

The global increase in dental caries. A pending public health crisis

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ABSTRACT: A current review of the available epidemiological data from many countries clearly indicates that there is a marked increase in the prevalence of dental caries. This global increase in dental caries prevalence affects children as well as adults, primary as well as permanent teeth, and coronal as well as root surfaces. This increase in dental caries signals a pending public health crisis. Although there are differences of opinion regarding the cause of this global dental caries increase, the remedy is well known: a return to the public health strategies that were so successful in the past, a renewed campaign for water fluoridation, topical fluoride application, the use of fluoride rinses, a return to school oral health educational programs, an emphasis on proper tooth brushing with a fluoride dentifrice, as well as flossing, a proper diet and regular dental office visits. If these remedies are not initiated, there could be a serious negative impact upon the future oral health (and systemic health) of the global community, as well as a strain on the dental profession along with a major increase in the cost of dental services. (*Am J Dent* 2009;22:3-8).

CLINICAL SIGNIFICANCE: A current review of the available epidemiological data from many countries clearly indicates that there is a marked increase in the prevalence of dental caries. If remedies are not initiated, there could be a serious negative impact upon the future oral health (and systemic health) of the global community, as well as a strain on the dental profession and a major increase in the cost of dental services.

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Introduction

During the past decades the common consensus from many reports worldwide was that dental caries had declined significantly and was continuing to decline in populations. The dental community has prided itself on efforts that have reduced dental caries including use of systemic and topical fluorides, toothpastes, sealants, improvements in diet, oral health education and dental care.^{1,2}

There are however, recent studies that report alarming increases in caries (Table 1). These increases are in children and adults, primary and permanent teeth, and include coronal and root surfaces. The emerging public health issues are related to disparities in prevalence and treatment of dental caries. An important facet is the social impact of differences in dental caries for specific groups of individuals throughout the world. The increases in caries appear to occur in lower socioeconomic groups, new immigrants and children. While causes for these increases in caries are unclear, it is possible that the benefits of prevention are not reaching these groups.

Recent trends in the use of bottled *versus* fluoridated tap water and dietary changes may be responsible. The caries increases and disparities could be brought about from changes in world demographics. The influx of immigrants has been occurring in Europe, the United States, and Asia. Changes in oral health are occurring due to shifts in populations. The large movements of rural people to urban centers in search of new manufacturing jobs in Asia and other countries have spawned entire cities. These populations have left the rural farming life for urban labor with the attending negative changes in diet, lifestyle and health.³

It is important for public health to be cognizant of deterioration in the level of oral health and dental caries so that efforts can be increased toward prevention of these problems. We cannot be lax with thoughts that dental caries is

Table 1. Dental caries prevalence, on an individual basis, from the studies that are referred to in this review.

Age	Prevalence (%)	Sample size	Country	Year
5-9	50	1,598	USA	2004
17	78	3,249	USA	2004
6	97.1	4,050	Philippines	2006
6-12	92.3	1,200	Philippines	2005
2-6	59-92	993	Philippines	2003
3-5	55	2,014	China	2007
5-74	100	350,000	China	2008
5	76	140,712	China	2002
5-6	84	1,587	China	2001
6	89.4	178	Taiwan	2006
1-6	52.9	981	Taiwan	2006
0-5	40	1,487	Brazil	2007
1-2.5	20	186	Brazil	2007
12	53.6	1,151	Brazil	2004
7-9	78.5	121	Argentina	2006
6-12	90.2	3,048	Mexico	2006
6-9	34.7	452	Mexico	2006
8	50	5,580	UK	2003
12	59.8	48,168	Norway	2006
12	86	117	Armenia	2005

not a problem today and that it will continue to decline.

Several recent reports have presented concerns with the levels of caries that have been identified in populations in diverse parts of the world.

Review of Literature

United States

According to the United States Surgeon General's report,⁴ dental caries is stated to be the most common chronic childhood disease of children aged 5 to 17 years and is five times more common than asthma and seven times more common than hay fever. The magnitude and severity of dental caries in primary and permanent teeth continue to be a major

problem and should receive special attention.

