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The Open Dentistry Journal, 2013, *7*, 175-180

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Fluoride Exposure, Caregiver Education, and Decayed, Missing, Filled Teeth (*dmft)* in 2-5 year-old English or Spanish Speaking Children

Paola R. Uceda[1], Lauren A. Sanzone[2], Ceib L. Phillips[3] and Michael W. Roberts[2,*]

[1]*Private general practice, 6334 Seton House, Charlotte, NC 28277*

[2]*Department of Pediatric Dentistry, School of Dentistry, University of North Carolina, Chapel Hill, NC 27599-7450, USA*

[3]*Department of Orthodontics, School of Dentistry, University of North Carolina, CB#7450, Chapel Hill, NC 27599-7450, USA*

Abstract: Dental caries is a multifactorial disease that includes behavioral and cultural components. The study's purpose was to determine the caries experienced (as measured by *dmft*) in a group of 2-5 y/o children, assess their family and home environment including consumption of fluoridated drinking water, use of a fluoride containing dentifrice, and level of caregiver formal education.

Parents of children referred for dental treatment under general anesthesia and who either spoke and read English or Spanish were recruited and consent obtained. Selected information on the family home, parental education and selected fluoride contact data was obtained. An oral clinical examination of the child assisted by intraoral radiographs was completed and the number of decayed, missing, filled primary teeth (*dmft)* recorded for each child. Bitewings were obtained if posterior or anterior teeth contacts were closed but only periapical radiographs were obtained if contacts were open. Children of English speaking caregivers had statistically more *dmft* after controlling for the effect of the child's age and years of parental education ($p=0.04$). English speaking families had lived in their current home longer and the parent had more formal education than did the Spanish speaking parent. When available, the English children drank municipal tap water more often than did the Spanish children. Spanish speaking parents often chose bottled drinking water. No difference between the two groups was found in the use of tap water for cooking or the use of fluoridated dentifrice.

In conclusion, increased parent education, language spoken by the parents and time living in the current home were not associated with lower *dmft*. Drinking fluoridated drinking water did not affect the *dmft*. However, using fluoridated water when available to cook and using fluoride containing dentifrice by both groups may have been mutually beneficial.

Keywords: Caries, education, ethnicity, fluoride, parent, teeth.

INTRODUCTION

Dental caries is a multifactorial, chronic, transmissible disease that is prevalent in both industrialized and developing countries [1]. Among preschool children, dental caries is the most common childhood illness with a prevalence surpassing asthma and constitutes a major health problem [2-4]. A disproportionately large disease burden has been found among children from low-income families and racial-ethnic-minority groups [5-8]. There has recently been a large increase in the Hispanic population in the United States. The 2010 census showed the Hispanic population in the US grew by 43%, or four times the nation's 9.7% growth rate [9].

*Address correspondence to this author at the Department of Pediatric Dentistry, School of Dentistry, University of North Carolina, CB#7450, Chapel Hill, NC 27599-7450; Tel: (919)537-3955; Fax: (919)537-3950;
E-mail: mike_roberts@dentistry.unc.edu

Among children 2-5 years of age, twenty-eight percent have experienced early childhood caries (ECC). This figure increases to 90% among Head Start children aged 3-5 years of age with no differences between males and females [10-15] ECC is defined as one or more decayed, missing or filled tooth surface in the primary dentition of a child aged 6 years or younger and is the result of multiple processes initiated by inappropriate diet and feeding practices [16]. Specific tooth-adherent bacteria metabolize dietary sugars and fermentable carbohydrates to produce acids which demineralizes tooth structure [17]. Race and percent of poverty level have been identified as significant factors in the number of untreated caries. Hispanic children of Mexican origin and children below 100% poverty level had significantly more untreated caries [15, 18, 19]. In a study in Arizona, preschool children with caregivers in the lowest income category had a mean *dmft* score four times higher than those with caregivers in the highest category [20].

