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Community-Based Assessment and Intervention for Early Childhood Caries in Rural El Salvador

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ABSTRACT

Objective: The Objectives are to assess Early Childhood Caries (ECC) in rural areas of El Salvador and to investigate the changes in caries and mouth pain in the presence of community-based interventions.

Methods: This study is a retrospective analysis of de-identified and anonymous data obtained from baseline and four annual follow-up visits that focused on the preventive oral health intervention and nutrition in a convenience sample of children age 0-6 years of age. The dmft index was used as the survey tool. Caries was defined as a cavitated lesion. Descriptive statistics were used to describe prevalence of ECC in the sample in relation to age and dmft score. Linear mixed model ANOVAs and generalized linear mixed effects models were used to compare the pre-intervention and post-intervention outcomes.

Results

The prevalence of caries was 58%. Incorporation of a community oral health education and fluoride supplementation program contributed to significant reductions in children's caries experience (from 74% to 61%) and mouth pain (from 58% to 39%) in children 3 to 6 years of age.

Conclusions

ECC is a common public health problem in rural El Salvador. In an established community-based maternal-child health program in El Salvador, there appears to be an association between the incorporation of preventive oral health intervention and improvement in children's oral health and quality of life over time.

INTRODUCTION:

The World Health Organization (WHO) identifies caries as one of the most prominent chronic diseases in the world, affecting 60-95% of children in developed and developing countries, with especially high rates in Latin America and Asia. (1) More than 80 percent of the world's children live in developing countries where dental health care resources are extremely limited.(2) From a public health perspective, the rate of early childhood caries (ECC) in developing countries is particularly alarming. (3-5)

Dental caries is a common chronic, bacterially-mediated disease resulting from tooth-adherent bacteria, such as *Streptococcus mutans,* which cause disease when driven by ecological pressures. Thus, when oral bacteria are frequently exposed to fermentable carbohydrates, they metabolize sugars to produce acid, which, over time, demineralizes tooth surfaces. (6-8)

The American Association of Pediatric Dentistry (AAPD) defines ECC as the presence of one or more decayed (noncavitated or cavitated lesions), missing (due to caries), or filled tooth surfaces in any primary tooth in a child under the age of 6. Severe early childhood caries in children younger than three years of age is defined as any sign of smooth-surface caries. From ages 3-5, one or more cavitated, missing (due to caries), or filled smooth surfaces in primary maxillary anterior teeth or a decayed, missing, or filled score of greater than or equal to four (age 3), greater than or equal to five (age 4), or greater than or equal to six (age 5) surfaces also constitutes severe ECC. Caries-conducive dietary practices are established by 12 months of age and are maintained throughout early childhood. (9, 10) Prolonged and frequent nighttime bottle-feeding with cariogenic beverages increases the risk of caries (11-13). During nighttime feeding, salivary flow is reduced and demineralization occurs in the absence of salivary cleansing and buffering. Some evidence suggests that sugary liquids as well as milk in formula and breast milk have cariogenic potential (14)

To prevent ECC, the AAPD recommends minimizing the frequency of sugar intake. Other important prevention factors include city water fluoridation, reducing baby bottle

use and intake of dietary fermentable carbohydrates, and improved oral hygiene measures, including adequate plaque removal by daily tooth brushing, topical fluoride application (i.e. fluoride varnish), and regular dental office visits for screening and treatment. (15-17) The optimal time to implement oral hygiene measures should be no later than at the time of eruption of the first primary tooth (around 6 months of age). (18-20) In addition, tooth brushing with fluoridated toothpaste should be performed for young children by a parent twice daily.(3) A 2013 Cochrane systemic review showed that application of a fluoride varnish two to four times a year resulted in a reduction of caries by 64% and 44% in primary and permanent teeth respectively (21). Thus, most authorities have concluded that this is an extremely efficacious caries preventive strategy to be used in public settings.