Poor oral health is detrimental for children since it affects their nutrition, growth and development. Childhood oral disease, if untreated, leads to pain, development of dentofacial anomalies and other serious health problems, such as severe toothache, dental abscess, destruction of bone, and spread of infection *via* the bloodstream.⁴ The social impact of oral diseases in children is very high. More than 51 million school hours are lost every year to dental-related illness.⁴ Poor children have almost 12 times more restricted activity days due to dental-related illness than children from higher-income families.⁴ Dental caries can affect a child's eating habits and nutritional intake, potentially influencing growth and early childhood development and school readiness. Pain and infection from dental caries leads to poor school attendance and problems in eating, speaking, and learning.

Tooth decay or early loss of teeth may lead to malnutrition and other health problems. Caries and its complications affect the quality of life, both physically and physiologically. Premature loss of primary teeth can result in a variety of adverse consequences, such as gastro-intestinal disorders, esthetic and psychological problems. Early childhood caries may dramatically increase a child's risk for future dental caries.

Scientific research continues to make progress in identification of best practices for diagnosing, treating, and preventing dental caries. Traditional approaches for treating carious lesions in a surgical manner are being replaced by newer strategies that emphasize disease prevention and conservation of tooth structure.

In the United States, over 50% of 5-9 year-old children have at least one cavity or restoration, and that proportion increases to 78% among 17 year-olds. There are striking disparities in dental disease by income. Poor children suffer twice as much dental caries as their more affluent peers, and their disease is more likely to be untreated. These poor/non-poor differences continue into adolescence. One out of four children in America is born into poverty, and children living below the poverty line (annual income of \$17,000 for a single family of four) have more severe and untreated decay. Professional care is necessary for maintaining oral health, yet 25% of poor children have not seen a dentist before entering kindergarten. Medical insurance is a strong predictor of access to dental care. Uninsured children are 2.5 times less likely than insured children to receive dental care. Children from families without dental insurance are 3 times more likely to have dental needs than children with either public or private insurance. For each child without medical insurance, there are at least 2.6 children without dental insurance. Medicaid has not been able to fill the gap in providing dental care to poor children.

Fewer than one in five Medicaid-covered children received a single dental visit in a recent yearlong study period. Although new programs such as the State Children's Health Insurance Program (SCHIP) may increase the number of insured children, many will still be left without effective dental coverage. Despite marked declines in caries in the past 30 years, dental caries in pre-schoolchildren remains a major dental public health problem in most countries and is a serious public health problem in disadvantaged communities in both

developing and industrialized countries.⁵

Oral health disease prevalence data was reported recently from the continuous United States National Health and Examination Survey (NHANES) from 1988-1994 and 1999-2004.⁶ These studies included between 10,000 and 15,000 children aged 2-11 years and is therefore one of the most important statistical representations of the oral health of the civilian United States population. Important differences were documented in disease prevalence and severity by sociodemographic characteristics. No reductions were observed in the prevalence and severity of dental caries in primary teeth during the 10-year period of each survey. This is in contrast to the caries reductions reported in previous studies and has caused alarm among dental public health professionals. A large percentage of untreated tooth decay was found across all age groups and socio-demographic characteristics.⁶

Philippines

Reports from a National Oral Health Survey in the Philippines⁷ reported urgent needs with 97.1% of 6 year-olds with dental caries and 84.7% with symptoms of dental infection. An index to identify treatment revealed no treatment was provided for the 4,050 children examined, representing the 12 million public elementary school population of the Philippines. Twenty percent of 6 year-olds and 16% of 12 year-olds reported pain or discomfort in their mouths.⁷

Another recent study⁸ in the Philippines examined 1,200 schoolchildren aged 6 to 12 years. The overall prevalence of caries was 92.3%. The primary dentition showed 71.7% prevalence while the permanent dentition had 68.2%. Untreated decayed teeth dominated the scores reflecting the high level of unmet treatment needs.

