

Caries Incidence in School Children Included in a Caries Preventive Program: A Longitudinal Study

Laura Emma Rodríguez-Vilchis, Rosalía Contreras-Bulnes,
Felipe González-Solano, Judith Arjona-Serrano,
María del Rocío Soto-Mendieta and Blanca Silvia González-López
*Centro de Investigación y Estudios Avanzados en Odontología,
Facultad de Odontología de la Universidad Autónoma del Estado de México
México*

1. Introduction

Several epidemiological studies (Okawa, et al., 1992; Marthaler & O'Mullane, 1996; Beltrán-Aguilar, et al. 1999; Vrbič, 1996; Brown, et al., 2000; Carvalho, et al., 2001; Estupiñan-Day, et al., 2001; Bönecker, et al., 2003) on dental caries experience in children and adolescents have been carried out around the world for the last three decades. Most of the reports agree that caries has been reduced, and these data have been confirmed by the Global Data Bank of the World Health Organization; however, the distribution and severity of dental caries varies in different parts of the world and within the same region or country.

Caries decline has been observed in children and adolescents from industrialized countries while those living in some less developed countries show a tendency to increase. The reported caries reduction is the result of a number of public health measures, coupled with changing living conditions, lifestyles and improved self-care practices. (Petersen, et al., 2005)

It has been shown that schools provide an important setting for promoting health. (Kwan, et al., 2005) In Mexico, a school-based caries preventive program was established in the 1970's in the State of Mexico as a pioneer program. This program is focused on oral health education and mouth rinse (0.2% NaF) twice a month; however, there are no previous reports that assess the impact of this local program on dental caries prevention. It is assumed that caries will be reduced.

The aim of this study was to evaluate annually the impact of a school-based caries preventive program on the dental status and caries incidence, in Mexican schoolchildren within a three year period.

2. Dental caries

There is now extensive knowledge about the etiology, prevention, diagnostic and treatment of dental caries. Regarding the etiology, the role of bacteria in the production of acid by

fermenting carbohydrates causes the decrease in pH, with the subsequent loss of tooth minerals. The preventive measures include: diet and plaque control (mechanical and chemical methods), use of fluorides (systemic and topical), pit and fissure sealants (Harris & Garcia-Godoy, 1999; Featherstone, 2000; Axelsson, 2000, 2004; Gussy, et al., 2006). Furthermore, strategies to control the disease through risk assessment have been developed, which have also been extensively investigated (Vanobbergen, et al., 2001; Pearce, et al., 2002; Bratthall & Hänsel Petersson, 2005; Featherstone, et al., 2007; Ramos-Gomez, et al., 2010; Gao, et al., 2010). On the other hand, the advance of technology has also developed tools for the proper diagnosis of the lesion incipient such as DIAGNOdent and QLF (Stookey, 2004; Berg, 2007; Tranæus, et al., 2007) as well as the need to detect in epidemiological studies noncavitated lesions (Ismail, et al., 2007). In the treatment of lesion there is a large amount of literature, resources and works focused on prevention of the formation of cavities. Despite all the existing measures for caries control there are no populations free of dental caries in the world.

3. Trends in dental caries

Caries epidemiology continues to be an important issue in both oral health surveillance and research into refined methods for caries diagnosis (Marthaler, 2004). The changing on caries disease patterns throughout the world are closely linked to number of public health measures, including effective use of fluorides, together with changing living conditions, lifestyles and improved self-care practices (Petersen, et al., 2005).

In Europe and specifically in Western Europe the decline in caries prevalence has been very substantial. It has not received much attention until recently but is now often taken for granted. However, caries prevalence is still very different when looking at various parts of Europe, and may undergo unexpected changes due to various factors. Increasing immigration has been identified as a new factor, leading to increases of the overall dental caries prevalence in Switzerland (20% non-Swiss residents), the Netherlands and Germany (Marthaler, 2004). Furthermore, there has been a decline in caries prevalence between 1993 and 2003 in all age groups apart from 3-year-old Sweden children (Jacobsson, et al., 2011).

As levels of oral disease decreased in the 1980s and 1990s, the oral health of children and adults in the UK has been improving steadily since the 1970s. The average number of decayed missing and filled permanent teeth (DMFT; a measure of the severity of caries attack in the permanent dentition) at 12 years fell rapidly in the 1980s and has since shown a further steady decline. This has been matched by an increase in the proportion of children who have no evidence of decay. Thus by 2009, only 33% of 12-year-old children had a mean DMFT>0 (a measure of caries prevalence) and the average decay experience was 0.74 DMFT. Nonetheless, those children with treated or untreated dental caries had, on average, 2.21 DMFT and the care index, which is the proportion of that decay which is filled, was only 47%. In addition there was a marked geographic gradient with the north of England showing higher levels of decay than the south of England. For 5-year-olds there has been an overall decline in the average level of dental disease and an increase in the proportion of children who are decay-free, but the change is less pronounced. Over 20 years, the average number of decayed, missing and filled primary teeth has fallen from 1.80 in 1983 to 1.55 in 2004 (Drugan & Downer, 2011).

On the other hand in the United States of America the caries continues to decline in the permanent dentition for many children but is increasing among poor non-Hispanic whites

aged 6–8 years (8–22%) and poor Mexican-Americans aged 9–11 years (38–55%). Although dental caries in older children continues to decline or remain unchanged, increasing tooth decay among some young children is a concern. Moreover, it is also troublesome that paediatric caries appears to be disproportionately affecting young boys compared with girls considering that there has not been a difference in prevalence of caries between boys and girls observed in national surveys prior to NHANES 1999–2004. Although the increasing prevalence of dental caries appears to be occurring in some of our traditionally 'low-risk' groups such as the nonpoor, primary caries is also increasing in a small number of 'high-risk' groups as well. Our findings suggest that future caries research should be expanded towards better understanding of not only the factors that promote paediatric dental caries among traditionally high-risk children, but also among those once considered low-risk for tooth decay (Dye, et al., 2010).