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Most children can be successfully treated in the dental office environment with the use of traditional behavior management techniques such as tell-show-do, nitrous oxide-oxygen analgesia, or conscious sedation with the assistance of pharmacological adjuncts. However, many very young children with significant dental disease and demonstrated acute situational anxieties associated with dental care, as well as patients with special health care needs must have their dental care completed in the operating room under general anesthesia [21-24].

The purpose of this study was to assess in a non-generalized sample the relationship between caries prevalence, level of parent education, home environment, consumption of fluoride containing drinking water and use of fluoride dentifrice among relatively healthy 2-5 year old children of English or Spanish speaking families who were scheduled for comprehensive dental care in the operating room under general anesthesia.

MATERIALS AND METHODOLOGY

This study was approved by the Institutional Review Board of the University of North Carolina-Chapel Hill (Study # 10-0361). Potential research subjects included families with children between 2-5 years of age who were scheduled for comprehensive dental treatment in the University of North Carolina Hospitals operating room under general anesthesia due to the amount of dental disease present or because of the child not being able to cooperate for dental care in the conventional manner. All age-eligible children who met the health criteria of being classified as an ASA 1 or 2 [25, 26], and whose parent(s) spoke and read either English or Spanish between April 2010-February 2012 were eligible to participate. Parents of 248 children agreed to participate in the study, including 126 English-speaking and 122 Spanish-speaking subjects. We did consecutive sampling with a target goal of a minimum of 100 subjects per group which would provide sufficient power to detect moderate differences. The participating parent signed an approved Consent to Participate in a Research Study form and completed a survey questionnaire in their preferred language. The survey form solicited information in the following areas: how long the family had lived in the present home, the number of years of school completed by the primary care-giving parent of the child, whether the home water came from a municipal water supply or from a private/community well, whether the drinking water was fluoridated, whether the child drank water from the home tap and how many glasses of water were consumed per day, whether the child consumed bottled water, whether tap water was used for cooking in the home, and whether the child's teeth were brushed with a fluoridated dentifrice. No child in the study was reported to have taken or was taking a fluoride supplement. Data from the completed questionnaires were reviewed and entered on an Excel spread sheet. All families whose home received water from a private/community well were offered a water sample collection kit to determine whether the water source contained measurable amounts of fluoride. The water analysis was completed by the State Laboratory of Public Health (North Carolina).

For each child, a complete oral examination was completed in the operating room and a full series of six-to-eight intraoral periapical and/or bitewing radiographs were obtained, with the exact number depending upon whether the contacts of the posterior and anterior teeth were open and could be examined visually. One calibrated study investigator (MWR) reviewed the oral examination and dental radiographs to determine the *dmft* score for each child. Bivariate analyses (Chi-square for nominal, and Wilcoxon Rank Sum for continuous variables) [27] were used to assess whether the English speaking and the Spanish speaking families differed in demographic, fluoride usage characteristics and the *dmft* of the children. Linear regression was used to assess whether the average *dmft* of the two groups differed after adjusting for the educational level of the primary care giver and the age of the child. Level of significance was set at 0.05.

RESULTS

Data from 124 English and 117 Spanish speaking families were included in the statistical analysis. Children from two English speaking and five Spanish speaking parents originally enrolled in the study were excluded from the analyses due to incomplete data. A significant difference was found between the median ages of the children in the two groups ($p=0.006$). The median age of the children in the Spanish speaking family group was younger than that in the English speaking family group. There was also a significant difference between the two groups in how long the family had lived at the current address ($p=0.05$). No difference was found in the number of male and female children ($p=0.75$) in the two groups. Age of the child was positively associated with an increased *dmft*; older children tended to have a higher *dmft* score ($r=0.21$; $p<0.001$). There was also a significant difference between the two groups in the median number of years of formal education completed by the primary care-giving parent. ($p<0.001$). The median number of years completed by Spanish speaking care-givers was 9.0 years, compared to 12.0 years among English-speaking caregivers (Table **1**). Children of English speaking caregivers had statistically more *dmft* after controlling for the effect of age of the child and years of formal care-giver education ($p=0.04$). The adjusted median *dmft* score was 8.5 for children in English speaking families and 7.0 for children in Spanish speaking families. The age of the child was associated with *dmft* even after controlling for parental education level and language group ($p<0.001$) (Table **2**).