In the Northern Philippines, a study⁹ of 993 children aged 2 to 6 years reported a Decayed, Missing and Filled Teeth Index (DMFT) caries prevalence from 59% (4.2 DMFT) to 92% (10.1 DMFT). Caries was diagnosed using World Health Organization (WHO) criteria. Only obvious frank cavitation was recorded as caries. The authors stated that caries rates were similar to those of developing countries with untreated lesions dominating all ages.

China

In 2007, a report¹⁰ of a cross-sectional survey was conducted on a representative sample of Chinese preschool-children aged 3-5 years. The sample included 2,014 children and examinations were conducted using the World Health Organization (WHO) criteria. Results demonstrated a prevalence of 55% with regular dental caries and 14% with rampant dental caries. Caries prevalence and severity increased with age. A high proportion of young children had dental caries and most decayed teeth were untreated.

A study¹¹ from 2005 describes the caries status and oral related behaviors of 3-5 year-old children in Guangxi Province, China. Representative samples of 957 children from two ethnic groups were examined. Overall, 60% of children had dental caries. Rampant caries ranged from 9% to 13% for ethnic groups. For both groups decayed teeth dominated the caries indices. A high level of caries was demonstrated in

these groups. A report¹² in 2002 on a National Survey of Oral Health in China included a total of 140,712 individuals aged from 5-74 years. The study included representative samples of provinces, districts, townships and cluster sampling. For age 5, more than 76% of children had caries with a mean DMFT caries score of 4.5. Among 65-74 year olds, there was a high incidence of root surface caries.

In 2001, Wong *et al*¹³ and others published data on 1,587 children, aged 5-6 years and 1,576 children 12 years of age in Guangdong Province. The overall weighted prevalence of dental caries (DMFT) was 84% for the younger children while for the older group the DMFT caries score was 42%. Rural children in both groups had higher caries attack rates. Decayed teeth accounted for most of the caries experience.

In 2008, Deyu Hu presented a report entitled *Dental Caries Trends in China from a Review of three National Health Surveys* (Chinese Society of Preventive Dentistry, Chinese Stomatological Association, unpublished data, 2008) which presented the results from oral health assessments conducted in over 70 provinces and cities. The total number of subjects in the three surveys was over 350,000, and included all age groups, from 5 to 74 years. The results of the surveys reported as follows: (1) the number of untreated caries in the primary teeth of 5-6 years olds showed no improvement over the past 10 years; (2) the permanent teeth of adults aged 35-44 and 65-74 years have more caries and less restorations; and (3) root surface caries in the older population has become more common.

Taiwan

In Taiwan, a two stage sampling method was utilized to assure random sampling from the entire country.¹⁴ A total of 5,625 house units were sampled which resulted in 981 children less than 6 years of age being included in the study. By age 6, 89.38% of children had caries. The prevalence of dental caries for all children combined was 52.9%. The authors reported a high level of untreated caries among children.

Brazil

A 2007 study in Brazilian preschoolers showed high levels of caries in primary teeth.¹⁵ The sample included 1,487 children from 0-5 years of age in government nurseries in Southern Brazil. Trained examiners conducted dental examinations. Forty percent of the children had caries and the caries increment increased with age. Caries was significantly higher in children with mothers of low education and low family income.

A longitudinal study¹⁶ was reported in Bahia, Brazil where the water supply is optimally fluoridated. The sample included 186 children from 12-30 months of age. Caries detection was conducted at the initial examination and an examination 1 year later. A low prevalence of dental caries (6.4%) was recorded at the initial examination, but caries increased threefold (20%) with new disease being observed during the study period. With children who had caries at baseline, the prevalence doubled at the 1-year interval. These increases occurred in spite of water fluoridation in the community.

In 2000, an epidemiological survey¹⁷ was conducted in São Paulo, Brazil among 1,151 randomly selected school-children. For 5 year-olds, the prevalence of primary teeth dental caries was 45.8%, while for 12 year-olds the prevalence of dental caries in the permanent dentition was 53.6%.