The prevalence of dental caries in primary teeth of children aged 2–4 years increased from 18% in 1988–1994 to 24% in 1999–2004. Racial disparities persisted in that age group, with caries significantly more prevalent among non-Hispanic black and Mexican American children than among non-Hispanic white children. Caries prevalence in primary teeth of non-Hispanic white children aged 6–8 years remained unchanged, but increased among non-Hispanic black and Mexican American children. State-specific prevalence of caries among third-graders ranged from 40.6% to 72.2%. Caries in permanent teeth declined among children and adolescents, while the prevalence of dental sealants increased significantly. State oral health programs' funding and staffing remained modest, although the proportion of states with sealant programs increased 75% in 2000 to 85% in 2007 and the proportion with fluoride varnish programs increased from 13% to 53% (Tomar & Reeves, 2009).

For most Americans, oral health status has improved since 1988–1994. Dental caries continues to decrease in the permanent dentition for youths, adolescents, and most adults. Among seniors, the prevalence of root caries decreased, but there was no change in the prevalence of coronal caries. However, the prevalence of dental caries in the primary dentition for youths aged 2–5 years increased from 1988–1994 to 1999–2004. The prevalence of dental sealants among youths and adolescents increased. Tooth retention and periodontal health improved for both adults and seniors, and edentulism among seniors continued to decline. Dental utilization (experiencing a dental visit within the past 12 months) remained unchanged between 1988–1994 and 1999–2004 for youths, adolescents, and seniors; however, dental utilization declined for most adults (Dye, et al., 2007).

According to the World Health Organization the dental caries is still a major public health problem in most industrialized countries, affecting 60–90% of schoolchildren and the vast majority of adults. It is also a most prevalent oral disease in several Asian and Latin American countries while it appears to be less common and less severe in most African countries. Currently, the disease level is high in the Americas but relatively low in Africa. In light of changing living conditions; however, it is expected that the incidence of dental caries will increase in the near future in many developing countries in Africa, particularly as a result of growing consumption of sugars and inadequate exposure to fluorides (Petersen, 2003).

Whelton estimated that changes in the progression of caries have been problematic due to the shortage of longitudinal data in the literature for children, adolescents, and young and older adults. The cohort effect, combined with sampling effects and diagnostic differences,

confounds the investigation of the true changes in caries progression with time. The elucidation of the age-related pattern and rate of caries development in successive age cohorts will be important in informing future clinical trial design. In summary, the changes in caries patterns which have an impact on the design of caries clinical trials are:

- the lower caries incidence in children,
- the relatively greater effect of fluorides in preventing caries on approximal surfaces;
- the slower rate of progression of caries,
- the increased risk of primary caries in adults, and
- the increased use of fissure sealants.

These changes indicate that caries continues to be a challenge throughout life. The conduct of clinical trials of caries-preventive agents must now incorporate more sensitive diagnostic methods capable of valid and reliable measurement of caries initiation and progression in its early stages. The application of sophisticated statistical analysis which takes account of the pattern of caries attack will also help to overcome the difficulties posed by these changes in caries patterns. The application of such techniques to dental datasets which have large numbers of tooth-surface variables and multiple observations has been made possible by the increasing capacity of and accessibility to high-speed computers (Whelton, 2004).

4. Fluorides

Fluoride as a caries-preventive agent was discovered as the side effect of fluorosis in teeth in areas with elevated levels of fluoride in the drinking water (Ten Cate, 2004). Research on the oral health effects of fluoride started around 100 years ago. For the first 50 years or so it focused on the link between water borne fluoride – both natural and artificial – and dental caries and fluorosis (Petersen, et al., 2004). It was difficult to determine small (sub-ppm) concentrations of fluoride in drinking water. Nevertheless, the early studies on fluoridation of the drinking water were convincing and initiatives were taken to add various types of fluorides to other oral hygiene products (Ten Cate, 2004). In the second half of the 20th century, fluoride research was focused on the development and evaluation of fluoride toothpastes and rinses and, to a lesser extent, alternatives to water fluoridation such as salt and milk fluoridation.

Fluoride mouthrinses were commonly used in school-based programs with 0.2% NaF solution weekly or fortnightly during the 1960's-1980's, but have now, to great extent, been withdrawn since most children are using fluoride toothpaste. The effect of the rinsing programs was in the range of 20-40% caries reduction (Koch & Poulsen, 2006).

The first test of a fluoride mouthrinse was conducted in the 1940s. An acidified NaF mouthrinse used three times a week, for 1 year by dental students failed to achieve a significant caries reduction, possibly because of very low fluoride concentrations. Fluoride mouthrinse received little attention until the early 1960s, when the effect was extensively evaluated in well-controlled clinical studies as well as in field trials on schoolchildren in Scandinavia, particularly in Sweden. Most of these studies and programs were based on weekly supervised rinsing with a neutral 0.2% NaF solution.

Drinking water is not fluoridated in Sweden, and during the early 1960s effective fluoride toothpaste had not yet become available. In addition, the standard of oral hygiene was very

low. Few schoolchildren cleaned their teeth every day. Therefore, caries prevalence among children was very high, and most children developed several new caries lesions every year. Under these conditions, the introduction of a simple preventive measure, supervised rinsing with 0.2% NaF solutions once a week, resulted in very significant caries reductions (25% to 40%) (Axelsson, 2004).

Several efforts have been made to summarize these extensive data sets through systematic reviews, such as those conducted on water fluoridation by the UK University of York Centre for Reviews and Dissemination; on fluoride ingestion and bone fractures; and on fluoride toothpastes and rinses through the Cochrane Collaboration Oral Health Group. These systematic reviews concluded that:

1. Water fluoridation reduces the prevalence of dental caries (% with dmft /DMFT > 0) by 15% and in absolute terms by 2.2 dmft/DMFT.
2. Fluoride toothpastes and mouth rinses reduce the DMFS 3-year increment by 24–26%.
3. There is no credible evidence that water fluoridation is associated with any adverse health effects.
4. At certain concentrations of fluoride, water fluoridation is associated with an increased risk of unaesthetic dental fluorosis although further analysis suggested that the risk might be substantially greater in naturally fluoridated areas and less in artificially fluoridated areas.
5. There was a paucity of research into any possible adverse effects of fluoride toothpastes and rinses.