Spanish speaking families lived in homes with municipal tap water more often than did English speaking families ($p<0.001$). Virtually all municipal water supplies were fluoridated ($p=0.006$). In only one incidence was a measurable amount of fluoride detected in a private well (0.26 parts per million/fluoride), a level significantly lower than the current recommendation for optimal fluoridation of drinking water. English speaking families drank the water from the tap significantly more often ($p<0.001$) than did the Spanish speaking families, while Spanish speaking families were more likely to choose bottled drinking water ($p<0.001$). It was not determined whether the bottled water drank contained fluoride (Table **3**). When tap water was drunk, children of Spanish

Table 1. Decayed, Missing and Filled Teeth (dmft) and Demographic Variables (n=241)

Variable	Spanish (n=117)			English (n=124)			p-value
	Median	P_{25}	P_{75}	Median	P_{25}	P_{75}	
dmft	7.0	4.0	10.0	8.5	6.0	11.0	0.004
Years family living at current address	2.0	1.0	4.0	3.0	1.0	6.3	0.05
Years of education of primary care-giving parent	9.0	6.0	12.0	12.0	12.0	14.0	<0.001
Age of child in years	3.4	2.8	4.3	4.1	3.3	4.8	0.006
Gender							
Male	59 (50%)			60 (50%)			0.75
Female	58 (48%)			64 (52%)			

Note:
Chi-square test was used for gender (categorical variable).
Wilcoxon rank-sum test was used for the other variables (continuous variable).
P_{25} (25^{th} percentile)
P_{75} (75^{th} percentile)

Table 2. Anova table for linear regression model assessing the effect of language, age of child, and parent's years of education on dmft scores in children from English and Spanish speaking families

Effect	DF	Type III SS	MS	F-value	p-value
Language	1	57.25	57.25	4.08	0.04
Age	1	103.22	103.22	7.36	0.001
Years of education	1	0.41	0.41	0.03	0.87

Assessment of the effect of language and age of child on number of glasses of water drunk by children in English and Spanish speaking families

Effect	DF	Type III SS	MS	F-value	p-value
Language	1	4.02	4.02	2.81	0.09
Age	1	0.35	0.35	0.24	0.62

DF (degrees of freedom)
Type III SS (Type III Sum of Squares)
MS (Mean Square)

Table 3. Water Sources and Fluoride Exposure Among Study Participants

Variable	Spanish	English	p-value
	N (%)	N (%)	
Home water supply			
Municipal	96 (82.1)	74 (59.7)	<0.0001
Well	21 (17.9)	50 (40.3)	
Fluoridated tap water			
Yes	93 (79.5)	60 (48.4)	0.0006

Table 3. contd…

Variable	Spanish	English	p-value
	N (%)	N (%)	
No	9 (7.7)	34 (27.4)	
Do not know	15 (12.8)	30 (24.2)	
Glasses of water drunk per day	2.27	2.63	0.01
Drinking water source			
Tap water	48 (41%)	93 (75%)	<0.001
Bottled water	69 (59%)	31 (25%)	<0.001
Use tap water to cook	109 (93%)	117 (94%)	0.57
Use fluoridated dentifrice	103 (88%)	108 (87%)	0.35

Chi-Square was used for categorical variables
Wilcoxon rank sum used for glasses of water drunk per day

speaking families drank fewer glasses of water, on average, than children of English speaking families (P=0.01). However, this difference was explained by the difference in the age distributions in the two groups (Table **2**). No difference was found between the two groups in the use of tap water for cooking (p=0.57) or in the use of fluoride containing dentifrice to clean the teeth (p=0.35) (Table **3**).