When these health maintenance practices are not adopted, and dental disease is allowed to develop and progress to cavities and abscesses, there are serious negative consequences on children's oral health, and in turn, on their general health. Children's quality of life can be significantly affected by dental pain. In a comparative study of two of the most common chronic pediatric diseases (asthma vs. dental caries), dental caries was shown to cause dental pain that can disturb children's sleep, prevent them from playing and attending school, and most importantly, cause an inability to eat in the preceding week. (22)

Most global epidemiologic studies regarding caries have been done with school-aged children. (23, 24) Few studies have looked at ECC and its risk factors in children from birth to six years of age. (11, 25-27) However, as previous studies have shown (18-20), prevention of dental caries is most effective in the preschool age group. Consequently, there is tremendous need to implement public-health interventions to prevent dental caries in preschool-age populations in developing countries. Such interventions must be accessible, affordable, culturally-sensitive, and effective. Unfortunately, there is a paucity of research on the feasibility and effectiveness of such interventions in developing communities.(2) While we know that implementation of comprehensive dental care programs can substantially reduce morbidities associated with ECC, there is an urgent need to evaluate and adopt culturally and regionally appropriate regimens of intervention

within developing country settings. (28)

The aim of this study was to determine the prevalence and severity of ECC and oral pain in young children in rural El Salvador, and to evaluate the impact of oral health education and fluoride in reducing ECC and mouth pain in those communities.

METHODS:

Research Design:

This study was a retrospective analysis of oral health and nutrition data derived from a community-based survey and intervention program in rural El Salvador. De-identified and anonymous data was obtained from baseline and four annual follow-visits, which focused on the oral health and nutrition in a convenience sample of children age 0-6 years of age. The research has been conducted in full accordance with the World Medical Association Declaration of Helsinki. The study was reviewed and approved by the institutional review board at the University of California Office for the Protection of Human Subjects (2010-06-1655).

Intervention program:

ASAPROSAR (Asociación Salvadoreña Pro-Salud Rural - The Salvadoran Association for Rural Health) is a non-governmental, non-profit organization that provides health, education, environmental, and economic development programs in El Salvador.(29) One of these programs is designed to recruit and train rural community health workers, or health promoters, who are focused on maternal and children's health and nutrition. The oral health program was implemented as a partnership with the Salvadoran Ministry of Health, and the University of California, Berkeley, School of Public Health in the fifteen rural communities served by health promoters.

There were three main components to the preventive oral health intervention: 1) oral health education, 2) distribution of oral care products (each child received a new toothbrush and toothpaste 3 times per year), and 3) fluoride varnish application. The educational component included annual training of health promoters on topics regarding

healthy and unhealthy foods, the importance of oral health, and when to seek dental care. Health promoters then integrated the oral health education and practices into their work with parents through home visits and in preschools. Free toothbrushes and fluoride toothpaste were provided to all children and family members that were under the care of the health promoters. Lastly, fluoride varnish was applied to children's teeth three times a year (except for a temporary suspension from July 2008 to July 2009).

Annual written reports and oral presentations identified areas of success and challenges (e.g., long duration of baby bottle use). Based on health promoters' observations, the group developed a costumed character "The Bottle Fairy" to take away babies' bottles after their 1-year birthday. At the end of the five-year pilot program, ASAPROSAR continued the oral health program with technical support from the Ministry of Health and supplies provided by Colgate Palmolive and private donors.

Data Collection:

Parents who participated in the dental intervention program were required to give informed consent for their child's and their own participation. The community health promoters explained the procedures, possible risks or discomforts, and possible benefits. Written informed consent was obtained from the parents prior to the investigation.

Trained Spanish-speaking volunteers conducted interviews with the child's primary caregiver (usually the mother), in as private a setting as possible. The interview questionnaire was comprised of 50 questions on household and mother and child characteristics: mother and child diet, oral hygiene and dental problems; medical and dental care utilization; and the caregiver's assessment of the child's oral health and overall health. The interviewer read each question aloud, and recorded the caregiver's response on a data collection form. Following the interviews, the UC Berkeley research team reviewed the forms for discrepancies, and conducted training updates for interviewers to address any problems. ASAPROSAR community health workers carried out the coordination, education on oral hygiene, and fluoride varnish application three times a year in conjunction with dentists from the Ministry of Health.

