WS. The use of fluoride tablets for the prevention of dental caries. In: Forrester DJ, Schulz EM, editors. International workshop for the prevention of dental caries. Baltimore: University of Maryland; 1974. p. 25-111.

Driscoll WS, Heifetz SB, Korts DC. Effect of chewable fluoride tablets on dental caries in schoolchildren: results after six years of use. J Am Dent Assoc 1978 Nov;97(5):820-4.

Elwood JM, Gallagher RP. Factors influencing early diagnosis of cancer of the oral cavity. Can Med Assoc J 1985;133:651-6.

Fejerskov O, Manji F, Baelum V. The nature and mechanisms of dental fluorosis in man. J Dent Res 1990;69(SI):692-700.

Fiore MC. Smoking cessation: a systems approach. Clinical practice guideline no. 18. Rockville (MD): Agency for Health Care Policy and Research; 1997. AHCPR no. 97-0698. Available from: http://www.ahcpr.gov/clinic/smoksys.htm.

Forrest JL, Horowitz AM, Shmuely Y. Dental hygienists' caries prevention knowledge and practices. J Den Res 1998 [abstract].

Galagan DJ, Vermillion JR. Determining optimum fluoride concentrations. Public Health Rep 1957;72: 491-3.

Gallup Organization, Inc. A Gallup study of parents' behavior, knowledge and attitudes toward fluoride. Dent Office 1992:9-10.

Garcia AI. Caries incidence and costs of prevention programs. J Public Health Dent 1989;49(5 Spec No): 259-71.

Gift HC, Corbin SB, Nowjack-Raymer RE. Public knowledge about prevention of dental disease—1990 NHIS. Public Health Rep 1994;109:397-404.

Gold RS, Horowitz AM. Oral health information in textbooks. Paper presented at: 121st Scientific Session of the American Public Health Association; 1993 Oct 26; San Francisco.

Green LW, Kreuter MW. Health promotion planning: an educational and environmental approach. 3rd ed. Mountain View (CA): Mayfield Publishing Company; 1999.

Greene JC, Louie R, Wycoff SJ. Preventive dentistry, I. Dental caries. JAMA 1989 Dec 22;262(24):3459-63.

Grimard G, Nolan T, Carlin JB. Head injuries in helmeted child bicyclists. Inj Prev 1995 Mar;1(1):21-5.

Hardison JR. The use of pit-and-fissure sealants in community public health programs in Tennessee. J Public Health Dent 1983 Summer;43(3):233-9.

Helfenstein U, Steiner M. Fluoride varnishes (Duraphat): a meta-analysis. Community Dent Oral Epidemiol 1994 Feb;22(1):1-5.

Heller KE, Reed SG, Bruner FW, Eklund SA, Burt BA. Longitudinal evaluation of sealing molars with and without incipient dental caries in a public health program. J Public Health Dent 1995 Summer;55: 148-53.

Hennon DK, Stookey GK, Muhler JC. The clinical anticariogenic effectiveness of supplementary fluoride-vitamin preparations—results at the end of four years. J Dent Child 1967 Nov;34(6):439-43.

Holm AK. Effect of fluoride varnish (Duraphat) in preschool children. Community Dent Oral Epidemiol 1979 Oct;7(5):241-5.

Horowitz AM, Nourjah PA. Patterns of screening for oral cancer among U.S. adults. J Public Health Dent 1996;56:331-5.

Horowitz AM, Suomi JD, Peterson JK, Mathews BL, Voglesong RH, Lyman BA. Effects of supervised daily dental plaque removal by children after 3 years. Community Dent Oral Epidemiol 1980;8:171-6.

Horowitz AM, Nourjah P, Gift HG. U.S. adult knowledge of risk factors for and signs of oral cancers: 1990. J Am Dent Assoc 1995;126:39-45.

Horowitz AM, Goodman HS, Yellowitz JA, Nourjah PA. The need for health promotion in oral cancer prevention and early detection. J Public Health Dent 1996;56:319-30.

Horowitz AM, Moon HS, Goodman HS, Yellowitz JA. Maryland adults' knowledge of oral cancer and having oral cancer examinations. J Public Health Dent 1998;58:281-7.

Horowitz HS, Ismail AI. Topical fluorides in caries prevention. In: Fejerskov O, Ekstrand J, Burt BA, editors. Fluoride in dentistry. 2nd ed. Copenhagen: Munksgaard; 1996. Chapter 17.

