Chapter **38**

Oral and Craniofacial Diseases and Disorders

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The oral cavity is an essential part of the body and contributes to total health and well-being. Recent research indicates that poor oral health affects general health and that some systemic diseases can affect oral health. A variety of diseases involve the oral cavity; the two main oral diseases present worldwide and lead to tooth destruction or tooth loss:

- dental caries, the disease that leads to cavities in the teeth
- periodontal disease, which leads to loosening of teeth.

Both diseases are preventable, and strong efforts have been made to control them. Other diseases and conditions are much less prevalent, yet serious, and sometimes even life threatening: oral precancer and cancer, oral manifestations of HIV and AIDS, noma, developmental disorders, and fluorosis of teeth.

DENTAL CARIES

Dental caries develops by the localized dissolution of the tooth hard tissues, caused by acids that are produced by bacteria in the biofilms (dental plaque) on the teeth and eventually lead to "cavities." The biofilm consists of microorganisms, including the highly cariogenic mutans streptococci, and a matrix made up mainly of extracellular polysaccharides. The destructive acids are produced when fermentable carbohydrates (sugars) reach these biofilms, each episode resulting in tooth damage (attack). If this process does not occur frequently, then the natural capacity of the body (through saliva) to remineralize will prevent formation of a cavity. Thus, the main risk factors include presence of cariogenic biofilms and frequent consumption of fermentable carbohydrates. Exposure to fluorides in optimum concentrations reduces the risk, and normal saliva flow and saliva protective systems are also important to counteract the cariogenic factors.

Untreated caries can give rise to infection of the tooth pulp, which can spread to the supporting tissues and the jaws, culminating in advanced disease conditions that are often painful. For example, in Thailand, recent surveys of a sample of 12-year-old children revealed that 53 percent had suffered from pain or discomfort from teeth over the past year (Petersen and others 2001). The corresponding figures in China were 34 percent for 12-year-olds (Peng, Petersen, Fan, and others 1997) and 74 percent for adults (Petersen, Peng, and Tai 1997).

Tooth decay is a public health problem worldwide. According to the U.S. Surgeon General's report (U.S. Public Health Service 2000), dental caries is the single most common chronic childhood disease in the United States. Epidemiological data for almost 200 countries are available in the World Health Organization (WHO) Country/Area Profile Programme (CAPP) oral health database (http://www.whocollab.od.mah.se/index.html) (see table 38.1 for examples). Caries prevalence of permanent teeth is expressed by the decayed, missing, and filled teeth (DMFT) index (calculated by counting the number of DMFT of individuals and taking the mean for the group examined). One indicator age group used for international comparisons is 12-year-old children. The WHO oral health goal was to achieve three DMFT or fewer among 12-year-olds

Table 38.1 Mean DMFT and SiC Index of 12-Year-Olds for Some Countries, by Ascending Order of DMFT

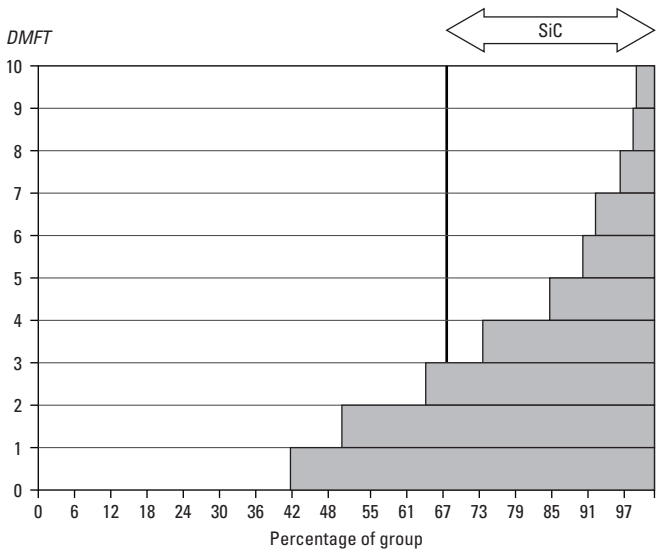
Country	Mean DMFT	SiC Index	Year	Sample size	Reference
Australia	0.8	2.4	1999	29,130	Armfield, Roberts-Thomson, and Spencer 2003
Nepal	0.8	2.5	2000	623	Data from WHO, courtesy P. E. Petersen
Sweden	0.9	2.6	2001	71,896	Sundberg 2002
Jamaica	1.0	2.8	1995	362	Data from PAHO, courtesy E. D. Beltran and S. Estupinan-Day
China	1.0	3.0	1996	23,452	Data from WHO, courtesy P. E. Petersen
Senegal	1.2	2.8	1994	300	Sembene, Kane, and Bourgeois 1999
Sri Lanka	1.4	3.6	1994–95	2,003	Abayaratna and Krishnarasa 1997
England, U.K. (Northwest)	1.4	3.2	2000–1	12,029	Pitts and others 2002
United States	1.4	3.6	1988–91	176	Data from PAHO, courtesy E. D. Beltran and S. Estupinan-Day
Portugal	1.5	3.6	1999	800	Data from WHO, courtesy P. E. Petersen
Germany	1.7	4.1	1997	1,043	Micheelis and Reich 1999
Israel	1.7	4.1	2002	1,327	Courtesy S. P. Zusman, Division of Dental Health, Israel
South Africa	1.7	4.3	1988–89	1,571	van Wyk 1994
Greece (Northeastern province) (11-year-olds)	1.8	4.2	2001	2,217	Demertzi and Topitsoglou 2002
Scotland (U.K.)	1.8	4.3	1996–97	6,165	Data from K. Woods from the study Pitts, Evans, and Nugent 1998
France	2.0	4.7	1998	6,000	Hescot and Roland 2000
Thailand	2.4	4.9	2001	1,116	Data from WHO, courtesy P. E. Petersen
Mexico (state of Mexico)	2.5	5.0	1997	1,138	Irigoyen and Sanchez-Hinojosa 2000
Uruguay	2.5	5.3	1999	596	Sector Público 1999
Comoros	2.6	6.1	2000	142	Data from WHO, courtesy P. E. Petersen
Belarus	2.7	5.4	1999	2,537	Data from WHO, courtesy P. E. Petersen
Romania	2.7	5.8	2001	785	Data from WHO, courtesy P. E. Petersen
Nicaragua	2.8	5.7	1997	365	Data from PAHO, courtesy E. D. Beltran and S. Estupinan-Day
Greenland	3.5	7.0	2002	236	Data from WHO, courtesy P. E. Petersen
Latvia	3.8	7.1	1998	416	Data from WHO, courtesy P. E. Petersen
Poland	3.9	7.2	1997	1,732	Data from WHO, courtesy P. E. Petersen
Honduras	4.0	7.5	1997	307	Data from PAHO, courtesy E. D. Beltran and S. Estupinan-Day
Bolivia	4.7	8.8	1995	389	Data from PAHO, courtesy E. D. Beltran and S. Estupinan-Day
Slovak Republic	5.9	14.3	1998	1,589	Data from WHO, courtesy P. E. Petersen
Costa Rica	8.5	13.7	1988	1,349	Data from PAHO, courtesy E. D. Beltran and S. Estupinan-Day

Source: Authors.
PAHO = Pan American Health Organization; SiC = Significant caries.

by 2000. According to the CAPP database, 70 percent of the countries had achieved three DMFT or fewer by 2001, representing 85 percent of the world population. Several developing economies, however, have reported a trend toward higher levels of dental caries.

A detailed analysis of caries data for many countries, both industrial and developing, shows skewed distributions of the disease—that is, a proportion of a population of children showing a high or very high number of caries and the rest showing a low number of caries or none. Expressing caries prevalence as mean DMFT may, therefore, not accurately describe the disease level in populations with skewed distribution. The Significant Caries (SiC) Index was proposed to bring attention to those hidden high caries groups (Bratthall 2000). The SiC Index is calculated by simply taking the mean DMFT of the one-third of the group having the highest DMFT in a population (figure 38.1). Table 38.1 shows several countries having fewer than three mean DMFT but high SiC Index values, thus illustrating the hidden caries burden for children (Nishi and others 2002).

Dental caries is found not only in children and young adults but also in all age groups. The elderly, in particular those with exposed tooth root surfaces, constitute a special risk



Source: Adyatmaka and others 1998.