Four licensed US dentists conducted children's dental examinations. Caries was defined as a cavitated lesion. Caries were assessed by visual inspection using a headlamp under natural light and a dental mirror but without the use of a dental explorer. Children were examined in the preferred position for the examiner and for the child's comfort--either recumbent on a table, knee-to-knee with the mother, or seated in a chair. During the dental exam, the status of each tooth was stated verbally for an assistant to record. The status categories included whether the tooth was deciduous, erupted, healthy, missing, decayed (only cavitated lesions were recorded), or filled. Thus, the dmft index, which measures the number of primary teeth decayed, missing, and filled teeth was used as the survey tool. At the initial health training session and annually, the dentists standardized their exam assessments by independently examining 3-5 children, and then comparing and reconciling their exam findings to ensure consistency between examiners. If any questionable judgments arose during the dental exams, the examiners consulted with each other to agree upon the classification of a lesion. No official calibration tests were performed.

Statistical Analyses:

Study data were entered in Excel and verified by a second individual. Data were then translated into English. A trained study team member transferred de-identified coded data to SPSS 19.0 software for analysis. Descriptive statistics (counts, percentages) were used to describe prevalence of ECC in the sample in relation to age and dmft score. Linear mixed model ANOVAs were used to compare the pre-intervention and post-intervention caries counts and mouth pain frequency scores, and generalized linear mixed effects models were used to compare the pre-intervention and post-intervention binary caries variables. Age was included as a covariate. Random effects were included for village to account for clustering effects of the village, for family to account for correlations among siblings, and for subject to correlate multiple observations within a child over time.

RESULTS

Baseline Results

Demographics

Table 1 illustrates the baseline (2006) demographic characteristics of the study population (children, mother, and household), nutritional practices of children, and oral health practices of both children and mothers. A total of 886 children were seen for 1259 dental visits from 2006 to 2010. The children's mean age was 3.9 years. The mothers had a mean age of 30.5 years and a mean level of education of 4.5 years. Of these households, 55% had potable water and 78% had electricity. While nearly all children (96%) were breastfed, nearly half of the children (45%) were given a baby bottle, which often included sugary and acidic liquids such as coffee (7%), lemonade (14%), juice-soda or sugary water (51%). Baseline survey data showed that 84% of children had a toothbrush, 74% had toothpaste, and only 30% had been to the dentist.

Table II illustrates the percent of children in each age group by year. Results of this study show that the prevalence of caries, dmft (extent of caries experience) and mouth pain increased with age (*Figure-1A, B and C*). The prevalence of caries in the primary dentition increased from 10% at age 1 to 100% by age 6 (*Figure 1A*). The dmft score increased from <1 at age 1 to approximately 8 at age 6 (*Figure 1B*). The steepest slope for the increase in prevalence of caries and dmft was from birth to 3 years of age. The prevalence of mouth pain increased from approximately 25% of 3 year olds to 50% of 6 year olds.

A cross-sectional evaluation of cavitated caries lesions in children from 2006-2010 is shown in Figure 2. These numbers illustrate that caries prevalence went from of a high of 90% to a low of 70% from years 2006 to 2008, then when the intervention was interrupted the numbers again increased to a high of 85% by year 2010. Similarly, mean dmft scores went from of a high of 6.34 to a low of 4.27 from years 2006 to 2008, then when the intervention ceased/was interrupted the numbers again increased to a high of 4.92 by year 2010. For children age 0 to 2 years, the prevalence of untreated dental caries, dmft and mouth pain did not significantly differ across the years from 2006 to 2010.

An assessment of the longitudinal data revealed that 273 children had at least one return dental visit with the UC Berkeley research team over the course of the study. For children who needed urgent dental treatment, referrals were made to the Ministry of Health dental clinics.

The pre-intervention and post-intervention changes in dmft and mouth pain for the 3 to 6 year old children is illustrated in Figures 3 and 4. For older children 3 to 6 years of age, there was statistically significant reduction in the prevalence of severe ECC (dmft+DMFT) over time from 74% to 61% (*Figure 3*); a non-significant reduction was also observed for dmft+DMFT counts (6.04±0.44 to 5.45±0.37, p=0.15). Similarly, these children also revealed a significant reduction in the frequency of mouth pain from 58% to 39% (*Figure 4*). The younger children, 0 to 2 years old, did not experience a significant reduction in dmft or mouth pain (*Figures* 3 and 4, dmft+DMFT counts 1.45±0.37 to 1.37±0.14).

DISCUSSION

Prevalence and Severity:

This study documents a widespread problem of early childhood caries (ECC) in a sample of children from rural El Salvador. ECC was present in the first two years of life and increased steadily in prevalence and severity with age, affecting virtually all children by 6 years of age. The extent of high caries experience, the prevalence of untreated decayed teeth and mouth pain, and limited access to dental care among the children in this study indicate a pressing need for both prevention and treatment of ECC in this population.