Hutton WL, Linscott BW, Williams DB. Final report of local studies on water fluoridation in Brantford. Can J Public Health 1956;47:89-92.

Institute of Medicine (IOM), Food and Nutrition Board. Dietary reference intakes: calcium, phosphorus, magnesium, vitamin D, and fluoride. Washington: National Academy Press; 1997.

Ismail AI. Fluoride supplements: current effectiveness, side effects and recommendations. Community Dent Oral Epidemiol 1994 Jun;22(3):164-72.

Ismail AI, Lewis DW. Periodic health examination, 1993 update: 3. Periodontal diseases: classification, diagnosis, risk factors and prevention. Canadian Task Force on the Periodic Health Examination. Can Med Assoc J 1993 Nov 15;149(10):1409-22.

Ismail AI, King W, Clark DC. An evaluation of the Saskatchewan pit and fissure sealant program: a longitudinal followup. J Public Health Dent 1989;49(4):206-11.

Johnson RM, McCarthy MC, Miller SF, Peoples JB. Craniofacial trauma in injured motorcyclists: the impact of helmet usage. J Trauma 1995 Jun;38(6):876-8.

Johnston DW. Current status of professionally applied topical fluorides. Community Dent Oral Epidemiol 1994 Jun;22(3):159-63.

Joint Commission on National Health Education Standards. National health education standards: achieving health literacy. Atlanta: American Cancer Society; 1995.

Karlson TA. Injury control and public policy. Crit Rev in Environ Control 1992;22:195-241.

Kaste LM, Selwitz RH, Oldakowski RJ, Brunelle, JA, Winn DM, Brown LJ. Coronal caries in the primary and permanent dentition of children and adolescents 1-17 years of age: United States, 1988-1991. J Dent Res 1996 Feb;75(Spec No):631-41.

Kirkegaard E, Petersen G, Poulsen S, Holm SA. Caries-preventive effect of Duraphat varnish application versus fluoride mouthrinses: 5-year data. Caries Res 1986;20:548-55.

Klausner R. Evolution of tobacco control studies at the National Cancer Institute. Tob Control 1997;6(Suppl):2:S1-2.

Klein SP, Bohannan HM, Bell RM, Disney JA, Foch CB, Graves RC. The cost and effectiveness of school-based preventive dental care. Am J Public Health 1985 Apr;75(4):382-91.

Koch G, Petersson LG, Ryden H. Effect of fluoride varnish (Duraphat) treatment every six months compared with weekly mouthrinses with 0.2 percent NaF solution on dental caries. Swed Dent J 1979;3(2):39-44.

Kugel W, Fischer T. Rise and fall of caries prevalence in German towns with different F concentrations in drinking water. Caries Res 1997;31:166-73.

Kumar JV, Davila ME, Green EL, Lininger LL. Evaluation of a school-based sealant program in New York State. J Public Health Manag Pract 1997 May;3(3):43-51.

Last JM. A dictionary of epidemiology. 3rd ed. New York: Oxford University Press; 1995.

Lee MC, Chiu WT, Chang LT, Liu SC, Lin SH. Craniofacial injuries in unhelmeted riders of motorbikes. Injury 1995 Sep;26(7):467-70.

Leverett DH. Effectiveness of mouthrinsing with fluoride solutions in preventing coronal and root caries. J Public Health Dent 1989;49(5 Spec No):310-6.

Leverett DH, Adair SM, Vaughn BW, Proskin HM, Moss ME. Randomized clinical trial of the effect of prenatal fluoride supplements in preventing dental caries. Caries Res 1997;31(3):174-9.

Lewis DW, Ismail AI. Periodic health examination, 1995 update: 2. Prevention of dental caries. Canadian Task Force on the Periodic Health Examination. Can Med Assoc J 1995 Mar 5;152(6):836-46.

Lewit EM, Hyland A, Kerrebrock N, Cummings KM. Price, public policy, and smoking in young people. Tob Control 1997;6(Suppl):2:S17-24.

Llodra JC, Bravo M, Delgado-Rodriguez M, Baca P, Galvey R. Factors influencing the effectiveness of sealants—a meta-analysis. Community Dent Oral Epidemiol 1993 Oct;21(5):261-8.

Löe H, Theilade E, Jensen SB. Experimental gingivitis in man. J Periodontol 1965 May-Jun;36:177-87.

Lynch BS, Bonnie RJ. Institute of Medicine. Growing up tobacco free: preventing nicotine addiction in children and youths. Washington: National Academy Press; 1994.