DISCUSSION

Children raised in communities that have a recommended level of fluoride in the drinking water have fewer dental caries [28]. In our study the Spanish speaking families were more transient but they were also more likely to live in urban areas with a municipal water supply than were the English speaking families. Municipal water sources were generally fluoridated (79.5%) but only one private well tested had any detectable fluoride content. Thus, the children of Spanish speaking parents more often had access to fluoride in their home tap water but their families often chose to drink bottled water rather than tap water therefore probably missing the benefit from drinking water containing an optimal level of fluoride. From professional experience, although commercially available, Spanish speaking families do not tend to purchase bottled fluoridated water. Thus, it is presumed that the bottled water did not contain fluoride. Spanish speaking caregivers often expressed a preference for drinking bottle water due to cultural concerns for the safety of drinking tap water. In our study, whether the child did or did not consume known fluoridated drinking water during these early formative years did not appear to affect their caries prevalence. However, when available both groups primarily used tap water for cooking which could have introduced fluoride into the diet.

Fluoride prevents caries mainly by its topical effect [29]. However, the dental caries preventing benefits of fluoride can be obtained by means other than by drinking water containing fluoride and both groups used primarily fluoride containing dentifrice [11, 30-36]. The families that used drinking water from a private/community well rarely had the benefit of fluoridated water as fluoride is rarely found in the catchment area of this study. The regular use of a fluoride containing dentifrice has been demonstrated to be beneficial in reducing the incidence of caries [37]. However, the number of times a day the child's teeth were brushed and whether the brushing was done by the child alone or with adult assistance was not recorded.

It is not known what combination of global fluoride exposures is adequate for caries prevention. Since there was no difference between the two groups relative to the use of municipal tap water for food preparation, possibly the fluoride in the water used for cooking or from other sources, such as soda, juice and infant formula, may have confounded the results.

It has been reported that the prevalence of *dmft* among children is often indirectly related to the family's socioeconomic status [6-8, 15, 18-20]. The socioeconomic status of a family is often positively related to the years of formal education/ training by the parent(s). This would suggest that the English speaking families in this study should be more economically comfortable. However, an inverse relationship between years of formal education of the primary care giver and caries prevalence in the affected child was not found. No relationship was found between the caregiver's education level and the *dmft* of their child in either the English or Spanish speaking samples (English r=-0.06, P=0.52; Spanish r=0.01, P=0.88). This may suggest that an education threshold had not been reached to make a measureable difference in the socioeconomic status of the two groups. It may also suggest that in comparing Spanish-versus English-speaking caregivers, there are other factors affecting caries prevalence. Although the sample size per group may be an issue with respect to detecting such small differences between the groups, it is more likely that families, both English and Spanish speaking, whose children require treatment in the operating room represent unique populations.

The diet of the two groups of children was not examined. Whether there was a significant difference in dietary contacts and frequency with sugar and other fermentable carbohydrates is not known.

CONCLUSIONS

1. Under the conditions of this study in this non-generalized group of relatively healthy children referred for comprehensive dental care in the operating room under general anesthesia, children of English speaking caregivers had statistically more *dmft* compared to the children of Spanish speaking caregivers after controlling for the effect of age of the child and years of formal caregiver education.

2. English speaking caregivers reported significantly more years of formal education than the Spanish speaking parents. However, it is unknown whether a threshold level of formal education exists above which risk of caries in their children begins to decrease.

3. Drinking fluoridated municipal tap water rather than bottled water did not appear to result in a reduced *dmft*.

4. When available, both English and Spanish speaking groups reported generally using fluoridated municipal water supply for cooking. In addition, both groups reported equally using a fluoride containing dentifrice to clean the children's teeth. These fluoride exposures may have provided some dental protective benefits to both groups.

CONFLICT OF INTEREST

The authors confirm that this article content has no conflicts of interest.

ACKNOWLEDGEMENTS

Declared none.

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Received: August 26, 2013 Revised: October 31, 2013 Accepted: November 11, 2013