Peru

A study¹⁸ was reported in 2006 from Lima, Peru using a stratified cluster sample of 121 children aged 7 to 9 years. The authors state that dental caries in the primary dentition is a risk indicator for caries in the permanent dentition. Clinical examination results showed a prevalence of dental caries in the permanent dentition to be 78.5%.

Mexico

A cross sectional study¹⁹ with 3,048 children aged 6-12 years in Mexico was reported in 2006. Mean age was determined to be 8.81 years with a primary dentition caries prevalence of 90.2%. In the permanent dentition, caries prevalence was reported to be 82%. The majority of the children (81.1%) needed restorations of at least two tooth surfaces. Caries experience increased with age.

A longitudinal study²⁰ of the permanent dentition was reported on 6-9 year-olds in Campeche, Mexico. Two calibrated examiners conducted dental examinations. Prevalence of caries in permanent teeth increased from year 1999 to 2000 by over 20%. The percentage of children with new dental caries increased from 14.2% to 34.7%. The authors concluded that the study demonstrated significant increments in dental caries in as short a time period as 18 months, stating that priorities need to be set to identify children who will likely develop new caries so that preventive methods can be provided.

United Kingdom

The 2003 United Kingdom Children's Dental Health Survey,²¹ commissioned by the four United Kingdom Health Departments, is the fourth in a series of National Children's Dental Health surveys that have been carried out every 10 years since 1973 in England and Wales and in the whole of the United Kingdom since 1983. The survey provides information on the dental health of children in the United Kingdom, measures changes in oral health since the last survey in 1993 and provides information on children's experiences of dental care and treatment and their oral hygiene. The 2003 survey was based upon a representative sample of children aged 5, 8, 12, and 15 years of age attending government maintained and independent schools in the United Kingdom. A total of 12,698 children were sampled within participating schools and asked to take part in a dental examination at school. In total, 10,381 children were examined, a response rate of 82%. Background data on children's oral hygiene and dental care which were requested by questionnaire from the parents of a random sub-sample of 5,480 examined children. In total, 3,342 questionnaires were returned, a response rate of 61%.

Over four out of 10 children showed signs of obvious decay experience by the age of 5 years, while over half (57%) of 8 year-olds had obvious decay experience. There were no

Table 2. Countries with post 1995 data available that have not achieved the WHO Goal 2000 of a DMFT dental caries of less than 3.0 for 12 year-olds.

Region/Country	DMFT	Year
Europe		
Bosnia and Herzegovina	8.6	1998
Bulgaria	4.2	1998
Croatia	3.5	1999
Czech Republic	3.4	1998
Hungary	3.8	1996
Latvia	4.2	1998
The Former Yugoslav Republic of Macedonia	3.6	1996
Poland	4.1	1999
Russian Federation	3.7	1995
Slovakia	4.3	1999
Eastern Mediterranean		
Jordan	3.3	1995
The Americas		
Bolivia	4.7	1995
Brazil	3.1	1996
Chile	4.1	1996
Costa Rica	4.8	1996
Dominican Republic	4.4	1997
Honduras	3.7	1997
Panama	3.6	1997
Western Pacific		
Republic of Korea	3.1	1995
Philippines	4.6	1998
Tokelau	4.8	1999

Sources: World Health Organization;²⁷ Moynihan & Petersen.²⁸

statistically significant changes between the 1993 and 2003 surveys in the proportion of 5 and 8 year olds with obvious caries or teeth with caries extending from the enamel layer into the dentin layer in primary teeth.

Children attending deprived primary schools were reported to have experienced more tooth decay than children in non-deprived schools. In deprived schools, 60% of 5 year-olds and 70% of 8 year-olds had obvious tooth decay experience in their primary teeth, compared with 40% of 5 year-olds and 55% of 8 year-olds attending non-deprived schools. In permanent teeth, 55% of 12 year-olds and 72% of 15 year-olds attending deprived schools had obvious tooth decay experience compared with 42% of 12 year-olds and 55% of 15 year-olds in non-deprived schools.