Lynch GR, Prout MN. Screening for cancer by residents in an internal medicine program. J Med Educ 1986;61:387-93.

Maestrello-deMoya MG, Primosch RE. Orofacial trauma and mouth-protector wear among high school varsity basketball players. ASDC J Dent Child 1989 Jan-Feb;56(1):36-9.

Mandel ID. Fluoride varnishes—a welcome addition [editorial]. J Public Health Dent 1994;54:67.

Manley MW, Lynn W, Epps R, Grande D, Glynn T, Shopland D. The American Stop Smoking Intervention Study for cancer prevention: an overview. Tob Control 1997a;6(Suppl 2):S5-11.

Manley MW, Pierce JP, Gilpin EA, Rosbrook B, Berry C, Wun LM. Impact of the American Stop Smoking Intervention Study on cigarette consumption. Tob Control 1997b;6(Suppl 2):S12-6.

Marine WM, Kerwin EM, Moore EE, Lezotte DC, Baron AE, Grosso MA. Mandatory seatbelts: epidemiologic, financial, and medical rationale from the Colorado matched pairs study. J Trauma 1994 Jan;36(1):96-100.

McDonald AK. The National Electronic Injury Surveillance System: a tool for researchers. U.S. Consumer Product Safety Commission, October 1994.

McGavran EG. What is public health? In: Barr HH, Barrie FH, editors. Edward G. McGavran: guardian of the body politic. Chapel Hill: School of Public Health, The University of North Carolina; 1979.

McNutt T, Shannon SW Jr, Wright JT, Feinstein RA. Oral trauma in adolescent athletes: a study of mouth protectors. Pediatr Dent 1989 Sep;11(3):209-13.

Meadow D, Lindner G, Needleman H. Oral trauma in children. Pediatr Dent 1984 Dec;6(4):248-51.

Mertz-Fairhurst EJ. Current status of sealant retention and caries prevention. J Dent Educ 1984 Feb;48(2 Suppl):18-26.

Messer LB, Calache H, Morgan MV. The retention of pit and fissure sealants placed in primary school children by Dental Health Services, Victoria. Aust Dent J 1997 Aug;42(4):233-9.

Morgan MV, Crowley SJ, Wright C. Economic evaluation of a pit and fissure dental sealant and fluoride mouthrinsing program in two nonfluoridated regions of Victoria, Australia. J Public Health Dent 1998 Winter;58(1):19-27.

Murphy GP, Lawrence W, Lenhard RE, editors. American Cancer Society textbook of clinical oncology. 2nd ed. Atlanta: American Cancer Society; 1995.

Murray JJ, Naylor MN. Fluorides and dental caries. In: Murray JJ, editor. The prevention of oral disease. 3rd ed. Oxford; New York: Oxford University Press; 1996.

Murray JJ, Rugg-Gunn AJ, Jenkins GN. Fluorides in caries prevention. 3rd ed. Oxford; Boston: Wright; 1991.

National Cancer Institute (NCI). Community-based interventions for smokers: the COMMIT field experience. Bethesda (MD): U.S. Department of Health and Human Services, Public Health Service, National Institutes of Health, National Cancer Institute, 1995. Smoking and tobacco control monograph 6. NIH Pub. no. 95-4028.

National Center for Health Statistics (NCHS). Healthy People 2000 review. Hyattsville (MD): U.S. Department of Health and Human Services Public Health Service, Centers for Disease Control and Prevention, National Center for Health Statistics; 1992. p. 90-95. Available from US GPO, Washington. PHS Pub. no. 93-1232-1.

National Center for Health Statistics (NCHS). Healthy People 2000 review, 1998-99. Hyattsville (MD): U.S. Public Health Service; 1999.

National Center for Injury Prevention and Control, Centers for Disease Control and Prevention. Injury-control recommendations: bicycle helmets. MMWR Morb Mortal Wkly Rep 1995 Feb 17;44(RR-1):1-17.

National Institutes of Health (NIH). Consensus Development Conference Statement. Dental sealants in the prevention of tooth decay. J Dent Educ 1984 Feb;48(2 Suppl):126-31.

National Research Council (NRC). Health effects of ingested fluoride. Washington: National Academy Press; 1993.

Newbrun E. Effectiveness of water fluoridation. J Public Health Dent 1989;49(5 Spec No):279-89.

Newbrun E. The fluoridation war: a scientific dispute or a religious argument? J Public Health Dent 1996;56(5 Spec No):246-52.