Note: The mean DMFT is 2.3. The Significant Caries Index is 5.4. Arrow indicates the proportion of individuals who are included in the calculation of the index. West Kalimantan is one of the most caries-affected provinces in Indonesia.

Figure 38.1 DMFT for 331 12-Year-Olds, West Kalimantan, Indonesia

population (Barmes 2000). A Swedish study reported DMFT values of 21.4 and 24.4 for 50- and 70-year-olds, respectively, indicating that nearly all teeth were affected in these age groups (Hugoson and others 1995). Thomson (2004), reviewing longitudinal studies of older adults (age 50+), found an incidence of root surface caries varying from 29 to 59 percent and concluded that older people are a caries-active group, experiencing new caries at a rate comparable to that of adolescents. With increasing numbers of people becoming 50 years of age or older in some developing countries, root surface caries may become a significant problem.

When we consider the global epidemiology of dental caries, the main patterns seem to be the following:

- Countries with low mean sugar consumption (less than 10 to 15 kilograms of sugar per person per year) generally have low mean caries prevalence.
- Countries with high mean sugar consumption (more than 20 to 25 kilograms of sugar per person per year) and without effective preventive programs generally have high mean caries prevalence.
- Countries with high mean sugar consumption (more than 20 to 25 kilograms of sugar per person per year) using effective preventive programs have been able to reduce the caries prevalence.

If we consider the prevalence of caries *within* a population, the main patterns seem to be as follows:

- Disadvantaged or poor population groups have higher dental caries experience than advantaged groups.
- Individuals with poor oral hygiene and frequent sugar intake are at increased risk.
- Individuals not exposed to fluorides—for example, from fluoridated water or toothpastes—are at increased risk of caries.
- Persons with individual risk factors, such as reduced saliva flow or exposed tooth root surfaces, or with certain general diseases are also at increased risk of caries.

Caries Intervention Programs

Since the discovery of the caries-preventive effect of fluorides in the 1930s, different forms of fluoride administration programs have been implemented, often with remarkable caries-reducing effects. Fluoride has been added to different vehicles, such as water, salt, toothpaste, and milk. Fluoride tablets and fluoride mouth rinsing have been used among young children and in schools, and more recently even among adults at high caries risk (Petersen 1989, 1990). For individual use, fluoride in high concentrations has been added to various forms of gels and varnishes to be applied on the teeth. Furthermore, fluoride in chewing gum is available in some countries. When a group of international experts on cariology were asked in a study to identify the main causes of the caries decline seen in several Western countries during recent decades, practically all the experts pointed to fluoride dentifrice as the most significant factor (Bratthall, Hänsel-Petersson, and Sundberg 1996).

According to WHO (1994), community water fluoridation is safe and cost-effective in preventing dental caries in every age group, benefiting all residents served by the community water regardless of their social or economic status (Burt 2002; Petersen and Lennon 2004; White, Antczak-Bouckoms, and Weinstein 1989). Examples of countries with fluoridated water supplies for significant parts of the populations are Argentina, Brazil, Brunei Darussalam, Canada, Chile, Ireland, New Zealand, the United Kingdom, and the United States. In many developing countries, lack of community water supplies makes water fluoridation impossible.

Effective fluoride toothpastes have been available for about 40 years (WHO 1994). They have been tested in numerous studies, in particular in school-based programs. The most commonly used concentrations are 1,000 or 1,500 parts per million (ppm). Because most studies have been conducted in developed countries, WHO launched a program testing a so-called "affordable fluoridated toothpaste" in developing countries. In the West Kalimantan Province of Indonesia, a supervised school-based toothbrushing program was implemented over a period of three years, resulting in a reduction of 12 to 40 percent of caries incidence in the study groups when compared to control groups (Adyatmaka and others 1998).

Domestic salt fluoridation is another method of automatic fluoridation. In the early 1950s, Switzerland and Austria

introduced this approach by offering their populations fluoridated salt for the table and for cooking. The fluoride concentration in the salt originally was 90 ppm and was later increased to 250 ppm. Fluoridated salt is now available in several countries in Europe and in South and Central America. A comparison of caries data for Jamaica in 1984 (before salt fluoridation) and 1995 (after salt fluoridation) showed a reduction of caries experience of 69 percent, 84 percent, and 87 percent among 15-, 12-, and 6-year-olds, respectively (Estupinan-Day and others 2001).

Milk fluoridation projects are being conducted in several countries, including Bulgaria, China, the Russian Federation, Thailand, and the United Kingdom. In Bulgaria, a milk fluoridation project resulted in a 79 percent lower DMFT in those children who had participated in the full five years of the program than in the control children (Pakhomov and others 1995).

Fluoride tablets and fluoride mouth-rinsing programs under supervision in schools have been implemented in several countries, including the Scandinavian countries, the United Kingdom, and the United States. The requirement that teachers and students be motivated has limited such approaches. In recent years, many national fluoride programs have been adjusted as the additional caries-reducing effects of topical applications with daily use of fluoridated toothpaste have been questioned (Petersen and Torres 1999).

Oral Health Education and Promotion Programs

The WHO Global Oral Health Programme has developed a manual for integration of oral health with school health programs (WHO 2003). In many industrial countries, school health education programs have included oral health, and researchers have shown that children's self-care capacity improved in regard to regular toothbrushing with the use of fluoridated toothpaste (Flanders 1987; Honkala, Kannas, and Rise 1990; Petersen and Torres 1999; Sogaard and Holst 1988; Wang and others 1998). Examples also exist from school oral health education in developing countries. Some programs have been organized within the context of the WHO Health Promoting Schools Initiative. In Madagascar, the evaluation of program outcomes has shown remarkably good results in reducing dental caries risk, improving self-care capacity of children and mothers, and introducing higher levels of dental knowledge and attitudes (Razanamihaja and Petersen 1999). Other successful examples are available from Tanzania (Petersen and others 2002; van Palenstein Helderman and others 1997), Zimbabwe (Frencken and others 2001), and Namibia (Priwe 1998).

In China, principles from the WHO Health Promoting Schools Initiative have been applied in certain provinces; positive effects of programs were obtained regarding health-related knowledge and behavior, but the clinical outcome measures were less evident (Petersen and others 2004; Tai and others 2001). The Chinese health authorities have emphasized preventive oral care and oral health education since the late 1980s. The nationwide mass campaign "Love Teeth Day" has been conducted annually since 1989, and the effective transmission of oral health messages to the public has shown improved oral health knowledge and behavior in children as well as in adults (Peng, Petersen, Tai, and others 1997).

In addition, various dental organizations (Cohen 1990) and private companies have developed and carried out successful oral health programs worldwide. For example, toothpaste manufacturers have donated toothpastes, toothbrushes, and educational material promoting oral health in several countries.

Effectiveness of the Oral Health Programs

In countries with systematic national oral disease prevention programs, the total cumulative effect of these programs is reflected in the epidemiological figures demonstrating caries decline (table 38.2) and in the growing proportions of caries-free individuals. However, singling out the effects of specific activities or methods of programs is difficult because several program components often operate simultaneously. For example, in industrial countries, practically all individuals use fluoridated toothpaste, and removing this preventive measure from a group of individuals just to evaluate the effect of another fluoride program would be unethical. In addition, other factors affect caries reduction, such as changing lifestyles, changing patterns of sugar consumption, and improving living conditions.

The current trend in clinical health care and public health is to base recommendations on evidence derived from systematic reviews of the literature and critical assessment of the quality of results (U.S. Public Health Service 2000). The office of the U.S. Surgeon General (U.S. Public Health Service 2000) and the Swedish Council on Technology Assessment in Health Care (SBU 2002) are examples of entities that have attempted to determine the effectiveness in public health of evidence-based approaches and technologies.