The survey identified a relationship between socio-economic status and obvious tooth decay experience. For example, a lower proportion of 5 year-olds (34%) from managerial and professional backgrounds had obvious tooth decay in primary teeth than 5 year-olds from routine and manual labor backgrounds (53%). Among 15 year-olds, children from managerial and professional backgrounds had lower incidence of obvious tooth decay (47%) compared with those from intermediate (66%) and routine and manual labor backgrounds (65%). Although few children had lost teeth due to tooth decay, more 15 year-olds from routine and manual labor backgrounds (7%) had teeth extracted due to tooth decay than 15 year-olds from managerial and professional backgrounds (2%).

Norway

Data²² reported from Norway for the years 1985-2004 show a reversal of caries decline and similar trends of increasing caries in permanent teeth of children aged 12 years. This study included samples of over 50,000 children using aggregated data reported from clinics to the national level. Results indicated a linear decline in caries in 12 year-old children from 1985 to 2000. This decline was followed by a rise in caries from 2000 to 2004. The increase was 3.3% per year, in contrast to a decline of 3.0% before 2000. More 12 year-old Norwegian children were affected by caries in 2004 than in 2000 (59.8% versus 52.2%).

Armenia

There are very limited data available on many post-Soviet Republics concerning the prevalence of dental caries. One study²³ conducted by the American University of Armenia in 2005 reported an 86% prevalence of dental caries in a sample of 12 year-old schoolchildren. As with many similar countries, Armenia does not have the benefits of water fluoridation or other similar preventive methods.

Palestine

A recent oral health survey²⁴ in the Palestinian West Bank area among Palestinian schoolchildren reported a very high mean DMFT caries score of 6.5. The authors concluded that these results indicate a population of schoolchildren at a high caries risk, demanding immediate public health intervention.

India

A very extensive and comprehensive National Health Survey²⁵ was conducted in 2004 throughout the entire country of India in order to ascertain the oral health status and prevalence of dental disease in representative age groups. The following percent prevalence of dental caries was reported for the various age groups examined, for both coronal and root surfaces:

- 51.9% in 5 year-old children
- 53.8% in 12 year-old children
- 63.1% in 15 year-old teenagers
- 80.2% in adults aged 35-44 years-old
- 85.0% in adults aged 65-74 years-old

The report concluded that a preventive dentistry program, such as water fluoridation, should be initiated to address this national crisis in dental caries.

World Health Organization estimation of global dental caries

A World Health Organization (WHO) estimation of global DMFT for 12 year-old children reported that in the 188 countries included in their database, that on a global basis, 200,335,280 teeth were either decayed, filled or missing among just that age group. This was based on the data available in 2004 from the WHO Oral Health Database, Country/Area Profile Program (CAPP).²⁶ This is why WHO continues to advocate that efforts to improve the overall situation are still highly indicated (Table 2).^{27,28}

Global consultation on oral health through fluoride

In November 2006, dental authorities from across the world gathered in Geneva, Switzerland and Ferney-Voltaire, France under the auspices of the Federation Dentaire Internationale (FDI), the World Health Organization (WHO) and the International Association for Dental Research (IADR) to discuss common issues related to global oral health.²⁹

The following are quotations concerning tooth decay from a joint conference report entitled *Call to Action to Promote Dental Health by Using Fluoride*:

“Eighty experts from thirty countries expressed their deep concern about growing disparities in dental health and the lack of progress in tackling the worldwide burden of tooth decay (dental caries), particularly in disadvantaged populations.”

“The burden of tooth decay affects children, adults and the elderly, disrupts life and causes considerable pain, suffering and economic hardship. Much of the disease remains untreated, particularly in low and middle-income populations.”

Conference in oral health through fluoride for China and Southeast Asia

In September 2007, dental authorities from across the world again gathered in Beijing, China, under the auspices of Federation Dentaire Internationale (FDI), World Health Organization (WHO), International Association for Dental Research (IADR) and the Chinese Stomatological Association (CSA) to discuss issues related to global oral health.³⁰

The following is a quotation from a World Health Assembly Report by the WHO Secretariat entitled *Oral Health: Action Plan for Promotion and Integrated Disease Prevention*, which was distributed at that conference:

“Globally, the burden of oral disease is particularly high among the older people and has a negative effect on their quality of life. In most low and middle income countries, the general population does not benefit from systematic oral health care, nor have preventive programs been established. In some countries the incidence of dental caries has increased over recent years and may further increase as a result of growing consumption of sugar and inadequate exposure to fluoride.”