Although these findings are important, it must be acknowledged that a lack of fluoride does not cause dental caries (Petersen, et al., 2004).

Not all fluoride agents and treatments are equal. Different fluoride compounds, different vehicles, and vastly different concentrations have been used with different frequencies and durations of application. These variables can influence the clinical outcome with respect to caries prevention and management. The efficacy of topical fluoride in caries prevention depends on a) the concentration of fluoride used, b) the frequency and duration of application, and, to a certain extent, c) the specific fluoride compound used. The more concentrated the fluoride and the greater the frequency of application, the greater the caries reduction (Newbrum, 2001).

In recent years, an increasing number of reports have been published in which the observed caries- preventive effect of fluoride has been lower than could have been expected on the basis of the earlier literature. This is true for both systemic and topical methods such as water fluoridation, fluoridated school milk, fluoride mouthrinses and professional applications of topical fluoride including fluoride varnish applications. The current low levels of caries occurrence and the wide spread use of fluoridated toothpastes as well as other fluoride products and methods have been suggested as reasons for the reduced relative effect of water fluoridation. In the same way, the fact that people are today commonly exposed to fluoride from multiple sources is likely to dilute the effect of fluoride from any single source. The moderate usefulness of added fluoride exposure at the population level today may also be due to the fact that individually applicable fluoride regimes are most likely to reach people who least need them. The individuals whose dental health-related lifestyles are most unfavorable and who are not visiting a dentist regularly

are likely to be least exposed to fluoride, and it is not easy to provide them with any individual protection against caries. The advantage of community water fluoridation is that it reaches even the least advantaged segments of the population. If the risk for caries is high, however, water fluoridation alone cannot provide full protection against the onset of cavities (Hausen, 2004).

The WHO report is quite clear that the post-eruptive effect of sugar consumption is one of the main etiological factors for dental caries and notes in particular the damaging effects of:

1. Refined or processed foods in general.
2. The consumption of sugary soft drinks.
3. Children going to bed with a bottle of a sweetened drink or drinking at will from a bottle during the day.

A WHO/FAO analysis of the evidence on the role of diet in chronic disease recommends that free (added) sugars should remain below 10% of energy intake and the consumption of foods/drinks containing free sugars should be limited to a maximum of four times per day. For countries with high consumption levels it is recommended that national health authorities and decision-makers formulate country-specific and community-specific goals for reduction of consumption of free sugars. However, WHO also notes that many countries currently undergoing nutrition transition do not have adequate fluoride exposure. It is the responsibility of national health authorities to ensure implementation of feasible fluoride programs for their country.

First, it is clear that all countries and communities should advocate a diet low in sugars in accordance with the WHO/FAO recommendations. This has been emphasized most recently in May 2004 at the World Health Assembly by the confirmation of the WHO Global Strategy on Diet, Physical Activity and Health. Secondly, countries with excessive levels of fluoride ingestion, particularly where there is a risk of severe dental fluorosis or of skeletal fluorosis, should maintain a maximum fluoride level of 1.5 mg/l as recommended by WHO Water Quality Guidelines, although this objective is admittedly not always technically easy to achieve. Thirdly, where sugar consumption is high or increasing, the caries-preventive effects of fluorides need to be enhanced.

WHO recommends that every effort must be made to develop affordable fluoride toothpastes for use in developing countries. As a public health measure, it would be in the interest of countries to exempt these toothpastes from the duties and taxation imposed on cosmetics (Petersen, et al., 2004).

Twetman reported strong evidence for a caries-preventive effect of daily use of fluoride toothpaste compared with placebo in the young permanent dentition (PF, 24.9%), that toothpastes containing 1500 ppm of fluoride had a superior preventive effect (additional PF, 9.7%) compared with standard dentifrices of 1000 ppm of fluoride. Also, strong evidence for higher caries reductions with supervised toothbrushing compared with unsupervised brushing was founded. There was incomplete evidence regarding the effect of fluoride toothpaste in the primary dentition. This systematic review reinforces the importance of daily toothbrushing with fluoridated toothpastes for preventing dental caries, although long-term studies in age groups other than children and adolescents are still lacking (Twetman, et al., 2003).

Water fluoridation, where technically feasible and culturally acceptable, has substantial advantages particularly for subgroups at high risk of caries. Alternatively, fluoridated salt, which retains consumer choice, can also be recommended. WHO is currently in the process of developing guidelines for milk fluoridation programs, based on experiences from community trials carried out in both developed and developing countries (Petersen, et al., 2004).

The proposal of salt as a vehicle for fluoride in caries prevention is attributed to Wespi (1948, 1950). In the mid-1950s, domestic salt supplemented by potassium fluoride, up to 90 mg/kg, became available in various cantons of Switzerland.

The first 5-years results following consumption of fluoride-rich domestic salt were published by Marthaler and Schenardi (1962). The documented caries reduction of 32% fewer DMFSs in the permanent teeth of 7-to 9-year-old children was not statistically significant. Only with the subsequent caries data that became available from studies in Colombia (250 mg F/kg as NaF), and Hungary (250 mg F/kg as NaF) was it shown that fluoride-induced caries reductions could reach 50%.

A prerequisite was the availability of domestic salt with a high fluoride concentration. The state of knowledge on the subject, up to the mid-1970s, was summarized by Marthaler (1978). The conclusions were that fluoride ingested via salt prevents dental caries in man, the cariostatic effect being similar to water fluoridation: The fluoride content of salt is adjusted so that urinary fluoride excretion levels are similar to those in areas with optimal water fluoride content (Axelsson, 2004).