Oral Health in America, the U.S. Surgeon General's report (U.S. Public Health Service 2000), reviewed experiences from the administration of fluorides. Primarily based on U.S. studies, the report had these conclusions:

- Strong evidence exists supporting the effectiveness of water fluoridation in preventing crown and root caries in children and adults.
- Strong evidence exists of the effectiveness of the school-based fluoride supplement (tablets) program. The program, with motivated supervising personnel, such as teachers, is recommended for children at high risk for caries.
- Evidence supports the effectiveness of school-based fluoride (0.2 percent sodium fluoride) mouth-rinsing programs conducted before 1985 (before the introduction of fluoride

Table 38.2 Declining Caries Experience in Some Countries

Country	Year	DMFT in 12-year-olds	Reference
African region			
Côte d'Ivoire	1996	1.8	Guinan and others 1999
	1993	2.6	Data from Oral Health Programme, WHO
Niger	1997	1.3	Petersen and Kaka 1999
	1992	1.5	Data from Oral Health Programme, WHO
	1988	1.7	Woodward and Walker 1994
American region			
Colombia	1998	2.3	Data from PAHO
	1984	4.8	Woodward and Walker 1994
Costa Rica	1999	2.3	Data from PAHO
	1996	4.8	Data from Ministry of Health
	1993	4.9	Data from PAHO
Guyana	1995	1.3	Beltran-Aguilar, Estupinan-Day, and Baez 1999
	1983	2.7	Woodward and Walker 1994
Haiti	2000	1.0	Data from PAHO
	1994	2.2	Data from PAHO
Honduras	*1997*	*3.7*	Beltran-Aguilar, Estupinan-Day, and Baez 1999
	1987	*5.7*	Beltran-Aguilar, Estupinan-Day, and Baez 1999
Jamaica	1995	1.1	Beltran-Aguilar, Estupinan-Day, and Baez 1999
	1984	6.7	Beltran-Aguilar, Estupinan-Day, and Baez 1999
Nicaragua	1997	2.8	Beltran-Aguilar, Estupinan-Day, and Baez 1999
	1983	6.9	Beltran-Aguilar, Estupinan-Day, and Baez 1999
Panama	*1997*	*3.6*	Beltran-Aguilar, Estupinan-Day, and Baez 1999
	1989	*4.2*	Beltran-Aguilar, Estupinan-Day, and Baez 1999
United States	1992–94	1.28	NHANES III, Courtesy D. Bruce
	1988–91	1.4	Beltran-Aguilar, Estupinan-Day, and Baez 1999
	1986–87	1.8	Beltran-Aguilar, Estupinan-Day, and Baez 1999
Venezuela, R. B. de	1997	2.1	Beltran-Aguilar, Estupinan-Day, and Baez 1999
	1986	3.6	Data from PAHO
Middle Eastern region			
Saudi Arabia	1995	1.7	Data from Oral Health Programme, WHO
	1991	2.1	Data from Oral Health Programme, WHO
United Arab Emirates	1995	1.6	Nithila and others 1998
	1993	2.0	Data from Oral Health Programme, WHO
European region			
Belarus	2000	2.7	Leous and Petersen 2002
	1994	3.8	Leous and Petersen 2002
Denmark	2002	0.9	Data from National Board of Health, Denmark
	1995	1.2	Data from National Board of Health, Denmark
	1980	5.0	Data from National Board of Health, Denmark

(Continues on the following page.)

Table 38.2 Continued

Country	Year	DMFT in 12-year-olds	Reference
France	1998	1.9	Hescot and Roland 2000
	1993	2.1	Hescot and Roland 2000
	1990	3.0	Hescot and Roland 2000
Hungary	*1996*	*3.8*	Szoke and Petersen 2000
	1991	*4.3*	Szoke and Petersen 2000
	1985	*5.0*	Szoke and Petersen 2000
Israel	2002	1.66	Data from Dr S. P. Zusman, Division of Dental Health, Israel
	1989	3.0	Zadik, Zusman, and Kelman 1992
Latvia	*2000*	*3.9*	Latvia, State Dentistry Centre 2000
	1998	*4.2*	Latvia, State Dentistry Centre 2000
Norway	2000	1.5	Data from Norwegian Board of Health
	1992	2.2	von der Fehr 1994
	1986	3.1	Haugejorden 1994
Poland	*2000*	*3.8*	Wierzbicka and others 2002
	1991	*5.1*	Wierzbicka and others 2002
Portugal	1999	1.5	de Almeida and others 2003
	1990	3.2	de Almeida and others 2003
	1984	3.7	de Almeida and others 2003
Romania	2000	2.7	Petersen and Rusu 2002
	1990	3.9	Petersen and others 1994
Sweden	2001	0.9	Sundberg 2002
	1995	1.4	Sundberg 2002
	1985	3.1	Sundberg 2002
United Kingdom	1996–97	1.1	Pitts, Evans, and Nugent 1998
	1983	3.1	Downer 1994
Asian region			
Bangladesh	2000	1.0	Ullah 2001
	1981	1.5	Data from Oral Health Programme, WHO
Sri Lanka	1994–95	1.4	Abayaratna and Krishnarasa 1997
	1983–84	1.9	Sri Lanka, Ministry of Health 1985
Western Pacific region			
Australia	1999	0.8	Armfield, Roberts-Thomson, and Spencer 2003
	1990	1.4	Armfield, Roberts-Thomson, and Spencer 2003
	1980	3.6	Carr 1988
Hong Kong (China)	2001	0.8	Hong Kong, Department of Health 2003
	1986	1.5	Lo, Evans, and Lind 1990
Japan	1999	2.4	Data from Ministry of Health and Welfare
	1993	3.6	Miyazaki and Morimoto 1996
	1987	4.9	Miyazaki and Morimoto 1996
Malaysia	1997	1.6	Malaysia, Dental Services Division 1997
	1988	2.4	Malaysia, Dental Services Division 1997

Source: Authors.
PAHO = Pan American Health Organization; NHANES III = Third U.S. National Health and Nutritional Examination Survey.
Note: Numbers in italics indicate that the country did not achieve the WHO global goal of fewer than three DMFT by 2000 but shows caries decline.

toothpastes) in preventing caries in children. The cost-effectiveness of this intervention is reduced with the current decline in prevalence of caries. It is recommended for use in high-risk children consistently over a period of time.
- Strong evidence supports the effectiveness of sealants in preventing pits and fissure caries. The report recommends that the programs be limited to high-risk children and high-risk teeth.
- Fluoride varnishes were not approved for use in the United States until 1994; hence, investigations are ongoing of the effectiveness of this intervention.

The Swedish Council on Technology Assessment in Health Care (SBU 2002) applied strict criteria of evidence of effectiveness; that is, the study had to be randomized and have a sample representing the total population. For permanent teeth, a three-year follow-up was necessary. The number of studies meeting all the criteria was not very high. Here are some conclusions of this review:

- Daily use of fluoridated toothpaste is an effective method to reduce caries in permanent teeth among children and adolescents. Daily, weekly, or biweekly fluoride mouth rinsing can reduce caries, but together with daily fluoride toothpaste use, the additional effects are not strong.
- Daily fluoride mouth rinsing can reduce root surface caries in the elderly, and professional application of fluoride varnish twice a year has a caries-reducing effect in permanent teeth among youth, as does the use of fluoridated toothpaste.
- Fissure sealants have a caries-reducing effect.

According to the SBU report, it was difficult to interpret the effect of programs aimed at reducing the intake of sugars or the effect of so-called sugar substitutes. Systematic evaluation of community preventive programs should be carried out in the future, particularly to help identify appropriate alternatives for developing countries.

ASPECTS OF TREATMENT OF CAVITIES AND OF CARIES DISEASE

One has to differentiate between treatment of cavities and treatment of the disease process resulting in cavities. The normal treatment of a tooth with a cavity is a filling or, if the cavity is large, a crown. Large cavities may involve "root-fillings" or even extraction of the tooth. A variety of materials are used globally: composites, amalgam, gold, porcelain, and others. Options for replacing extracted teeth include removable prostheses, fixed bridges, or implants. The more complex treatments are costly, and no country has been able to afford to introduce systems in which all dental costs are covered by public funds. Moreover, a filling does not affect the disease process causing the cavities. Treatment must be directed against the causative factors (described earlier). For the individual case, several options are available in addition to the various fluoride programs mentioned: dietary counseling, sugar substitutes, antimicrobial agents to reduce plaque and specific bacteria, and the use of saliva-stimulating products.

In many developing countries, the lack of dental manpower means that carious teeth remain untreated. The ratio of dentists to population is particularly unfavorable in the African region compared with Western European countries. For instance, according to CAPP, the ratio is 1 to 1.2 million in Ethiopia, 1 to 225,000 in Mali, and 1 to 166,000 in Zambia, against about 1 to 1,000 in Scandinavian countries and 1 to 2,100 in the United Kingdom (see http://www.whocollab.od.mah.se/index.html). In India, the ratio is 1 to 27,000 in the urban areas but 1 to 300,000 in the rural areas (Shah 2001). Such ratios mean that neither dental caries disease nor the cavities will receive proper attention.