Nourjah P, Horowitz AM, Wagener DK. Factors associated with the use of fluoride supplements and fluoride dentifrice by infants and toddlers. J Public Health Dent 1994;54(1):47-54.

Nowjack-Raymer RE, Gift HC. Use of mouthguards and headgear in organized sports by school-aged children. Public Health Rep 1996 Jan-Feb;111(1):82-6.

O'Mullane DM. Efficiency in clinical trials of caries preventive agents and methods. Community Dent Oral Epidemiol 1976 Sep;4(5):190-4.

O'Neil HW. Opinion study comparing attitudes about dental health. J Am Dent Assoc 1984;109:910-5.

O'Rourke CA, Attrill M, Holloway PJ. Cost appraisal of a fluoride tablet programme to Manchester primary school children. Community Dent Oral Epidemiol 1988 Dec;16(6):341-4.

Orsay EM, Dunne M, Turnbull TL, Barrett JA, Langenberg P, Orsay CP. Prospective study of the effect of safety belts in motor vehicle crashes. Ann Emerg Med 1990 Mar;19(3):258-61.

Petersson LG. Fluoride mouthrinses and fluoride varnishes. Caries Res 1993;27(Suppl 1):35-42.

Petersson LG, Arthursson L, Ostberg C, Jonson P, Gleerup A. Caries-inhibiting effects of different modes of Duraphat varnish reapplication: a 3-year radiographic study. Caries Res 1991;25:70-3.

Peyron M, Matsson L, Birkhed D. Progression of approximal caries in primary molars and the effect of Duraphat treatment. Scand J Dent Res 1992 Dec;100(6):314-8.

Powers JM, Godwin WC, Heintz WD. Mouth protectors and sports team dentists. Bureau of Health Education and Audiovisual Services, Council on Dental Materials, Instruments, and Equipment. J Am Dent Assoc 1984 Jul;109(1):84-7.

Prout MN, Heeren TC, Barber CE, et al. Use of health services before diagnosis of head and neck cancer among Boston residents. Am J Prev Med 1990;6:77-83.

Rampton J, Leach T, Therrien SA, Bota GW, Rowe BH. Head, neck, and facial injuries in ice hockey: the effect of protective equipment. Clin J Sports Med 1997 Jul;7(3):162-7.

Reeves T. (CDC Division of Oral Health) Personal communication. 1999 May 2.

Reinfurt DW, St Cyr CL, Hunter WW. Usage patterns and misuse rates of automatic seat belts by system type. Accid Anal Prev 1991 Dec;23(6):521-30.

Ringelberg ML, Allen SJ, Brown LJ. Cost of fluoridation: 44 Florida communities. J Public Health Dent 1992;52(2):75-80.

Ripa LW. An evaluation of the use of professional (operator-applied) topical fluorides. J Dent Res 1990 Feb;69(Spec No):786-96.

Ripa LW. A critique of topical fluoride methods (dentifrices, mouthrinses, operator and self-applied gels) in an era of decreased caries and increased fluorosis prevalence. J Public Health Dent 1991 Winter;51(1):23-41.

Ripa LW. Sealants revisited: an update of the effectiveness of pit and fissure sealants. Caries Res 1993;27 (Suppl 1):77-82.

Rivara FP, Dicker BG, Bergman AB, Dacey R, Herman C. The public cost of motorcycle trauma. JAMA 1988 Jul 8;260(2):221-3.

Rivara FP, et al. The Seattle children's bicycle helmet campaign: changes in helmet use and head injury admissions. Pediatrics 1994 Apr;93(4):567-9.

Rivara FP, Thompson DC, Thompson RS. Epidemiology of bicycle injuries and risk factors for serious injury. Inj Prev 1997 Jun;3(2):110-4.

Roper Report on Oral Health. Study reveals conflicting ideas about periondontal disease. Dent Today 1994 Feb.

Sacks JJ, Kresnow M, Houston B, Russell J. Bicycle helmet use among American children, 1994. Inj Prev 1996 Dec;2(4):258-62.

Sane J. Comparison of maxillofacial and dental injuries in four contact team sports: American football, bandy, basketball, and handball. Am J Sports Med 1988 Nov-Dec;16(6):647-51.

Seppä L. Studies of fluoride varnishes in Finland. Proc Finn Dent Soc 1991;87(4):541-7.

Seppä L, Pollanen L. Caries preventive effect of two fluoride varnishes and a fluoride mouthrinse. Caries Res 1987;21(4):375-9.

Seppä L, Tolonen T. Caries preventive effect of fluoride varnish applications performed two or four times a year. Scand J Dent Res 1990;98:102-5.