Based on the successful results of caries prevention obtained by salt fluoridation program in Switzerland, Hungary, Colombia and other countries, fluoride has been added to the table salt in Mexico from the late 1980s. The Mexican Sanitary Norm indicated that a concentration of 250 mg F/kg of salt should be added. Irigoyen (Irigoyen & Sanchez Hinojosa, 2000) reported that the caries prevalence and the treatment needs experienced in the State of Mexico population have decreased over the last decade. However, dental health is far from optimal, and the state has not achieved the low caries index observed in many developed countries. It is necessary to continue the work with caries prevention programs and to improve access to dental care services. Since there is a National Salt Fluoridation Program already established, no additional systemic sources of fluoride should be implemented; nevertheless, to continue the promotion of the use of fluoridated dentifrices, fluoride rinses and gels, fissure sealants and health education activities could be benefit to the population's oral health status.

Recent literature has revealed instances where a considerable reduction of the level of preventive efforts has not been followed by an increase in caries frequency and vice versa. This must have been due to the fact that the studied preventive methods, that had proved to be effective elsewhere, were not effective and efficient in those particular settings. Since conditions strongly determine the usefulness of caries prevention including different fluoride regimes, more research is still needed to monitor the effectiveness of caries-preventive programs and their components in variable conditions of today and tomorrow (Hausen, 2004).

5. Dental programs for caries prevention

Oral Health is fundamental to general health and well-being. A healthy mouth enables and individual to speak, eat and socialize without experiencing active disease, discomfort or

embarrassments. Children who suffer from poor oral health are 12 times more likely to have restricted-activity days than those who do not. More than 50 million school hours are lost annually because of oral health problems which affect children's performance at school and success in later life (Kawan, et al., 2005).

Basically, erupting teeth are healthy. The first carious lesion and the first restoration in a tooth means the start of series of treatments that during the tooth's lifetime will end up in more and more complicated restorations or treatments if the caries process is not controlled. Today there is enough scientific knowledge about factors that might interfere in this process in order to develop preventive strategies. Operative treatment per se will never control caries. (Koch & Poulsen, 2006).

Minimal intervention is a key phrase in today's dental practice. Minimal intervention dentistry (MID) focuses on the least invasive treatment options possible in order to minimize tissue loss and patient discomfort. Concentrating mainly on prevention and early intervention of caries, MID's first basic principle is the remineralization of early carious lesions, advocating a biological or therapeutic approach rather than traditional surgical approach for early surface lesions. One of the key elements of a biological approach is the usage and application of remineralizing agents to tooth structure (enamel and dentin lesions). These agents are part of a new era of dentistry aimed at controlling the demineralization/remineralization cycle, depending upon the microenvironment around the tooth (Rao & Malhotra, 2011).

School provide man effective platform for promoting oral health because they reach over 1 billion children worldwide. The health and well-being of school staff, families and community members can also be enhanced by programs based in schools. Oral health messages can be reinforced throughout the school years, which are the most influential stages of children's lives, and during which lifelong beliefs, attitudes and skill are developed (Kwan, et al., 2005).

After caries decline of about 80% in children in Western Europe and other industrialized countries, there should be a critical debate about the best way for future caries prevention (Splieth, et al., 2004).

In Europe and Asia, positive results have come from implementing supervised toothbrushing programs in kindergartens and providing free fluoridated toothpaste to high risk children from underprivileged and multicultural groups. Furthermore, a comprehensive staged dental health program and professional fluoride varnish applications proved the possibility of a reduction in early childhood caries in vulnerable groups (Wennhall, et al., 2008).

Multiple fluoride use played an important role in caries reductions achieved in the 1980s and 1990s, but it also resulted in a polarization of lesion distribution in young people: the majority consists of low caries or even lesion-free individuals, while a minority is a so-called high caries risk group which seems not to be open to preventive programs. Last decade studies indicate that frequent fluoride applications (>6 times/year) in conjunction with effective plaque removal can be a successful approach for effective future caries prevention in high caries risk groups. Health promotion programs that are merely educational and do not provide fluoride do not seem to be effective. Alternatively, preventive measures could be performed at home or in a private practice, but only minimal compliance is reached in

high risk groups compared with out-reaching group programs. Thus, group programs are instrumental in providing effective and efficient caries-preventive measures in children. The more expensive time of a dental practice team should be limited to procedures where costly equipment is needed (professional tooth cleaning, sealants, etc.). For efficient caries prevention, measures formerly targeted specifically at either populations, groups, or individuals should be remodeled and aimed to interact in order to achieve optimal oral health in children at a reasonable cost (Splieth, et al., 2004).

School dental screening is a popular public health intervention in many countries throughout the world. In the United Kingdom, school dental screening is a statutory function of local National Health Service (NHS) bodies and has been a feature of children's dental services for the past hundred years (Education Act, 1918).

The process involves a visual dental examination of children in the school setting to identify the presence of dental disease and conditions; parents of children who are screened positive are informed and encouraged to take their child to primary care services for further investigation. The WHO has recently endorsed dental screening of children in the school setting, stating that, "Screening of teeth and mouth enables early detection, and timely interventions towards oral diseases and conditions, leading to substantial cost savings. It plays an important role in the planning and provision of school oral health services as well as health services." Due to the long history of school dental screening in the UK, the aims of this cluster-randomized controlled trial conducted in the UK failed to show that the intervention used in a national school dental screening program significantly reduces active dental caries levels or increases dental attendance rates at the public health level. Milsom, et al. reported that school dental screening delivered according to 3 different models in the northwest of England children aged 6-9 years derived little benefit in terms of attending the dentist, and receiving treatment for their carious permanent teeth. The current method of school dental screening is no longer tenable, alternative ways to ensure that vulnerable children receive adequate dental care need to be explored (Milsom, et al., 2006).

Oral health education program in Belgian primary schoolchildren has been effective in improving reported dietary habits and the proper use of topical fluorides and resulted in a higher care index.