In this study of rural El Salvadorian children, the prevalence of ECC (58%) appears similar to that reported in previous studies. A 2003 WHO report stated that the prevalence of caries (treated and untreated) globally was 60-90% (1, 30). However, in our study population, most of the lesions were untreated. Thus, the prevalence of untreated caries in the El Salvadorian population is significant and high compared to other places around the world since it represents primarily untreated ECC.

A recent systematic review and metaregression analysis of the prevalence of the global burden of disease showed that in 2010, caries in deciduous teeth was the 10th-most prevalent condition, with the highest prevalence at age 6. In that review, countries in southern Latin America exhibited an 85% prevalence rate of caries of primary teeth. According to United States, National Health and Nutrition Examination Survey (US-NHANES), the prevalence of caries in primary teeth in 1999–2004 were as follows: 2-5 years (total 27.90%, untreated caries 20.48%), 6-11 years (total 51.17%, untreated caries 24.49%). However, within US American Indian/Alaska Native (AI/AN), 68% of AI/AN children had experienced caries. In these children, the prevalence of untreated dental decay was 43.6%, and the mean dmft (decayed, missing, and filled teeth) was 3 times greater than for non-Natives. (31) AI/AN children have similar social, economic and cultural issues to children of rural El Salvador. Therefore it is important to survey unique populations that may exhibit significantly different characteristics from the overall group such as very high prevalence rates of ECC. These subpopulations may need intensive oral health interventions. Thus, although global and national surveys highlight mean caries prevalence or dmft values for whole populations, it is critical to acknowledge the caries values for subpopulations that represent the most significant disease; these may go unnoticed within the larger context of reported mean values. This underscores the health disparities that exist in large populations.

Socioeconomic Status

Socioeconomic status (SES) is consistently associated with caries levels in children. Indicators such as income, education, and urbanization are usually used to determine SES. American Indian/Alaska Native risk factors show such a close association with ECC as SES. (6, 32-34) Low SES is associated with lack of formal education, lack of preventive health care (i.e., prenatal or dental), and limited nutritional access. In an attempt to dissect the relationship between SES and ECC, some researchers have focused their studies on specific immigrant groups within the US population. Latino immigrant children showed higher than average ECC rates, second only to that of Native American children (6, 24, 26). These findings confirm that economic barriers and limited maternal oral health

knowledge are potential contributors to children's poor oral health (35) Factors related to maternal oral health beliefs and behaviors may vary with different SES and education levels. Among the mothers in our study in rural El Salvador, the level of education was less than five years. Only 13% of mothers sought regular dental care for themselves and 50% had never seen a dentist. These findings support the role of both economic barriers and limited maternal oral health knowledge as potential contributors to the children's oral health. Thus, limited overall literacy, and health literacy may have played a role in the increased risk for ECC in these communities.

Parental Practices and Risk Factors:

Caries is the result of a complex interaction between sociodemographic, behavioral, and microbiological factors. Prolonged or night-time bottle-feeding was correlated with ECC in studies from Saudi Arabia, US and Turkey. (12, 36, 37) Guidelines prepared by the American Academy of Pediatrics (AAP) suggest that parents should begin bottle weaning when their child is approximately nine months of age and accomplish weaning soon after the first birthday. (38) Studies from Japan and US showed that later weaning is also correlated with increased risk for ECC. (26, 39) Increased availability of fermentable carbohydrates in baby bottle was reported in more than half of Saudi Arabian children with ECC. (11, 40) In India, a high frequency consumption of fermentable carbohydrates, which were given as part of a reward system was correlated with ECC. (41) In this study, 45% of children were bottlefed ranging from 15.4 to 35.6 months, which is longer than the recommended duration suggested by the AAP. In our study, both the prolonged bottle-feeding and the increased availability of fermentable carbohydrates contents in baby bottles such as milk, natural juice, artificial juice and lemonade may contribute to high ECC in rural Salvadorian children.