After taking into consideration the high costs for dental treatment and the lack of dentists, atraumatic restorative treatment (ART) was introduced. This approach requires only hand instruments rather than sophisticated electric dental drills, and trained dental auxiliaries can deliver ART. The public dental health services in South Africa adopted the approach as an appropriate and economic means of providing basic restorative care in certain communities. A randomized clinical trial conducted in Tanzania showed no statistically significant differences between the retention of occlusal amalgam (74 percent) and ART occlusal restorations (67 percent) after a six-year follow-up (1992–98) (Mandari, Frencken, and Van't Hof 2003). A potentially affordable treatment procedure that could prevent untreated carious teeth from being extracted, ART may have relevance to some middle-income countries, although the method is not realistic for most low-income countries, where sustainability of such programs would be low.

PERIODONTAL DISEASES: CHRONIC GINGIVITIS AND CHRONIC PERIODONTITIS

Gingivitis, the inflammation of gum tissue caused by bacteria accumulating in the plaque along the gingival margin, precedes chronic periodontitis. The more destructive form of periodontal disease, which breaks down the supporting tissues of the teeth, progressively leading to loosening of teeth and tooth loss, affects 10 to 15 percent of most adult populations (Papapanou 1999). Cigarette smoking and diabetes mellitus (with poorly controlled diabetes) are two major risk factors associated with periodontal disease and appear markedly to affect the initiation and progression of the disease (Genco 1996; Papapanou 1999).

In recent years there has been a growing awareness of the association between some systemic diseases and oral disease, especially periodontal diseases. For example, a national study in the United States found that the prevalence of diabetes mellitus in patients with periodontitis was significantly greater (twofold) than in nonperiodontal patients (Soskolne and Klinger 2001). Periodontal disease may be considered one of the complications of diabetes. Effective control of periodontal infection in diabetics appears to reduce the levels of advanced glycogen end-products in the serum.

Proper oral hygiene practices can prevent both gingivitis and advanced periodontal disease. All intervention programs leading to improved oral hygiene are instrumental in the control of periodontal disease and will reduce risk of future tooth loss. The school-based oral health educational programs previously discussed are effective in preventing gingivitis, but no community-based intervention program addresses periodontal disease, especially among adults. Tobacco cessation programs are also important in the prevention of periodontal diseases. Treatment of periodontal diseases consists of plaque removal, scaling, and sometimes surgery, plus motivation and instruction in oral hygiene. Dental hygienists can perform parts of the treatment program.

ORAL PRECANCER AND CANCER

The most frequent form of oral precancerous lesion, leukoplakia, appears as a white patch that cannot be rubbed off, typically in the buccal mucosa, lateral borders of the tongue, and floor of the mouth. The prevalence of leukoplakia among those 15 years old and above ranged from 1.1 percent in Cambodia, to 1.7 percent in Myanmar, to 3.6 percent in Sweden (Axell 1976; Ikeda and others 1995). Malignant transformation varies in different populations; nearly 5 percent of lesions are found to be malignant at first biopsy, and 5 percent develop into malignancy at a later stage. Erythroplakias appear as red patches and are less common but have a higher tendency (90 percent or more) than leukoplakias to transform into malignancies (Sudbo and Reith 2003).

Oral cancers affect about 300,000 people worldwide annually (Ferlay and others 2001) and often develop from oral precancerous lesions (Sudbo and Reith 2003). Early detection of oral precancerous lesions, notably oral leukoplakia and erythroplakia, could easily prevent the development of the disfiguring disease oral cancer and premature death.

Tobacco use in any form (smoking or chewing) and excessive alcohol consumption remain the primary risk factors in the development of these precancerous lesions ("Early Diagnosis and Prevention of Oral Cancer and Precancer" 1995; Reichart 2001). Factors such as local irritation, *Candida albicans* infection, and nutritional deficiencies are also associated with the presence of leukoplakia.

Screening populations and routine examination in dental and medical clinics for oral precancer and early cancer lesions would reduce the mortality, morbidity, and cost of treatment associated with oral cancers. Not all oral premalignancies show malignant transformation, and detection of these oral lesions by biopsies are straightforward, not requiring sophisticated equipment. Tobacco cessation programs aimed at younger and older age groups and control of excessive alcohol intake are definitely beneficial in the prevention of oral cancer.

ORAL MANIFESTATIONS OF HIV/AIDS

The scarce epidemiological data available on oral manifestations of HIV in developing countries are difficult to interpret because these studies are not standardized (Holmes and Stephan 2002). In the study groups, the prevalence of oral lesions in Africa ranged from 15 percent to more than 90 percent of infected individuals; in India the prevalence was 72 percent; and in Thailand it was 82 percent. Reviews are available on the different studies performed on oral manifestations of HIV and AIDS (Naidoo and Chikte 1999; Patton and others 2002).

Candida infections, oral hairy leukoplakia, oral ulcers, and Kaposi's sarcoma are some of the common oral manifestations of HIV and AIDS. Notably, Kaposi's sarcomas were never detected in the Asian populations studied in India, Singapore, and Thailand but were seen in South African, Zambian, and Zimbabwean studies (Arendorf and others 1998; Hodgson 1997; Holmes and Stephan 2002; Lim and others 2001; Nittayananta and Chungpanich 1997; Ranganathan and others 2000). The presence of oral candidiasis and hairy leukoplakia alone or at the same time in an apparently healthy individual could be an early indicator of the undetected HIV infection progressing to AIDS. Those signs may be used as indicators during clinical examinations in developing countries where technology for laboratory tests is not available or is too expensive (Greenspan and Greenspan 2002; Holmes and Stephan 2002).

NOMA (CANCRUM ORIS)

Noma usually begins as a small ulcer of the gingiva and develops into a rapidly spreading gangrenous condition of the oral and facial tissues. Seen mainly in debilitated and malnourished children, it is disfiguring and deadly. The condition is reported in developing countries in several regions of the world, particularly in Sub-Saharan Africa (Enwonwu, Falkler, and Idigbe 2000; Naidoo and Chikte 2000; Petersen 2003). Noma disappeared from the industrial world in the 20th century except

during World War II. In contrast, risk factors such as poverty, poor hygiene, and malnutrition, eventually in combination with infectious diseases such as HIV and AIDS, may have recently increased the prevalence of this disease in Sub-Saharan Africa (Enwonwu 1995; Naidoo and Chikte 2000). Most important, 90 percent of infected children die without having received any care.

Although the specific etiologic factors for noma are not known, poverty has been identified as the single most important risk indicator. Accordingly, improving the overall socioeconomic conditions can prevent noma. Public health approaches such as providing a high-protein diet, clean water, and sanitation and preventing communicable diseases such as diphtheria, dysentery, and tuberculosis would be needed for effective prevention of noma in Africa. Prognosis of noma is considerably better with timely administration of antibiotics.

DEVELOPMENTAL DISORDERS

Developmental disorders involve teeth and the craniofacial structures. A few of these disorders are congenital diseases of the enamel or dentin; problems related to the number, size, or shape of teeth; and craniofacial birth defects, such as cleft lip and palate (CL/P). Among the most common congenital malformations seen in humans, cardiovascular malformation is ranked as the first and CL/P as the second. Unilateral CL/P occurs six times more frequently than the bilateral form. Females are more prone to get cleft palates, whereas cleft lip or CL/P is most common in males (U.S. Public Health Service 2000).

The incidence of CL/P differs from 0.18 to 3.74 per 1,000 live births, the highest incidence being seen in Native Americans at 3.74 per 1,000, closely followed by the Japanese at 3.36 per 1,000 live births. A fairly uniform incidence of 1 per 600 to 700 live births is reported among Europeans. Overall, the incidence rates appear high among Asians (0.82 to 3.36 per 1,000 live births), intermediate in Caucasians (0.9 to 2.69 per 1,000 live births), and often very low in black Africans (0.18 to 1.67 per 1,000 live births) (Hewson and McNamara 2000; Vanderas 1987; Wantia and Rettinger 2002).

The causes of CL/P are complex, involving multiple genetic and environmental risk factors. Not all cases of CL/P are inherited. A number of risk factors, such as folic acid deficiencies, maternal smoking, and maternal age, have been implicated in the formation of clefts (Wantia and Rettinger 2002).