Journal of Dental Research - Guest editorial

A guest editorial³¹ in the October, 2007 issue of the Journal of Dental Research entitled *A Global Theme – Poverty and Human Development* reported the following:

“Dental caries still affects most children and adults worldwide. Its prevalence in resource-poor nations appears to be increasing, probably due to increasing sugar consumption and the low availability or use of fluorides. Certain populations in resource-rich nations are also disproportionately affected.”

Journal of the American Dental Association - Global theme issue

An article³² in the November, 2007 issue of the Journal of the American Dental Association *Health, Oral Health and*

Poverty reported the following:

“Caries levels for 12 year-olds in developing countries has been increasing constantly and this is particularly alarming owing to the fact that the developing countries represent most of our world.”

Journal of the Canadian Dental Association - President's column

The President of the Canadian Dental Association, Dr. Darryl Smith, in the September, 2007 issue of the Journal of the Canadian Dental Association, in an article entitled *Are we going backwards with prevention?*³³ reported the following:

“With few exceptions, there is agreement on the subject of dental caries: more young children have early childhood caries, school-age children frequently have interproximal caries, and root caries is becoming a significant problem in seniors.”

Russian stomatological investigation

A 2006 epidemiological survey³⁴ of the incidence of stomatological diseases was conducted among 1,030 Russian military personnel. Within the group, a very high level of oral diseases was detected, including gingivitis, periodontitis, oral mucosal disturbances, missing teeth and especially dental caries. It was reported that 100% of the population had carious lesions. The report further states that this high incidence of oral diseases requires the urgent development of recommendations for prophylactic measures to reduce and prevent their occurrence.

A 15-year dental caries prophecy comes true

In 1993, in the preface to the proceedings from a conference on cariology, in a textbook entitled *Cariology for the Nineties*,³⁵ editors William Bowen and Lawrence Tabak wrote the following:

“To many, dental caries has become an intellectual bore – the disease is solved; there are no more scientific challenges; it is time to move on to more challenging fields. Thus, this conference was conceived out of an erroneous notion. We set out to show that caries continues to be a public health problem worldwide; that the enigma of dental caries is worthy of the attention of the finest scientific minds and the application of the most sophisticated techniques from epidemiology to molecular biology.”

Summary and Recommendations

This review of prevalent conditions of dental caries worldwide identifies the need for action by the global dental professional community.

As previously indicated, international research conferences convened over the past 25 years proudly reported that dental caries prevalence was declining on a global basis.

However, during the past decade, the situation has reversed and scientific report after report signal an alarming increase in the global prevalence of dental caries in children and adults, primary and permanent teeth, as well as coronal and root surfaces.

In dealing with this serious dental public health crisis, it is strongly recommend that:

1. An international global summit should be organized to bring researchers together from all parts of the world to examine the evidence and plan strategic efforts to deal with changes in dental caries prevalence.
2. A new global epidemiologic survey should be planned and implemented to scientifically gather important caries information that can help direct resources to stop and reverse the serious deterioration that has been identified with dental caries.
3. A new commitment of the global dental profession to return to the basics of prevention that many populations are not receiving. Efforts should be directed to fluorides, oral hygiene, dietary counseling, dental sealants and other established methods.
4. The commitment of research resources for the development of new anticaries materials and products to be able to bring the best that science and technology have to bear on the problem of dental caries.

In summary, dental caries continues to be a major health concern for populations worldwide with disparities related to well known issues of socioeconomic, immigration, lack of preventive efforts and dietary changes. New and renewed efforts must be marshaled together to focus on combating serious emerging increases in dental caries. Dentistry has the capability and resources to deal with this challenge and the time is now.

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