Another contributing factor for ECC is a phenomenon often referred to as “breastfeeding at will” or “breastfeeding on demand”. (19) Evidence that breastfeeding leads to ECC is controversial and confusing. In studies from Brazil and Turkey, there were no significant correlations between breastfeeding and ECC. (9) However, studies from Japan and Saudi Arabia support a correlation between breastfeeding on demand and ECC when continued

for more than 18 months. (39, 40) Similarly in our study, in rural El Salvador 96% of children were breastfed longer than 17 months. Therefore, it appears that feeding habits and the contents of the baby bottles can have an impact on ECC. (28) (42) (43)

Mouth Pain:

In this study, 60% of older children (3-6 years) with ECC reported oral pain. Studies have shown that children's oral health significantly impacts their physical, mental, and social well-being as assessed by their parents. (44) Painful caries can lead to difficulty eating and sleeping and paying attention at school. Pain can also lead to challenges with daily activities that can disturb basic functioning and growth and development. In addition, research has shown that children with ECC were rated by their parents as having worse oral health-related quality of life than caries-free children, and experienced significant improvements in complaint of pain, eating preferences, quantity of food eaten, and sleeping habits after treatment of dental caries. (45) Although formally assessing quality of life was beyond the scope of this study, our finding that more than half of the older children reported oral pain may indicate impairments in quality of life for this population.

Effectiveness of the Community-based Intervention

In 2002, the World Health Organization (WHO) and United Nations Children's Fund (UNICEF) developed a Global Strategy on Infant and Young Child Feeding to focus world attention on the impact of community-based interventions to improve feeding in infants and young children, and identification of factors important to ensure that interventions are successful and sustainable. In this study, oral health awareness and fluoride application starting in infancy were incorporated into a rural community health program in El Salvador. Results of the intervention show reductions in caries experience and mouth pain experience in children 3 to 6 years of age, which is consistent with the WHO and UNICEF recommendations on sustainable and successful community health intervention programs.

This community-based program has unique advantages and limitations. One important advantage is that families and communities were not just beneficiaries of the

interventions, but the also became resources to shape the interventions. The use of trained health workers from the community allowed for the implementation of health care close to where mothers, other caregivers, and young children lived. (2) After the conclusion of the study, the local community took ownership of the program and ensured its sustainability. Results of the study showed improvements in oral health and aspects relating to quality of life of the children. A limitation of this study was the absence of standardized inter-examiner calibration, since the dental examiners were volunteer US dentists who visited El Salvador annually.

CONCLUSION

This study shows that ECC is a common public health problem in rural El Salvador. Incorporation of oral health education, oral hygiene supplies and fluoride supplementation in an established community-based maternal-child health program beginning in infancy, appears to show improvements in children's oral health and quality of life over time. ASAPROSAR community health workers continue to provide education on oral hygiene and fluoride varnish application in conjunction with Ministry of Health dentists in El Salvador.

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Table I. Demographic Characteristics at baseline (2006)		Characteristics
		Child N=204
Participating child mean age, years (SD)		3.9 (1.70)
Participating child gender		42% M, 58%F
Participating child immunization up-to-date		96%
Mother age, years		30.5 (SD 9.57)
Mother's level of education		4.5 (SD 3.4)
Mother's prenatal care visits		90%
Number of children in family		3.0 (SD 1.8)
Number living in the house		5.1 (SD 1.8)
Potable water		55%
Electricity		78%
Cooking materials		
Wood only		41%
Wood and Gas		41%
Gas only		18%
Nutrition Practices		
Child ever breast fed		96%
How long breast fed (months)		17.8 (SD 11.9)
Child ever bottle fed		45%
How long bottle fed (months)		25.4 (SD 10.2)
Child drinks in the bottle:	Water	13%
	Milk	38%
	Formula	4%
	Coffee	7%
	Lemonade	14%
	Natural Juice	13%

	Artificial Juice	19%
	Soda	8%
	Sugar water	11%
Oral Health Practices		
Participating child has a toothbrush		84%
Participating child has a toothpaste		74%
Mother reports brushing child's teeth		65%
Participating child ever been to the dentist		30%
Mother never been to the dentist		54%
Mother last dental visit due to mouth pain		60%