Advanced surgery, specific prosthetic appliances, and orthodontic treatment can improve the quality of life for those born with clefts. However, such treatment is not accessible to children of several developing countries. Tobacco cessation programs aimed at pregnant mothers are essential in the prevention of CL/P.

FLUOROSIS OF TEETH

Fluorosis of teeth develops during formation of teeth when children are young. Drinking water having more than 1.5 ppm of fluoride can give rise to enamel defects and discoloration of teeth, leading to endemic fluorosis in the population. These effects may vary from mild to severe. For example, in the Great Rift Valley area of East Africa, the ground water has high levels of fluoride, leading to high rates of dental fluorosis—nearly 90 percent in some parts of Kenya (Chibole 1987). Some individuals in developed countries can acquire fluorosis of teeth as a result of the widespread use of different forms of fluorides in the prevention of caries, though the degree of fluorosis often is mild compared with endemic fluorosis.

Defluoridation of the central water supplies is possible when naturally occurring fluoride is excessive in the drinking water. However, most developing countries do not have central water distribution systems, and the cost of defluoridation equipment and its maintenance can be high. WHO encourages effective and inexpensive methods that are useful for individual households or community defluoridation of drinking water (WHO 1994). Such methods exist, but a number of operational problems have been identified, requiring further initiatives in this field (Kloos and Haimanot 1999).

COMMON-RISK-FACTOR INTERVENTION PROGRAMS

New research is pointing to associations between chronic oral infections—particularly periodontitis—and heart and lung diseases, stroke, osteoporosis, low birthweight, and premature births in addition to diabetes. Such findings strengthen WHO health promotion strategies that are based on the common-risk-factor approach, which controls essential risk factors that contribute to a large number of chronic diseases (Petersen 2003). Risk behaviors such as smoking; alcohol; diets rich in fats and sugars and low in fiber, fruit, and vegetables; stress; poor hygiene; and sedentary lifestyle are factors leading to such major chronic diseases as cardiovascular diseases, cancers, diabetes, obesity, osteoporosis, dental caries, and periodontal disease. These principal risk factors for major chronic diseases are often seen to cluster in the same individuals.

The WHO Global Oral Health Programme recommends the common-risk-factors approach (Petersen 2003), which implies development of integral activities in health promotion and disease prevention, involving health education, community empowerment, and legislative policy development. For example, such programs could aim at reducing the caries levels among preschool children and simultaneously improving general health. Promoting the reduction of sugar consumption would improve not only oral health but also general health

Table 38.3 Prevention Strategies for Oral Health

Disease or condition	Causes	Actions needed and methods
Dental caries	High or frequent sugar consumption, plaque present, highly cariogenic microorganisms, nonuse of fluorides, reduced saliva flow, systemic diseases, and other individual risk factors	Targeted actions against causative factors on community and individual levels Health education toward self-care capacity, fluoride programs, sugar restriction, actions based on risk assessment of individuals and groups
Periodontal diseases	Plaque present, pathogenic bacteria, influence of systemic diseases, tobacco use	Improved oral hygiene, professional cleaning, antibiotics, identification and treatment of systemic diseases Elimination of pockets if present and removal of local dental irritants, such as rough fillings Tobacco cessation
Oral precancer and cancer	Tobacco and alcohol use; see chapter 29	Tobacco cessation; see chapter 29
Oral manifestations of HIV/AIDS	See chapter 18	See chapter 18. Special oral care
Noma (cancrum oris)	Probably bacterial in connection with severe malnourishment	Antibiotics together with nutritional support; surgery sometimes necessary
Developmental disorders	Various genetic or environmental causes such as tobacco use	Tobacco cessation programs aimed at pregnant mothers
Fluorosis of teeth	Too high concentration of fluoride in drinking waters or from other sources	Identification of water sources and reduction of fluoride or recommendation of other water sources

Source: Authors; partly based on Bratthall and Barmes 1993.
Note: This table is by no means complete. Many other oral diseases or conditions are important and need attention. The listed ones are of special relevance for developing countries.

through better quality of children's diet. Some prevention strategies for oral health, suitable for developing countries are outlined in table 38.3.

RESEARCH AND FUTURE ACTIONS

Several promising actions against factors causing the two major oral diseases, caries and periodontal disease, are ongoing: attempts to control the formation of the biofilm with its microflora are of high priority. One research line is to identify pathogenic bacteria and try to replace them with genetically modified, less pathogenic bacteria or to eradicate them by antibiotics or antiseptics. Preventing dental caries by a vaccine is not a new idea, and efforts continue. Among other ideas is the use of plantibodies (plant-derived therapeutic antibodies) or genetically modified bacteria, releasing components targeting pathogens. Functional foods, which include various elements in food, may be another future option to control oral diseases. Although pilot or small-scale studies seem promising, it will be several years before such methods can possibly be of use in populations because large clinical trials have not even started.

Saliva is believed to be usable as a diagnostic tool, providing noninvasive assessment of a number of oral and systemic diseases. Devices are being designed to identify in saliva various bacteria and their virulence factors, drugs, metabolic products, hormones, biomarkers for oral cancer, inflammatory mediators, and more. Future developments may result in other affordable and effective devices.

Continuous attempts are being made to assess the sociobehavioral factors in oral health and the information on risk factors. Caries risk assessment models are tested also for the individual cases. Through present knowledge, individuals in need of targeted actions can be identified. Another strong trend is to use evidence-based reviews. This type of research is, of course, not restricted to oral health. Several reviews have already been done, and a frequent conclusion is that the number of randomized clinical trials is limited, in particular for common clinical procedures. This trend will change as the quality of future oral health research improves, but not all research problems can be solved by such studies. Community-based participatory research is another approach that may be used to improve oral health studies (O'Fallon and Dearry 2002).

Within the management of dental diseases—in particular, caries—is the "minimally invasive dentistry" approach, which promotes the concept that large restorations (crowns, bridges) are not as necessary as believed. Risk assessment, preventive measures, and improved dental materials with good adhesion capacity are some of the several components in this approach.

Research in transfer of knowledge using the Internet or other electronic media is another strongly expanding area, from which developing countries should be able to benefit.

COST-EFFECTIVENESS OF ORAL HEALTH CARE

Using the evidence available, the U.S. Surgeon General's report (U.S. Public Health Service 2000) and the report of the Swedish Council on Technology Assessment in Health Care (SBU 2002; see also Kallestal and others 2003) have attempted to determine the cost-effectiveness of oral health intervention programs from developed countries.

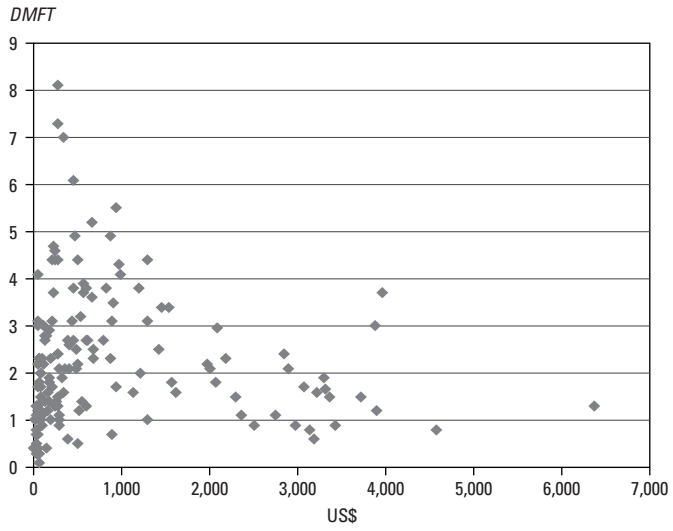
Among the findings in the U.S. report were the following:

- Water fluoridation costs about a dollar per person per year for water serving most individuals in the United States. Community water fluoridation is believed to be an effective and cost-effective caries preventive method.
- Economic analyses of community dental sealant programs suggest that they are cost-effective and may even provide cost savings when used in high-risk populations.

The Swedish report (SBU 2002), reviewing original studies on economic evaluation of caries prevention (a total of 17 selected from 1966 to 2003 MEDLINE and manual Internet searches), commented that no conclusion could be drawn owing to the low evidence values and contradictory results. This comment prompted the group to present its own calculation for cost-effectiveness based on Swedish caries prevalence and charges used in Swedish dental care. The group found that the cost-effectiveness for fluoridated toothpaste is extremely good (cost per prevented DMFT very low), which, of course, is not surprising, given the significant caries-reducing results in combination with low cost for society.