The implemented yearly based extra oral health promotional program did not result in a significant reduction of caries prevalence. The effectiveness on plaque level and gingival health was inconclusive. However, the favorable reported behavioral changes and the increased restoration level together with the educational responsibility of the profession justify the efforts and costs of this program (Vanobbergen, et al., 2004).

In the same way, supervised daily toothbrushing using fluoride toothpaste in schools and intensive oral hygiene instructions sessions program was successful in controlling dental caries in children, as reported by Al-Jundi, et al. in a school-based caries preventive program in children from Jordan over a period of 4 years (Al-Jundi, et al., 2006).

The evaluation of caries incidence after 7.5 years of follow-up, in an infant population under a dental health preventive program in Mostoles (Madrid), which consisted of preventive measures included health education, a weekly mouth rinse using sodium fluoride (NaF) at 0.2% concentration, fissure sealants to first permanent molars and topical application of

fluoride gel, showed that the preventive program had been effective and had a clear protective effect on permanent teeth (Tapias, et al., 2001).

The six months evaluation of a comprehensive preventive care from dental hygienists implemented in children at six Massachusetts elementary schools, grades 1 through 3, with pupil populations at high risk of developing caries indicates that this care model relatively quickly can overcome multiple barriers to care and improve children's oral health. If widely implemented, comprehensive caries prevention programs could accomplish national health goals and reduce the need for new care providers and clinics.

To increase access to care, improve oral health and reduce disparities in oral health care for children, treatments must be safe, effective, efficient, personalized, timely and equitable. This program can be implemented locally and can reduce the incidence of dental caries in school-aged children (Niederman, et al., 2008).

Sealants application programs have been suggested as an effective measurement for caries prevention. Khurshid reported that preventive oral health care as measured by the presence of dental sealants can significantly reduce the occurrence of dental caries in Hispanic children in underserved areas such as the US-Mexico border in Texas. The study confirms the strong effect of low house hold income and lack of health insurance in increasing the likelihood of dental caries in children. The old adage that prevention is better than cure applies to dental health as much as to any other public health issue (Khurshid, 2010).

6. Dental programs in Mexico

In Mexico, a school-based caries preventive program was established in the 1970's in the State of Mexico; it was a pioneer program, and later in 1988 the program of salt fluoridation was implemented for the first time as a pilot program in the state. The program was carried out with technical support from the Pan American Health Organization (PAHO) and financial from W.K. Kellogg. Then, the salt fluoridation program is positioned as a nationwide policy in 1992. Because in the country there are five states and other municipalities with concentrations of fluoride in drinking water above the optimum amount, steps were taken to prevent consumption in these regions.

The preventive educational program developed in preschool and primary school nationwide currently includes various activities, constituted in the "basic scheme of oral health" prevention that consists of 14 applications of sodium fluoride 0.2%, 4 detections of plaque, 4 brushing technique instructions, 4 flossing instructions (from 8 years old) and 4 educational talks. All the activities are developed in every school year; in addition, there is a curative care program that is not always free.

Great efforts have been made for the abatement of oral diseases of highest incidence and prevalence and major achievements have been accomplished, but it is necessary to strengthen the activities implemented with the purpose to achieve caries-free communities program so the action 2001-2006 oral health includes in its coverage of 4 to 15 years of age (Secretaria de Salud, 2011).

In Mexico State, the coverage of preventive educational program is around 75%, yet there are limited healing care facilities for school children; only a few dental schools have these

services available, and many times children are channeled to public institutions' clinics. The Autonomous University of Mexico State is involved in the implementation of the program as part of the training curriculum for students with some adjustments in regard to the educational component, and all other activities are performed according to the provisions of the educational program-including preventive fluoride 14 applications per year. This chapter includes the results of the incidence of caries within a 3 years follow-up of certain schools under the care of the University.

7. Study design

The present study is a 3-year longitudinal analysis of a school-based caries prevention program. The study protocol was reviewed and approved by the Research and Ethics Committee of Autonomous University of the State of Mexico (UAEM from its initials in Spanish). The inclusion criteria were children without orthodontic treatment and all children whose parents signed an informed consent form prior to the examinations. The sample was selected by a convenience non-probability sampling method, and included 145 schoolchildren (66 boys and 79 girls), 6-7 years of age, who attended from the first to the third school year in four public elementary schools at Toluca city, where the School of Dentistry of the Autonomous University of the State of Mexico is responsible for the implementation of the program. The program included 20 minute sessions of oral health education for children and teachers (five per school year), and parents (one per school year). The curriculum included information about caries etiology and prevention (oral hygiene, diet counseling, fluorides, pit and fissures sealants), 0.2% NaF mouth rinse (fourteen per school year), toothbrushing technique instructions (four per school year), flossing instructions in children up to 8 years old, and disclosing solution application (four per school year).

To motivate the children, oral health educational material was designed and adapted to their chronological age, using a puppet theater among other resources. The oral examination was performed on site (public elementary schools) in daylight conditions by two examiners, who used a dental mirror and a WHO/CPITN-type E probe (World Health Organization, 1997). No radiographs were taken. To ensure satisfactory inter-examiner reproducibility, the examiners were calibrated twice a week during the six months previous to the start of sampling (Kappa 0.95) by examining the same group of people and comparing their findings.

The oral health of children was evaluated by using deft/s and DMFT/S index. A tooth or surface was considered carious (D) if there was visible evidence of a cavity, including untreated dental caries and filled teeth with recurrent caries. The M component included missing teeth and / or decayed teeth with indication for extraction due to caries, or teeth missing as a result of caries. The F component was filled teeth; the sum of the three figures forms the DMFT/S-value. For primary dentition, deft/s index was used, where e indicates extracted teeth. Cumulative incidence was expressed as the proportion of new children with caries over the 3 years period. For caries incidence data were collected on DMFT and deft recording forms. Information to the parents about the oral health status of the children was provided by means of an advice/referral letter.