Seppä L, Leppanen T, Hausen H. Fluoride varnish versus acidulated phosphate fluoride gel: a 3-year clinical trial. Caries Res 1995;29:327-30.

Seppä L, Karkkainen S, Hausen H. Caries frequency in permanent teeth before and after discontinuation of water fluoridation in Kuopio, Finland. Community Dent Oral Epidemiol 1998;26:256-62.

Shopland DR. Smoking control in the 1990s: a National Cancer Institute model for change. Am J Public Health 1993 Sep;83:1208-10.

Siegal MD, Garcia AI, Kandray DP, Giljahn LK. The use of dental sealants by Ohio dentists. J Public Health Dent 1996 Winter;56(1):12-21.

Siegal MD, Farquhar CL, Bouchard JM. Dental sealants. Who needs them? Public Health Rep 1997a Mar-Apr;112(2):98-106.

Siegal MD, Lalumandier JA, Farquhar CL, Bouchard JM. School-based and school-linked public health sealant programs in the United States, 1992-93. Columbus (OH): Association of State and Territorial Dental Directors; 1997b.

Silverman S. American Cancer Society. Oral cancer. 4th ed. St. Louis: Mosby-Year Book; 1998.

Simonsen RJ. Retention and effectiveness of dental sealant after 15 years. J Am Dent Assoc 1991 Oct;122(11):34-42.

Skold L, Sundquist B, Eriksson B, Edeland C. Four-year study of caries inhibition of intensive Duraphat application in 11-15-year-old children. Community Dent Oral Epidemiol 1994;22:8-12.

Smith GS, Falk H. Unintentional injuries. Am J Prev Med 1987;3:143-63.

Sorenson WW. A look at air bag effectiveness using U.S. insurance company data. Proceedings of the International Conference on Air Bags and Seat Belts: evaluation and implications for public policy; 1993.

Sosin DM, Sacks JJ, Holmgreen P. Head injury—associated deaths from motorcycle crashes. Relationship to helmet-use laws. JAMA 1990 Nov 14; 264(18): 2395-9.

Stamm JW, Bohannan HM, Graves RC, Disney JA. The efficiency of caries prevention with weekly fluoride mouthrinses. J Dent Educ 1984 Nov;48(11):617-26.

Stephen KW. Systemic fluorides: drops and tablets. Caries Res 1993;27(Suppl 1):9-15.

Stephen KW, Campbell D. Caries reduction and cost benefit after 3 years of sucking fluoride tablets daily at school. A double blind trial. Br Dent J 1978 Apr 4;144(7):202-6.

Stephen KW, McCall DR, Tullis JI. Caries prevalence in northern Scotland before, and 5 years after, water defluoridation. Br Dent J 1987 Nov 21;163(10): 324-6.

Sterritt GR, Frew RA. Evaluation of a clinic-based sealant program. J Public Health Dent 1988 Fall;48(4): 220-4.

Sterritt GR, Frew RA, Rozier RG, Brunelle JA. Evaluation of a school-based fluoride mouthrinsing and clinic-based sealant program on a non-fluoridated island. Community Dent Oral Epidemiol 1990 Dec;18(6):288-93.

Stookey GK, Beiswanger BB. Topical fluoride therapy. In: Harris NO, Christen AG, editors. Primary preventive dentistry. 4th ed. Norwalk (CT): Appleton and Lange; 1995. Chapter 9. p. 193-233.

Sundberg H, Bjerner B, Sjogren K. Estimation of the prophylactic measures in Swedish public dental health care. Results from a questionnaire. Eur J Oral Sci 1996 Aug;104(4 Pt 2):477-9.

Sutyak JP, Passi V, Hammond JS. Air bags alone compared with the combination of mechanical restraints and air bags: implications for the emergency evaluation of crash victims. South Med J 1997 Sep;90(9): 915-9.

Task Force on Community Preventive Services. Introducing the guide to community preventive services: methods, first recommendations and expert commentary. Am J Prev Med 2000 Jan;18(1S).

Thompson DC, Nunn ME, Thompson RS, Rivara FP. Effectiveness of bicycle safety helmets in preventing serious facial injury. JAMA 1996;276(24):1974-5.

Torell P, Ericsson Y. Two-year clinical tests with different methods of local caries-preventive fluorine application in Swedish school-children. Acta Odontol Scand 1965 Jun;23:287-322.