No clear correlation appears to exist between caries experience and health care investment for individual countries. Some countries with the lowest health care expenditures have values for caries experience (DMFT) that are similar to or even lower than those countries having the highest expenditures on health (figure 38.2). Those low-income countries often have low per capita sugar consumption and, therefore, do not need to install expensive measures for treatment or prevention.

It may seem surprising that so few studies are available regarding the cost-effectiveness of caries prevention, or of any other oral disease. In a critical review article, Schwarz (1998) analyzed the issue. He wrote, "Several decades after considerable improvements in the oral disease situation were documented in Scandinavia, doubts are still expressed about whether preventive measures are cost-effective." In addition, he recommended that four elements be considered when a preventive effect was evaluated: the definition of prevention, the practical perception of effective prevention, the appropriateness of traditional cost-effectiveness analysis, and the time factor. He pointed out that "caries prevention is not uniformly defined by the profession, that dental research is casting doubt



Source: For health expenditure: http://www.who.int/en/; for DMFT: http://www.whocollab.od.mah.se/index.html, both for June 2003.

Note: Original data for health expenditures were in international dollars and were converted to U.S. dollars using the exchange rate of US$1 = 0.70681 (period average June 2003). Because the exchange rate varies over time, the data should be taken as approximate values.

Figure 38.2 DMFT as Related to Health Care Expenditure per Capita for 12-Year-Olds in 149 Countries

on the effectiveness of traditionally accepted preventive measures, that political pressures on health care are motivated by economic pressures." Finally, he stated that traditional cost-benefit and cost-effectiveness analyses have not been able to help the decision makers choose wisely and that the time perspective for the real effects of prevention lies beyond the interests of decision makers.

However, without proper prevention, the alternative strategy is restorative dentistry—that is, to make fillings, crowns, and dentures. Is this a feasible alternative for developing countries? Yee and Sheiham (2003) give some examples: In Nepal, a simple amalgam filling would cost about US$4, which does not include the many additional expenses for impoverished rural families, who may have to travel by bus or walk for a day or two to get to the clinic. The total expenses incurred, including dental fees, meals, and lodging but not including lost wages, would amount to US$12, an enormous sum considering the average Nepalese's earning of US$0.75 per day, and it is enough to buy food for a month. Yee and Sheiham conclude that treating caries with the traditional method of restorative dentistry is beyond the financial capabilities of most low-income nations because three-quarters of these countries do not even have sufficient resources to finance an essential package of health care services for their children. Yee and Sheiham (2003) estimate that treating dental caries by the traditional amalgam restorative dentistry in the permanent dentition of the child population would cost about US$2,000 for 1,000 children of mixed ages from 6 to 18 years, which would require financial

resources beyond the capabilities of low-income nations. Hence, they propose a public health and health promotion approach to reduce caries burden instead of the restorative approach.

Although several studies evaluating the effectiveness of intervention and oral health promotion programs in developing countries are becoming available (Estupinan-Day and others 2001; Pakhomov and others 1995; Petersen and others 2004), a definite need exists for further cost-effectiveness analysis on such programs, which should be addressed in the future. It would also be useful if studies were commenced on intervention programs using the common-risk approach suggested by WHO (Petersen 2003).

CONCLUSIONS

Dental caries and periodontal diseases are the most known oral diseases, but other conditions can strongly and negatively influence the quality of life. Effective programs to reduce the burden of oral diseases—in particular, caries—are available in principle, but to run these programs in developing countries, new approaches are needed. The WHO strategy of identifying common risk factors seems promising for health promotion. In broad terms, the most important challenges for oral health in the 21st century relate to the transfer of knowledge and experiences in preventive oral care to the poor and disadvantaged population groups in both developing and developed countries.

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REFERENCES

Abayaratna, S., and K. Krishnarasa. 1997. *National Oral Health Survey 1994–95*. Colombo: Ministry of Health.

Adyatmaka, A., U. Sutopo, P. Carlsson, D. Bratthall, and G. Pakhomov. 1998. *School-Based Primary Preventive Programme for Children: Affordable Toothpaste as a Component in Primary Oral Health Care—Experiences from a Field Trial in Kalimantan Barat, Indonesia*. Geneva: World Health Organization.

Arendorf, T. M., B. Bredekamp, C. A. Cloete, and G. Sauer. 1998. "Oral Manifestations of HIV Infection in 600 South African Patients." *Journal of Oral Pathology and Medicine* 27: 176–79.

Armfield, J. M., K. F. Roberts-Thomson, and A. J. Spencer. 2003. *The Child Dental Health Survey, Australia 1999: Trends across the 1990s*. Adelaide: Australian Institute of Health and Welfare. http://www.cecdo.org/pages/database%20intro.html.

Axell, T. 1976. "A Prevalence Study of Oral Mucosal Lesions in an Adult Swedish Population." *Odontologisk Revy* 27 (Suppl. 36): 1–103.

Barmes, D. E. 2000. "Public Policy on Oral Health and Old Age: A Global View." *Journal of Public Health Dentistry* 60: 335–37.

Beltran-Aguilar, E. D., S. Estupinan-Day, and R. Baez. 1999. "Analysis of Prevalence and Trends of Dental Caries in the Americas between the 1970s and 1990s." *International Dental Journal* 49: 322–29.

Bratthall, D. 2000. "Introducing the Significant Caries Index Together with a Proposal for a New Global Oral Health Goal for 12-Year-Olds." *International Dental Journal* 50: 378–84.

Bratthall, D., and D. E. Barmes. 1993. "Oral Health." In *Disease Control Priorities in Developing Countries*, ed. D. T. Jamison, W. H. Mosley, A. R. Measham, and J. L. Bobadilla, 647–59. Washington, DC: World Bank.

Bratthall, D., G. Hänsel-Petersson, and H. Sundberg. 1996. "Reasons for the Caries Decline: What Do the Experts Believe?" *European Journal of Oral Sciences* 104: 416–22.

Burt, B. A. 2002. "Fluoridation and Social Equity." *Journal of Public Health Dentistry* 62: 195–200.

Carr, L. M. 1988. "Dental Health of Children in Australia, 1977–1985." *Australian Dental Journal* 33: 205–11.

Chibole, O. 1987. "Epidemiology of Dental Fluorosis in Kenya." *Journal of the Royal Society of Health* 107: 242–43.

Cohen, L. K. 1990. "Promoting Oral Health: Guidelines for Dental Associations." *International Dental Journal* 40: 79–102.

de Almeida, C. M., P. E. Petersen, S. J. Andre, and A. Toscano. 2003. "Changing Oral Health Status of 6- and 12-Year-Old Schoolchildren in Portugal." *Community Dental Health* 20: 211–16.

Demertzi, A., and V. Topitsoglou. 2002. "Caries Prevalence of 11-Year-Olds between 1989–2001." Abstract. *Community Dental Health* 19: 203.

Downer, M. C. 1994. "The 1993 National Survey of Children's Dental Health: A Commentary on the Preliminary Report." *British Dental Journal* 176: 209–14.

"Early Diagnosis and Prevention of Oral Cancer and Precancer: Report of Symposium III." 1995. *Advanced Dental Research* 9: 134–37.

Enwonwu, C. O. 1995. "Noma: A Neglected Scourge of Children in Sub-Saharan Africa." *Bulletin of the World Health Organization* 73: 541–45.

Enwonwu, C. O., W. A. Falkler, and E. O. Idigbe. 2000. "Oro-Facial Gangrene (Noma/Cancrum Oris): Pathogenetic Mechanisms." *Critical Reviews in Oral Biology and Medicine* 11: 159–71.

Estupinan-Day, S. R., H. Baez, R. Horowitz, R. Warpeha, B. Sutherland, and M. Thamer. 2001. "Salt Fluoridation and Dental Caries in Jamaica." *Community Dentistry and Oral Epidemiology* 29: 247–52.

Ferlay, J., F. Bray, P. Pisani, and D. M. Parkin. 2001. *GLOBOCAN 2000: Cancer Incidence, Mortality and Prevalence Worldwide*. Version 1.0. IARC CancerBase, International Agency for Research on Cancer, Lyon. http://wwwdep.iarc.fr/globocan/globocan.htm.

Flanders, R. A. 1987. "Effectiveness of Dental Health Educational Programs in Schools." *Journal of the American Dental Association* 114: 239–42.