Table-II: The number and percent of children in each age group by year

Age	2006	2007	2008	2009	2010
0	7 (15%)	25 (18%)	22 (20%)	19 (15%)	21 (14%)
1	19 (41%)	54 (39%)	49 (44%)	59 (45%)	52 (36%)
2	20 (43%)	59 (43%)	40 (36%)	52 (40%)	73 (50%)
3	27 (17%)	35 (23%)	42 (32%)	32 (29%)	43 (32%)
4	44 (28%)	41 (27%)	35 (27%)	26 (23%)	31 (23%)
5	50 (32%)	44 (29%)	33 (25%)	32 (29%)	37 (28%)
6	37 (23%)	34 (22%)	22 (17%)	21 (19%)	22 (17%)
Total #	204	292	243	241	279

Figure Legends:

Figure 1. Mean dmft scores and the prevalence of caries and mouth pain increased with age in young El Salvadorean children from rural communities. The graphs illustrate the prevalence of caries (A), dmft score (B), and mouth pain prevalence (C) across different age groups (N=1259 dental visits).

Figure 2. Mean dmft scores and the prevalence of caries and mouth pain in young El Salvadorean children from rural communities fluctuated in tandem with the presence of a community based intervention program. The graphs illustrate the prevalence of caries (A), dmft score (B), and mouth pain prevalence (C) over time, (years 2006-2010; N= 1259 dental visits).

Figure 3. Older El Salvadorean children experienced a significant reduction in the prevalence of severe ECC over time following the adoption of a community based intervention program. The graph illustrates the levels of severe ECC (S-ECC) in different age groups, pre- and post-intervention (N= 1092 dental visits), (* = $p<0.05$)

Figure 4. Older El Salvadorean children experienced a significant reduction in mouth pain over time following the adoption of a community based intervention program. The graph illustrates the changes in mouth pain frequency of different age groups, pre- and post-intervention (N= 1092 dental visits), (* = $p<0.05$).