7.1 Statistical analysis

All data were analyzed using the SPSS 13.0 statistical package for Windows (SPSS Inc., Chicago, IL, USA). The measurements were analyzed using Kolmogorov-Smirnov test at a

($p \leq 0.05$) level of significance to assess distribution of data. The measurements were analyzed using Wilcoxon test was used with a level of significance of $p \leq 0.05$.

8. Results

The mean age of the 145 children at the baseline was 6.5 years old, while during final examination was 9.5 years old. After 3 years follow up mean dmft/s and DMFT/S (Table I). DMFT scores showed increased 0.1 a 0.9 with differences statistically significantly. The percentage of caries-free children is showed in Table 2. At the beginning of the study 93% of the children was caries-free for permanent teeth, decreasing to 57% while only 17% was healthy in both dentitions at the end of the study. Cumulative incidence was 0.39.

Year	dmft	dmfs	DMFT	DMFS
	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)
2007	4.2 (3.8) ^A	10.2 (12.1) ^{AB}	0.1 (0.4) ^A	0.1 (0.5) ^A
2008	4.2 (3.2) ^A	10.3 (10.4) ^A	0.5 (1.0) ^B	0.6 (1.5) ^B
2009	3.8 (2.9) ^B	9.3 (9.20) ^B	0.7 (1.2) ^C	0.9 (1.7) ^C
2010	2.8 (2.4) ^C	6.3 (6.60) ^C	0.9 (1.3) ^D	1.4 (2.2) ^D

* Groups with different letters are significantly different ($p \leq 0.05$).

Table 1. Caries experience of the study population in a three-year long follow up

Year	dmft≠0		dmft=0		DMFT≠0		DMFT=0		dmft=0 DMFT=0	
	no.	%	no.	%	no.	%	no.	%	no.	%
	2007	111	77	34	23	10	7	135	93	34
2008	116	80	29	20	36	25	109	75	27	19
2009	118	81	27	19	51	35	94	65	24	17
2010	110	76	35	24	63	63	82	57	25	17

Table 2. Percentage of children with caries and caries-free for dentition

Period	Caries-free permanent teeth	New decay permanent teeth	Cumulative Incidence
2007-2008	765	51	0.07
2008-2009	1403	37	0.03
2009-2010	1698	31	0.02

Table 3. Caries incidence changes from first to third year for study group

9. Conclusion

According to 1999-2004 survey in the United States, the mean dfs for children 2-8 years was 3.7, although for 6-11 years of age was 4.30 and 1.84 for dft. The same study reported 51.17% caries prevalence in primary dentition for 6-11 years old children. However, caries experience for permanent teeth was 21% while DFS index was 0.65. Additionally, a prevalence of 10.16%, 0.19 DFT and 0.29 DFS were reported in children from 6 to 8 years old (Dye, et al., 2010; National Institute of Dental and Craniofacial Research, 2011).

In 2004, 5 years-old children in the United Kingdom showed a 1.55 dmft, later in 2009, 33% from 12-years-old children had a mean DMFT>0 and the decay experience average was 0.74, showing that the proportion of children without decay has risen to 61% (Drugan & Downer, 2011).

Reports from Värmland, Sweden indicate that 76% of 6 years-old children are caries free in primary dentition, while 7,8,9 and 10 years old children were 98%, 96%, 94% and 92% caries free for permanent dentition, respectively. (Axelson, 2004). In Europe, some reports have indicated a 79-93% dmfs or DMFS, or equal to zero (Marthaler, et al., 2004)

In 2001, caries prevalence in Chinese children aged 5-6 years was 78 -86%, and dmft was 4.8 - 7.0. A lower prevalence of caries was reported (41-42%) in 12 years old children, and a 0.9% DMFT, according to WHO criteria (Wong, et al., 2001).

The results of this study, showed a high caries prevalence and also higher dmft, dmfs, DMFT and DMFS index compared with well developed countries such as United States, United Kingdom, Sweden and other countries in Europe, but similar to those in China.

It seems that the efforts to diminish dental caries through the evaluated preventive and educational program have do not had the expected impact though these children are under salt fluoridation program. It is necessary to reconsider the implementation of additional measures according to caries risk group as has been reported previously, as well as to evaluate the cost and the effectiveness of mouthwashes.

10. Acknowledgment

This study was financially supported by the Universidad Autónoma del Estado de Mexico. The authors would like to thank the staff of the three primary schools for their kind collaboration during the data collection.

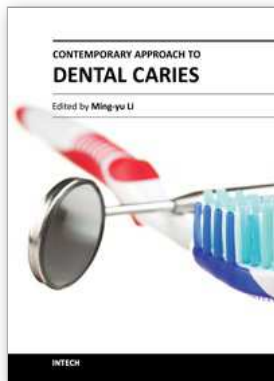
11. References

- Al-Jundi, S.H., Hammad, M. & Alwaeli, H. (2006). The efficacy of a school-based caries preventive program: a 4-year study. *International Journal of Dental Hygiene*, 4, 1, 30-4.
- Axelsson, P. *Diagnosis and risk prediction of dental caries*. (2000). Quintessence, ISBN 0-86715-362-8, Germany.
- Axelsson, P. *Preventive materials , methods and programs*. (2004). Quintessence, ISBN 0- 86715-364-4, Slovakia.
- Beltrán-Aguilar, E.D., Estupiñán-Day, S. & Báez R. (1999). Analysis of prevalence and trends of dental caries in the Americas between the 1970s and 1990s. *International Dental Journal*, 49, 322-329.