Frencken, J. E., K. Borsum-Andersson, F. Makoni, F. Moyana, S. Mwashaenyi, and J. Mulder. 2001. "Effectiveness of an Oral Health Education Programme in Primary Schools in Zimbabwe after 3.5 Years." *Community Dentistry and Oral Epidemiology* 29: 253–59.

Genco, R. J. 1996. "Current View of Risk Factors for Periodontal Diseases." *Journal of Periodontology* 67: 1041–49.

Greenspan, J. S., and D. Greenspan. 2002. "The Epidemiology of the Oral Lesions of HIV Infection in the Developed World." *Oral Diseases* 8 (Suppl. 2): 34–39.

Guinan, J. C., R. Bakayoko-Ly, M. Samba, A. L. Kattie, and A. E. Oka. 1999. "Caries Assessment of School Children 12 Years of Age in 1996 in Ivory Coast." *Tropical Dental Journal* 22: 48–54.

Haugejorden, O. 1994. "Changing Time Trend in Caries Prevalence in Norwegian Children and Adolescents." *Community Dentistry and Oral Epidemiology* 22: 220–25.

Hescot, P., and E. Roland. 2000. *La santé dentaire en France, 1998.* L'Union Française pour la Santé Bucco-Dentaire, Paris.

Hewson, A. R., and C. M. McNamara. 2000. "Cleft Lip and/or Palate in the West of Ireland, 1980–1996." *Special Care in Dentistry* 20: 143–46.

Hodgson, T. A. 1997. "HIV-Associated Oral Lesions: Prevalence in Zambia." *Oral Diseases* 3 (Suppl. 1): 46–50.

Holmes, H. K., and L. X. G. Stephan. 2002. "Oral Lesions of HIV Infection in Developing Countries." *Oral Diseases* 8 (Suppl. 2): 40–43.

Hong Kong, Department of Health. 2003. *Oral Health Survey 2001.* http://www.info.gov.hk/tooth_club/survey_eng.htm.

Honkala, E., L. Kannas, and J. Rise. 1990. "Oral Health Habits in 11 European Countries." *International Dental Journal* 40: 211–17.

Hugoson, A., G. Koch, T. Bergendal, A. L. Hallonsten, C. Slotte, B. Thorstensson, and H. Thorstensson. 1995. "Oral Health of Individuals Aged 3–80 Years in Jönköping, Sweden, in 1973, 1983 and 1993." *Swedish Dental Journal* 19: 243–60.

Ikeda, N., Y. Handa, S. P. Khim, C. Durward, T. Axell, T. Mizuno, and others. 1995. "Prevalence Study of Oral Mucosal Lesions in a Selected Cambodian Population." *Community Dentistry and Oral Epidemiology* 23: 49–54.

Irigoyen, M. E., and G. Sanchez-Hinojosa. 2000. "Changes in Dental Caries Prevalence in 12-Year-Old Students in the State of Mexico after 9 Years of Salt Fluoridation." *Caries Research* 34: 303–7.

Kallestal, C., A. Norlund, B. Soder, G. Nordenram, H. Dahlgren, L. G. Petersson, and others. 2003. "Economic Evaluation of Dental Caries Prevention: A Systematic Review." *Acta odontologica Scandinavica* 61: 341–46.

Kloos, H., and R. T. Haimanot. 1999. "Distribution of Fluoride and Fluorosis in Ethiopia and Prospects for Control." *Tropical Medicine and International Health* 4: 355–64.

Latvia, State Dentistry Centre. 2000. *Annual Report of Dental Health Care in Latvia.* Riga: State Dentistry Centre.

Leous, P., and P. E. Petersen. 2002. *Oral Health Status of Schoolchildren in Belarus, 2000.* Copenhagen: WHO Regional Office for Europe.

Lim, A. A., Y. S. Leo, C. C. Lee, and A. N. Robinson. 2001. "Oral Manifestations of Human Immunodeficiency Virus (HIV)–Infected Patients in Singapore." *Annals of the Academy of Medicine, Singapore* 30: 600–6.

Lo, E. C., R. W. Evans, and O. P. Lind. 1990. "Dental Caries Status and Treatment Needs of the Permanent Dentition of 6–12-Year-Olds in Hong Kong." *Community Dentistry and Oral Epidemiology* 18: 9–11.

Malaysia, Dental Services Division. 1997. *Dental Services.* Kuala Lumpur: Ministry of Health.

Mandari, G. J., J. E. Frencken, and M. A. Van't Hof. 2003. "Six-Year Success Rates of Occlusal Amalgam and Glass-Ionomer Restorations Placed Using Three Minimal Intervention Approaches." *Caries Research* 37: 246–53.

Micheelis, W., and E. Reich. 1999. *The Third German Oral Health Study (DMS III).* Cologne, Germany: Deutscher Aerzte-Verlag.

Miyazaki, H., and M. Morimoto. 1996. "Changes in Caries Prevalence in Japan." *European Journal of Oral Sciences* 104: 452–58.

Naidoo, S., and U. M. Chikte. 1999. "HIV/AIDS—The Evolving Pandemic and Its Impact on Oral Health in Sub-Saharan Africa." *South African Dental Journal* 54: 616–30.

———. 2000. "Noma (Cancrum Oris): Case Report in a 4-Year-Old HIV-Positive South African Child." *South African Dental Journal* 55: 683–86.

Nishi, M., J. Stjernsward, P. Carlsson, and D. Bratthall. 2002. "Caries Experience of Some Countries and Areas Expressed by the Significant Caries Index." *Community Dentistry and Oral Epidemiology* 30: 296–301.

Nithila, A., D. Bourgeois, D. E. Barmes, and H. Murtomaa. 1998. "WHO Global Oral Data Bank, 1986–96: An Overview of Oral Health Surveys at 12 Years of Age." *Bulletin of the World Health Organization* 76: 237–44.

Nittayananta, W., and S. Chungpanich. 1997. "Oral Lesions in a Group of Thai People with AIDS." *Oral Diseases* 3 (Suppl. 1): S41–45.

O'Fallon, L. R., and A. Dearry. 2002. "Community-Based Participatory Research as a Tool to Advance Environmental Health Sciences." *Environmental Health Perspectives* 110 (Suppl. 2): 155–59.

Pakhomov, G. N., K. Ivanova, I. J. Moller, and M. Vrabcheva. 1995. "Dental Caries-Reducing Effects of a Milk Fluoridation Project in Bulgaria." *Journal of Public Health Dentistry* 55: 234–37.

Papapanou, P. N. 1999. "Epidemiology of Periodontal Diseases: An Update." *Journal of the International Academy of Periodontology* 1: 110–16.

Patton, L. L., J. A. Phelan, F. J. Ramos-Gomez, W. Nittayananta, C. H. Shiboski, and T. L. Mbuguye. 2002. "Prevalence and Classification of HIV-Associated Oral Lesions." *Oral Diseases* 8 (Suppl. 2): 98–109.

Peng, B., P. E. Petersen, M. W. Fan, and B. J. Tai. 1997. "Oral Health Status and Oral Health Behaviour of 12-Year-Old Urban Schoolchildren in the People's Republic of China." *Community Dental Health* 14: 238–44.

Peng, B., P. E. Petersen, B. J. Tai, B. Y. Yuan, and M. W. Fan. 1997. "Changes in Oral Health Knowledge and Behaviour 1987–95 among Inhabitants of Wuhan City, PR China." *International Dental Journal* 47: 142–47.

Petersen, P. E. 1989. "Evaluation of a Dental Preventive Program for Danish Chocolate Workers." *Community Dentistry and Oral Epidemiology* 17: 53–59.

———. 1990. "Self-Administered Use of Fluoride among Danish Chocolate Workers." *Scandinavian Journal of Dental Research* 98: 189–91.

———. 2003. "The World Oral Health Report 2003: Continuous Improvement of Oral Health in the 21st Century—The Approach of the WHO Global Oral Health Programme." *Community Dentistry and Oral Epidemiology* 31 (Suppl. 1): 1–21.

Petersen, P. E., I. Danila, A. Delean, O. Grivu, G. Ionita, M. Pop, and A. Samolia. 1994. "Oral Health Status among Schoolchildren in Romania, 1992." *Community Dentistry and Oral Epidemiology* 22: 90–3.

Petersen, P. E., N. Hoerup, N. Poomviset, J. Prommajan, and A. Watanapa. 2001. "Oral Health Status and Oral Health Behaviour of Urban and Rural Schoolchildren in Southern Thailand." *International Dental Journal* 51: 95–102.