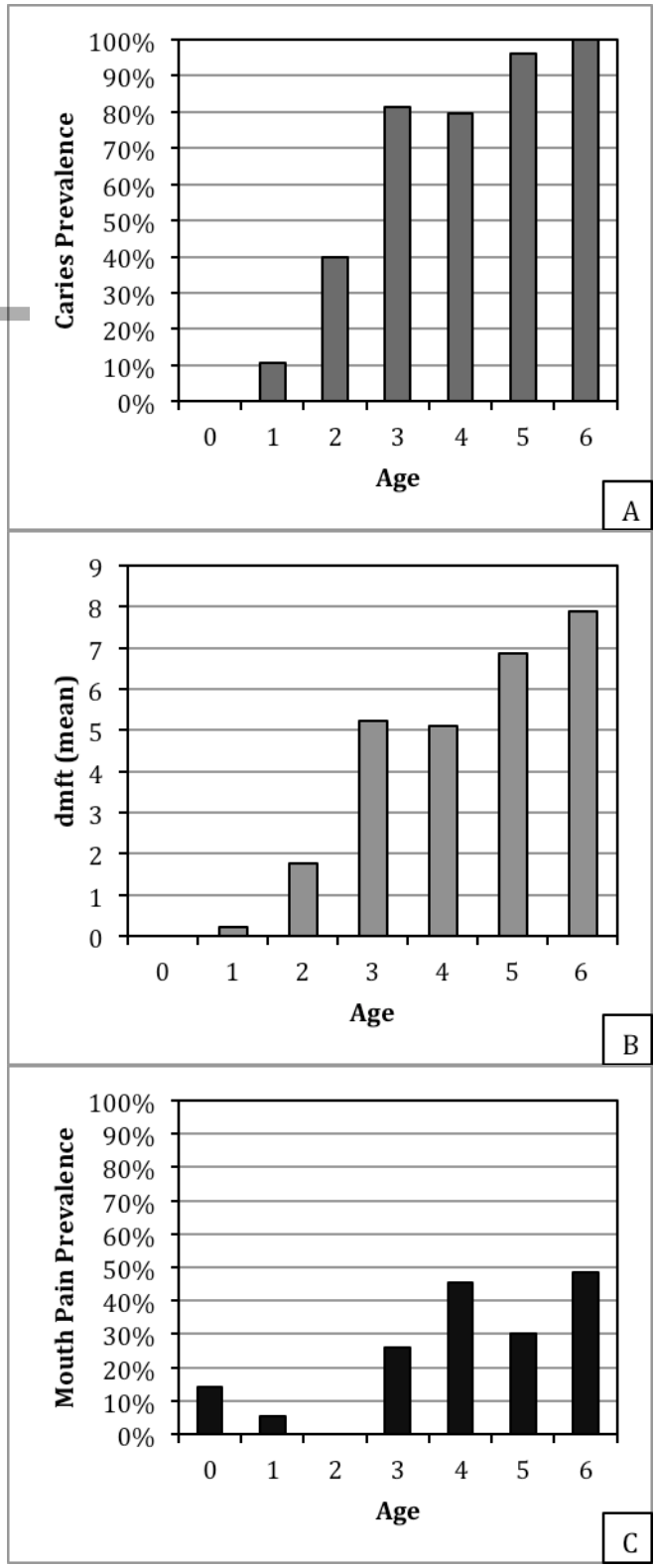

Figure-1: A. Prevalence of caries, B. dmft and C. mouth pain score across different age groups (N=1259 dental visits)

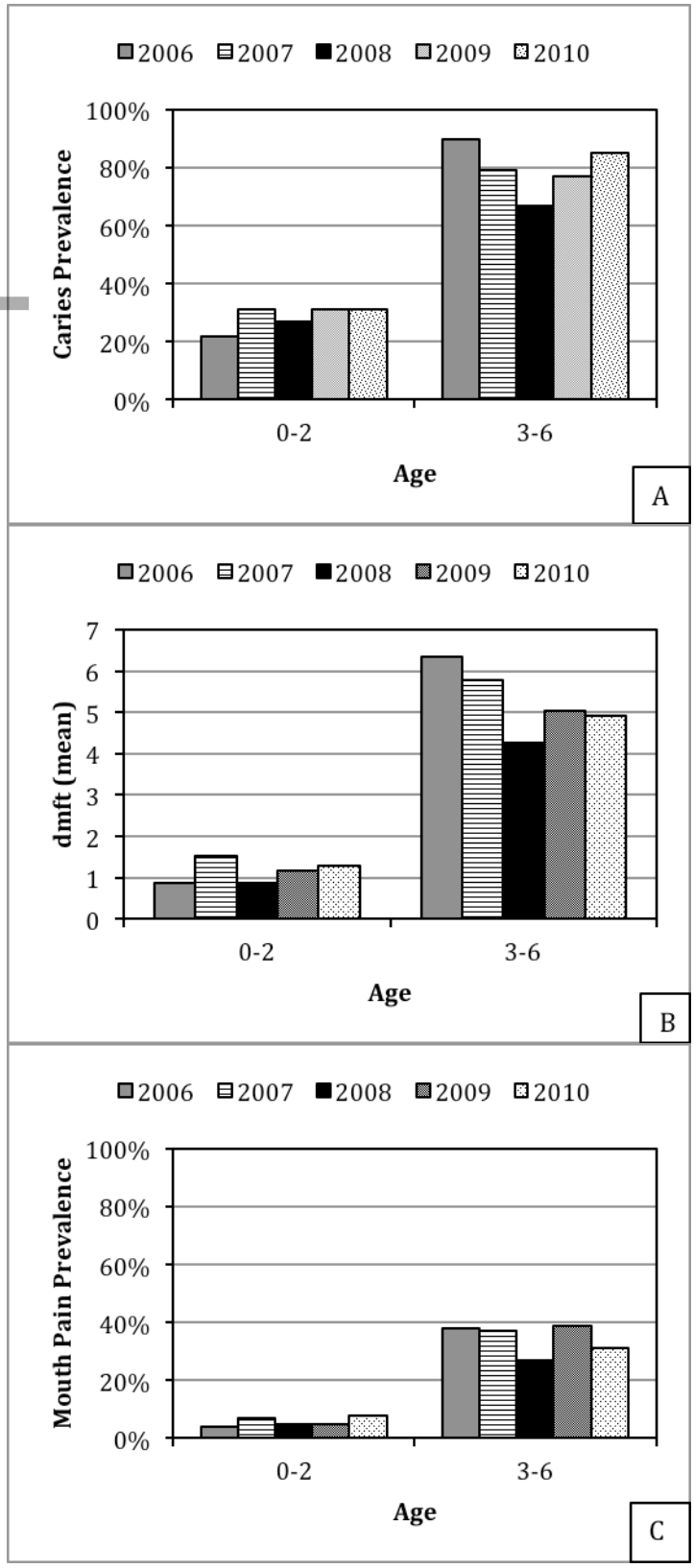

Figure-2: Prevalence of caries, B. dmft and C. mouth pain score over time, years 2006-2010 (N= 1259 dental visits)