- Berg, J.H. (2007). Dental caries detection and caries management by risk assessment. *Journal Esthetic Restorative Dentistry*, 19, 1, 49-55.
- Bönecker, M., & Cleaton-Jones, P. (2003). Trends in dental caries in Latin American and Caribbean 5-6 and 11-13-year-old children: a systematic review. *Community Dentistry and Oral Epidemiology*, 31, 152-7.
- Bratthall, D. & Hänsel Petersson, G. (2005). Cariogram - a multifactorial risk assessment model for a multifactorial disease. *Community Dentistry and Oral Epidemiology*, 33, 4, 256-64.
- Brown, L.J., Wall, T.P., & Lazar, V. (2000). Trends in total caries experience: permanent and primary teeth. *Journal of the American Dental Association*, 131, 223-231.
- Carvalho, J.C., Van Nieuwenhuysen, J.P., & D'Hoore, W. (2001). The decline in dental caries among Belgian children between 1983 and 1998. *Community Dentistry and Oral Epidemiology*, 29, 55-61.
- Drugan, C.S. & Downer, M.C. (2011). Dental health in the United Kingdom and influencing variables. *Bundesgesundheitsblatt Gesundheitsforschung Gesundheitsschutz*, 54, 9, 1027-34.
- Dye, B.A., Tan, S., Smith, V., Lewis, B.G., Baker L.k., Thornton-Evan, G., Eke P.I., Beltran-Aguilar, E., Horowitz, A.M. & Li, C-H. (2007). Trends in oral health status: United States, 1988-1994 and 1999-2004. *Vital Health Statistics*, 11, 248, 1-92.
- Dye, B.A., Arevalo, O. & Vargas, C.M. (2010). Trends in paediatric dental caries by poverty status in the United States, 1988-1994 and 1999-2004. *International Journal of Paediatric Dentistry*, 20, 132-143.
- Estupiñan-Day, S.R., Baez, R., Horowitz, H., Warpeha, R., Sutherland, B. & Thamer M. (2001). Salt fluoration and dental caries in Jamaica. *Community Dentistry and Oral Epidemiology*, 29, 247-52.
- Featherstone, J.D. (2000). The science and practice of caries prevention. *Journal of the American Dental Association*, 131, 7, 887-99.
- Featherstone, J.D., Domejean-Orliaguet, S., Jenson, L., Wolff, M. & Young, D.A. (2007). Caries risk assessment in practice for age 6 through adult. *Journal of the California Dental Association*, 35, 10, 703-713.
- Gao, X.L., Hsu, C.Y., Xu, Y., Hwang, H.B., Loh, T. & Koh, D. (2010). Building caries risk assessment models for children. *Journal of Dental Research*, 89, 6, 637-43.
- Gussy, M.G., Waters, E.G., Walsh, O. & Kilpatrick, N.M. (2006). Early childhood caries: current evidence for aetiology and prevention. *Journal of Paediatrics Child Health*, 42, 1-2, 37-43.
- Harris, N.O. & García-Godoy F. *Primary preventive dentistry*. (1999). 5 th. Appleton & Lange, ISBN 0-8385-8129-3, USA, 41-47, 279-285.
- Hausen, H. (2004). How to improve the effectiveness of caries-preventive programs based on fluoride. *Caries Research*, 38, 3, 263-7.
- Irigoyen, M.E. & Sánchez-Hinojosa, G. (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, 4, 303-7.
- Ismail, A.I., Sohn, W., Tellez, M., Amaya, A., Sen, A., Hasson, H. & Pitts, N.B. (2007). The International Caries Detection and Assessment System (ICDAS): an integrated system for measuring dental caries, *Community Dentistry and Oral Epidemiology*, 35, 170-178

- Jacobsson, B., Koch, G., Magnusson, T. & Hugoson, A. (2011). Oral health in young individuals with foreign and Swedish backgrounds-a ten-year perspective. *European Archives of Paediatric Dentistry*, 12, 3, 151-8.
- Khurshid, A. (2010). Effectiveness of preventive oral health care in Hispanic children living near US-Mexico border. *International Journal of Public Health*, 55, 291-298.
- Koch, G. & Poulsen, S. (2006). *Pediatric dentistry-a clinical approach*. Blackwell, ISBN 10-87-16-12271-2, Denmark ,119, 134.
- Kwan, S.Y.L., Petersen, P.E., Pine, C.M. & Borutta, A. (2005). Health-promoting schools: an opportunity for oral health promotion. *Bulletin of the World Health Organization*, 83, 9, 677-65.
- Marthaler, T.M. & O'Mullane, D.M. (1996). The prevalence of dental caries in Europe 1990-1995. Symposium Report. *Caries Research*, 30, 237-255.
- Marthaler, T.M. Changes in dental caries 1953-2003. (2004). *Caries Research*, 38, 173-181.
- Milsom, K., Blinkhorn, A., Worthington, H., Threlfall, A., Buchanan, K., Kearney-Mitchell P. & Tickle, M. (2006). Effectiveness of school dental screening: a cluster-randomized control trial. *Journal of Dental Research*, 85, 10, 924-928.
- National Institute of Dental and Craniofacial Research (NIDCR). (2011). Dental Caries (Tooth Decay) in Children (Age 2 to 11) Data Source: The National Health and Nutrition Examination Survey (NHANES) (collected between 1999 and 2004) data regarding dental caries in children. Available from:
<http://www.nidcr.nih.gov/DataStatistics/FindDataByTopic/DentalCaries/DentalCariesChildren2to11> Link
- Newbrum, E. (2001). Topical fluorides in caries prevention and management: a North American perspective. *Journal of Dental Education*, 2001, 65, 10, 1078-83.
- Niederman, R., Gould, E., Soncini, J., Tavares, M. Osborn, V. & Goodson, M. (2008). A model for extending the reach of the program traditional dental practice: the forsythkids *Journal of the American Dental Association*, 139, 1040-1050.
- Okawa, Y., Takahashi, Y., Sazuka, J., Matsukubo, T. & Takaesu, Y. (1992). Decline in caries prevalence in 6-14-year-old schoolchildren during 1975-85 in Shizouka, Japan. *Community Dentistry and Oral Epidemiology*, 20, 246-9.
- Pearce, E.I.F., Dong, Y-M., Yue, L., Gao, X-J., Purdie, G.L. & Wang J-D. (2002). Plaque minerals in the prediction of caries activity. *Community Dentistry and Oral Epidemiology*, 30, 61-9.
- Petersen, PE. (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 Dent Oral Epidemiology*, 31, 3-23.
- Petersen, P.E., & Lennon, MA. (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., Bourgeois, D., Ogawa, H., Estupinan-Day, S. & Ndiaye C. (2005). The global burden of oral diseases and risks to oral health. *Bulletin of the World Health Organization*, 83, 9, 661-9.
- Ramos-Gomez, F., Crystal, Y.O., Ng, M.W., Tinanoff, N., & Featherstone, J.D. (2010). Caries risk assessment, prevention, and management in pediatric dental care. *General Dentistry*, 58, 6, 505-17.