Petersen, P. E., and M. Kaka. 1999. "Oral Health Status of Children and Adults in the Republic of Niger, Africa." *International Dental Journal* 49: 159–64.

Petersen, P. E., and M. A. Lennon. 2004. "Effective Use of Fluorides for the Prevention of Dental Caries in the 21st Century: The WHO Approach." *Community Dentistry and Oral Epidemiology* 32: 319–21.

Petersen, P. E., U. Nyandindi, E. N. Kikiwilu, L. Mabelya, B. S. Lembariti, and V. J. Poulsen. 2002. *Oral Health Status and Oral Health Behaviour of Schoolchildren, Teachers, and Adults in Tanzania.* Geneva: World Health Organization.

Petersen, P. E., B. Peng, and B. J. Tai. 1997. "Oral Health Status and Oral Health Behaviour of Middle-Aged and Elderly People in PR China." *International Dental Journal* 47: 305–12.

Petersen, P. E., B. Peng, B. Tai, Z. Bian, and M. Fan. 2004. "Effect of a School-Based Oral Health Education Programme in Wuhan City, People's Republic of China." *International Dental Journal* 54: 33–41.

Petersen, P. E., and M. Rusu. 2002. *Oral Health Status of Romanian Schoolchildren—National Survey 2000.* Copenhagen: WHO Regional Office for Europe.

Petersen, P. E., and A. M. Torres. 1999. "Preventive Oral Health Care and Health Promotion Provided for Children and Adolescents by the Municipal Dental Health Service in Denmark." *International Journal of Paediatric Dentistry* 9: 81–91.

Pitts, N. B., D. J. Evans, and Z. J. Nugent. 1998. "The Dental Caries Experience of 12-Year-Old Children in the United Kingdom: Surveys Coordinated by the British Association for the Study of Community Dentistry in 1996/97." *Community Dental Health* 15: 49–54.

Pitts, N. B., D. J. Evans, Z. J. Nugent, and C. M. Pine. 2002. "The Dental Caries Experience of 12-Year-Old Children in England and Wales: Surveys Coordinated by the British Association for the Study of Community Dentistry in 2000/2001." *Community Dental Health* 19: 46–53.

Priwe, C. 1998. *The Smiling School Project: A School Based Oral Health Promotion Programme: Mid-Term Progress Report.* Windhoek: Ministry of Health and Social Services.

Ranganathan, K., B. V. Reddy, N. Kumarasamy, S. Solomon, R. Viswanathan, and N. W. Johnson. 2000. "Oral Lesions and Conditions Associated with Human Immunodeficiency Virus Infection in 300 South Indian Patients." *Oral Diseases* 6: 152–57.

Razanamihaja, N., and P. E. Petersen. 1999. "School Based Oral Health Promotion Programmes in Madagascar." In *Health Care Systems in Africa—Patterns and Perspectives*, ed. L. Blegvad, 123–29. Copenhagen: University of Copenhagen Press.

Reichart, P. A. 2001. "Identification of Risk Groups for Oral Precancer and Cancer and Preventive Measures." *Clinical Oral Investigations* 5: 207–13.

SBU (Swedish Council on Technology Assessment in Health Care). 2002. *Att förebygga karies: En systematisk litteraturöversikt.* Gothenburg: Swedish Council on Technology Assessment in Health Care.

Schwarz, E. 1998. "Is Caries Prevention Cost-Effective? Does Anybody Care?" *Acta odontologica Scandinavica* 56: 187–92.

Sector Público. 1999. *Encuesta de salud bucal, En escolares de 11 a 14 años.* Montevideo: Ministry of Public Health.

Sembene, M., A. W. Kane, and D. Bourgeois. 1999. "Caries Prevalence in 12-Year-Old Schoolchildren in Senegal in 1989 and 1994." *International Dental Journal* 49: 73–75.

Shah, N. 2001. "Geriatric Oral Health Issues in India." *International Dental Journal* 51: 212–18.

Sogaard, A. J., and D. Holst. 1988. "The Effect of Different School Based Dental Health Education Programmes in Norway." *Community Dental Health* 5: 169–84.

Soskolne, W. A., and A. Klinger. 2001. "The Relationship between Periodontal Diseases and Diabetes: An Overview." *Annals of Periodontology* 6: 91–98.

Sri Lanka, Ministry of Health. 1985. *National Oral Health Survey, 1983–84.* Colombo: Ministry of Health.

Sudbo, J., and A. Reith. 2003. "Which Putatively Pre-Malignant Oral Lesions Become Oral Cancers? Clinical Relevance of Early Targeting of High-Risk Individuals." *Journal of Oral Pathology and Medicine* 32: 63–70.

Sundberg, H. 2002. *Tandhälsan hos barn och ungdomar 1985–2001.* Newsletter. Swedish National Board of Health and Welfare, Stockholm.

Szoke, J., and P. E. Petersen. 2000. "Evidence for Dental Caries Decline among Children in an East European Country (Hungary)." *Community Dentistry and Oral Epidemiology* 28: 155–60.

Tai, B., M. Du, B. Peng, M. Fan, and Z. Bian. 2001. "Experiences from a School-Based Oral Health Promotion Programme in Wuhan City, PR China." *International Journal of Paediatric Dentistry* 11: 280–91.

Thomson, W. M. 2004. "Dental Caries Experience in Older People over Time: What Can the Large Cohort Studies Tell Us?" *British Dental Journal* 196: 89–92.

Ullah, M. S. 2001. *An Epidemiological Oral Health Study on 12-Year-Old Bangladeshi Schoolchildren.* Thesis, Faculty of Dentistry, Oslo.

U.S. Public Health Service. 2000. *Oral Health in America: A Report of the Surgeon General.* Washington, DC: U.S. Public Health Service. http://www.nidr.nih.gov/sgr/sgrohweb/TOC.htm.

Vanderas, A. P. 1987. "Incidence of Cleft Lip, Cleft Palate, and Cleft Lip and Palate among Races: A Review." *Cleft Palate Journal* 24: 216–25.

van Palenstein Helderman, W. H., L. Munck, S. Mushendwa, M. A. van't Hof, and F. G. Mrema. 1997. "Effect Evaluation of an Oral Health Education Programme in Primary Schools in Tanzania." *Community Dentistry and Oral Epidemiology* 25: 296–300.

van Wyk, P. J. 1994. *National Oral Health Survey, South Africa, 1988/89.* Pretoria: Department of Health.

von der Fehr, F. R. 1994. "Caries Prevalence in the Nordic Countries." *International Dental Journal* 44 (Suppl. 1): 371–78.

Wang, N. J., C. Kalletstal, P. E. Petersen, and I. B. Arnadottir. 1998. "Caries Preventive Services for Children and Adolescents in Denmark, Iceland, Norway and Sweden: Strategies and Resource Allocation." *Community Dentistry and Oral Epidemiology* 26: 263–71.

Wantia, N., and G. Rettinger. 2002. "The Current Understanding of Cleft Lip Malformations." *Facial Plastic Surgery* 18: 147–53.

White, B. A., A. A. Antczak-Bouckoms, and M. C. Weinstein. 1989. "Issues in the Economic Evaluation of Community Water Fluoridation." *Journal of Dental Education* 53: 646–57.

WHO (World Health Organization). 1994. *Fluorides and Oral Health.* Technical Report Series No. 846. Geneva: WHO.

———. 2003. *School Oral Health Promotion.* WHO School Health Information Series 11. Geneva: WHO.

Wierzbicka, M., P. E. Petersen, F. Szatko, E. Dybizbanska, and I. Kalo. 2002. "Changing Oral Health Status and Oral Health Behaviour of Schoolchildren in Poland." *Community Dental Health* 19: 243–50.

Woodward, M., and A. R. Walker. 1994. "Sugar Consumption and Dental Caries: Evidence from 90 Countries." *British Dental Journal* 176: 297–302.

Yee, R., and A. Sheiham. 2003. "Is Treating Caries in Children in Developing Countries by the Restorative Approach a Rational Objective?" *Developing Dentistry* 3: 10–17.

Zadik, D., S. P. Zusman, and A. M. Kelman. 1992. "Caries Prevalence in 5- and 12-Year-Old Children in Israel." *Community Dentistry and Oral Epidemiology* 20: 54–55