Torell P, Ericsson Y. The potential benefits to be derived from fluoride mouthrinses. In: Forrester DJ, Schulz EM, editors. International workshop on fluorides and dental caries reductions. Baltimore: University of Maryland; 1974. p. 113-76.

Twetman S, Petersson LG, Pakhomov GN, Caries incidence in relation to salivary mutans streptococci and fluoride varnish applications in preschool children from low- and optimal-fluoride areas. Caries Res 1996;30(5):347-53.

U.S. Consumer Product Safety Commission (USCPSC). Overview of sports related injuries to persons 5-14 years of age. Washington: U.S. Consumer Product Safety Commission, 1981.

U.S. Consumer Product Safety Commission (USCPSC). Tricycles: reporting hospitals and estimates reports 1982-1986. Washington: National Electronic Injury Surveillance System, U.S. Consumer Product Safety Commission; 1986.

U.S. Department of Health, Education, and Welfare (USDHEW). Public Health Service drinking water standards, revised 1962. Washington: U.S. Department of Health, Education, and Welfare. Public Health Service; 1962. PHS Pub. no. 956.

U.S. Department of Health and Human Services (USDHHS). Review of fluoride benefits and risks: report of the Ad Hoc Subcommittee on Fluoride of the Committee to Coordinate Environmental Health and Related Programs. Washington: U.S. Department of Health and Human Services, Public Health Service; 1991.

U.S. Department of Health and Human Services (USDHHS). Fluoridation census, 1992. Atlanta: U.S. Public Health Service, Centers for Disease Control and Prevention, Division of Oral Health; 1993.

U.S. Department of Health and Human Services (USDHHS). Preventing tobacco use among young people: a report of the Surgeon General. Atlanta: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion, Office on Smoking and Health; 1994.

U.S. Department of Health and Human Services (USDHHS). Healthy People 2010. (conference edition, in two volumes). Washington: U.S. Department of Health and Human Services; 2000.

U.S. Department of Transportation (USDOT). Fatal accident reporting system: a review of the information fatal traffic crashes in the United States annual reports, 1975-1993. Washington: U.S. Department of Transportation, National Highway Traffic Safety Administration, National Center for Statistics and Analysis; 1998.

U.S. Preventive Services Task Force (USPSTF). Guide to clinical preventive services. 2nd ed. Baltimore: Williams and Wilkins; 1996.

Vaughan RG. Motorcycle helmets and facial injuries. Med J Aust 1977 Jan 29;1(5):125-7.

Vehmanen R. An economic evaluation of two caries preventive methods [dissertation]. Turku, Finland: University of Turku; 1993 Nov.

Warren DP, Henson HA, Chan JT. A survey of in-office use of fluorides in the Houston area. J Dent Hyg 1996;70:166-71.

Watson MR, Horowitz AM, Garcia I, Canto MT. Caries conditions among 2-5 year old immigrant Latino children related to parents' oral health knowledge, opinions and practices. Community Dent Oral Epidemiol 1999;27:8-15.

Weintraub JA. The effectiveness of pit and fissure sealants. J Public Health Dent 1989;49(5 Spec No):317-30.

Weintraub JA, Stearns SC, Burt BA, Beltran E, Eklund SA. A retrospective analysis of the cost-effectiveness of dental sealants in a children's health center. Soc Sci Med 1993 Jun;36(11):1483-93.

Whyte RJ, Leake JL, Hawkey TP. Two-year follow-up of 11,000 dental sealants in first permanent molars in the Saskatchewan Health Dental Plan. J Public Health Dent 1987 Fall;47(4):177-81.

Wilkinson R. Unhealthy societies: the afflictions of inequality. London: Routledge; 1996.

Winn DM, Sandberg AL, Horowitz AM, Diehl SR, Gutkind S, Kleinman DV. Reducing the burden of oral and pharyngeal cancers. J Calif Dent Assoc 1998 Jun;26(6):445-51,454.

World Health Organization (WHO). Fluorine and fluorides: environmental health criteria 36. Geneva: World Health Organization; 1984.

World Health Organization (WHO). Fluorides and oral health. Geneva: The World Health Organization; 1994.

Yellowitz JA, Goodman HS. Assessing physicians' and dentists' oral cancer knowledge, opinions and practices. J Am Dent Assoc 1995 Jan;126(1):53-60.

Yellowitz JA, Horowitz AM, Goodman HS, Canto MT, Farooq NS. Knowledge, opinions and practices of general dentists regarding oral cancer: a pilot survey. J Am Dent Assoc 1998 May;129(5):579-83.