- Rao, A. & Malhotra, N. (2011). The role of remineralizing agents in dentistry: a review. *Compendium of Continuing Education in Dentistry*, 32, 6, 26-33.
- Secretaría de Salud y Subsecretaría de Prevención y Protección a la Salud. (2001). *Programa de Acción: Salud Bucal*. ISBN 968-811 999-7, México, 7-45.
- Splieth, C.H., Nourallah, A.W. & König, K.G.(2004). Caries prevention programs for groups: out of fashion or up to date? *Clinical Oral Investigations*, 8, 1, 6-10.
- Stookey, G.K. (2004). Optical methods-quantitative light fluorescence. *Journal of Dental Research*, 83 Spec No C:C 84-8.
- Tapias, M.A., De Miguel, G, Jiménez-García R, González A, Dominguez V. (2001). Incidence of caries in an infant population in Mostoles, Madrid. Evaluation of a preventive program after 7.5 years of follow-up. *International Journal of Paediatric Dentistry*, 11, 6, 440-6.
- Ten Cate, J.M. (2004). Fluorides in caries prevention and control: empiricism or science. *Caries Research*, 38, 3, 254-7.
- Tomar, S.L. & Reeves, A. F. (2009). Changes in the oral health of US children and adolescents and dental public health infrastructure since the release of the healthy people 2010 objectives. *Academic Pediatrics*, 9, 388-95.
- Tranaeus, S, Shi., X-Q. & Angmar-Månsson B. (2005).Caries risk assessment: methods available to clinicians for caries detection. *Community Dentistry and Oral Epidemiology*, 33, 265-73.
- Twetman, S., Axelsson, S., Dahlgren, H., Holm, A.K., Källestål, C., Lagerlöf, F., Lingström, P., Mejäre, I., Nordenram, G., Norlund, A., Petersson, L.G. & Söder B. (2003). Caries-preventive effect of fluoride toothpaste:a systematic review. *Acta Odontologica Scandinavica*, 2003, 61, 347-355.
- Vanobbergen, J., Martens, L., Lesaffre, E., Bogaerts, K. & Declerck D. (2001). The value of a baseline caries risk assessment model in the primary dentition for the prediction of caries incidence in the permanent dentition. *Caries Research*, 35, 6, 442-50.
- Vanobbergen, J., Declerck, D., Mwalili, S. & Martens L. (2004).The effectiveness of a 6-year oral health education programme for primary schoolchildren. *Community Dentistry and Oral Epidemiology*, 32, 173-82.
- Vrbič V. (1996). Oral health in Slovenia, 1987-1993. *Community Dentistry and Oral Epidemiology*, 24, 364-5.
- Wennhall, I., Matsson, L., Schröder, U. & Twetman, S. (2008). Outcome of an oral health outreach programme for preschool children in a low socioeconomic multicultural area. *International Journal of Paediatric Dentistry*, 18, 2, 84-90.
- Whelton, H. (2004). Overview of the impact of changing global patterns of dental caries experience on caries clinical trials. *Journal of Dental Research*, 83 (Spec Iss C), C29-C34.
- Wong, M.C., Lo, E.C., Schwarz, E. & Zhang, H.G. (2001). Oral health status and oral health behaviors in Chinese Children. *Journal of Dental Research*, 80, 5, 1459-65.
- World Health Organization. (1997). *Oral Health Surveys: Basic Methods*. 4th ed. Ed. Geneve.



Contemporary Approach to Dental Caries

Edited by Dr. Ming-Yu Li

ISBN 978-953-51-0305-9

Hard cover, 488 pages

Publisher InTech

Published online 14, March, 2012

Published in print edition March, 2012

With an update of the recent progress in etiology, pathogenesis, diagnosis, and treatment of caries, it may be said that the final defeat of dental caries is becoming possible soon. Based on the research in this area in recent decades, "Contemporary Approach to Dental Caries" contained the caries in general, the diagnosis of caries, caries control and prevention, the medical treatment of caries, dental caries in children and others such as secondary caries. This book provides the reader with a guide of progress on the study of dental caries. The book will appeal to dental students, educators, hygienists, therapists and dentists who wish to update their knowledge. It will make you feel reading is profitable and useful for your practice.

How to reference

In order to correctly reference this scholarly work, feel free to copy and paste the following:

Laura Emma Rodríguez-Vilchis, Rosalía Contreras-Bulnes, Felipe González-Solano, Judith Arjona-Serrano, María del Rocío Soto-Mendieta and Blanca Silvia González-López (2012). Caries Incidence in School Children Included in a Caries Preventive Program: A Longitudinal Study, Contemporary Approach to Dental Caries, Dr. Ming-Yu Li (Ed.), ISBN: 978-953-51-0305-9, InTech, Available from:

<http://www.intechopen.com/books/contemporary-approach-to-dental-caries/caries-incidence-in-school-children-included-in-a-caries-preventive-program-a-longitudinal-study->

INTECH

open science | open minds

InTech Europe

University Campus STeP Ri
Slavka Krautzeka 83/A
51000 Rijeka, Croatia
Phone: +385 (51) 770 447
Fax: +385 (51) 686 166
www.intechopen.com

InTech China

Unit 405, Office Block, Hotel Equatorial Shanghai
No.65, Yan An Road (West), Shanghai, 200040, China
中国上海市延安西路65号上海国际贵都大饭店办公楼405单元
Phone: +86-21-62489820
Fax: +86-21-62489821