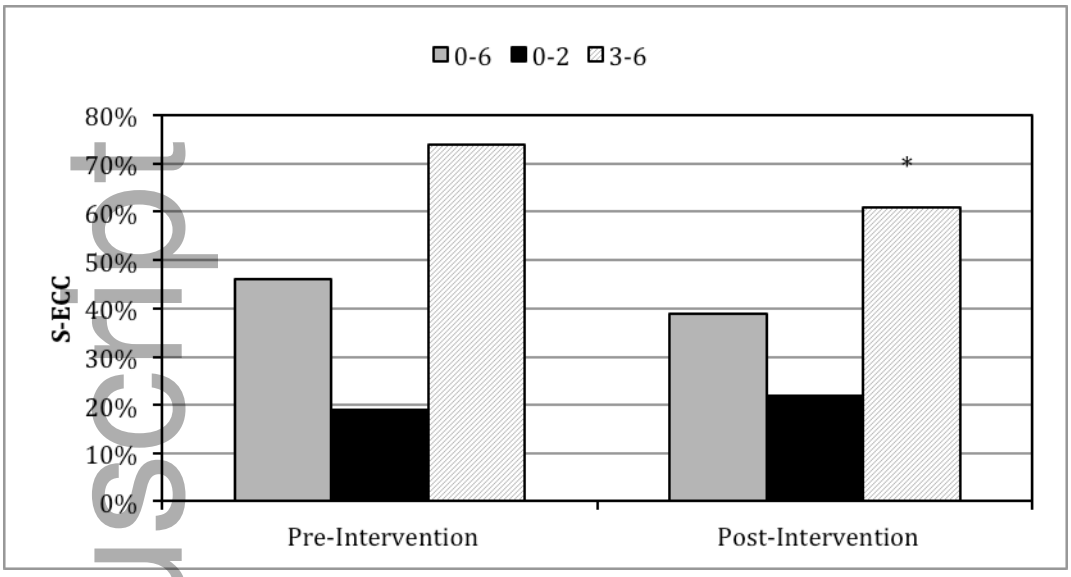

Figure-3: The effect of intervention on reducing dental caries risk (N= 1092 dental visits), (* = $p<0.05$)

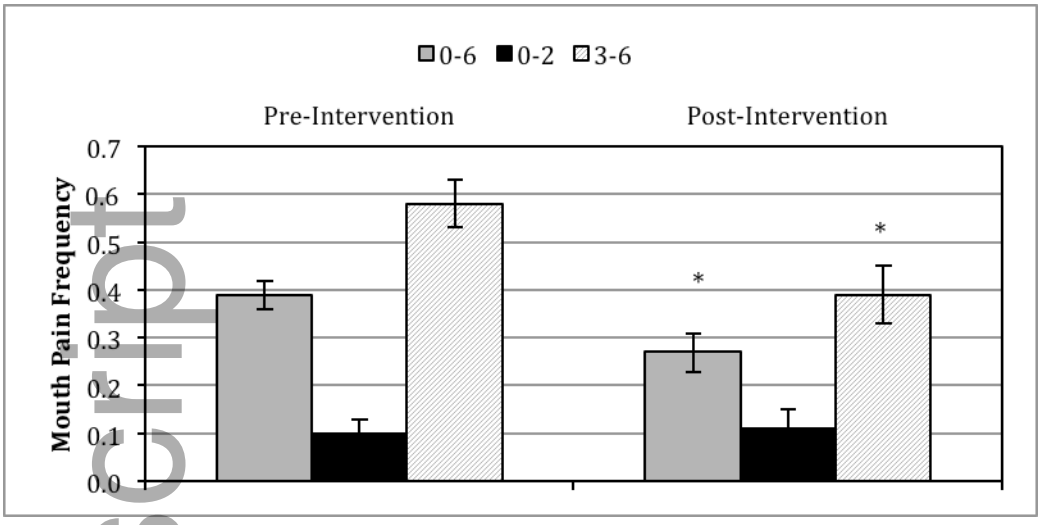

Figure-4: The effect of intervention on reduction of mouth pain (N= 1092 dental visits), (* = $p<0.05$)