Association between Early Childhood Caries, Feeding Practices and an Established Dental Home

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Abstract

Purpose: Early Childhood Caries (ECC) is a significant public health concern disproportionately affecting low-income children. The purpose of this study was to assess the association between the establishment of a dental home and ECC prevalence in a group of Medicaid-enrolled preschool children, and to explore feeding practices associated with an increased prevalence of ECC in Medicaid-enrolled preschool children with an established dental home was evaluated.

Methods: A cross-sectional survey was conducted among Medicaid-enrolled children (n=132) between 2 and 5 years of age with an established dental home and no dental home to compare feeding practices, parental knowledge of caries risk factors and oral health status.

Results: Children with an established dental home had lower rates of biofilm ($p<0.05$), gingivitis ($p<0.05$) and mean decayed, missing and filled teeth (DMFT) scores ($p<0.05$). Children with no dental home consumed more soda and juice ($p<0.05$) daily, and ate more sticky fruit snacks ($p<0.05$) than children with an established dental home. Establishment of a dental home had a strong protective effect on caries and DMFT index (odds ratio=0.22) in both univariate and confounding adjusted analyses.

Conclusion: The results suggest establishment of a dental home, especially among high-risk, low-income populations, decreases the prevalence of ECC and reduces the practice of cariogenic feeding behaviors.

Keywords: caries risk assessment, caries, diet, feeding methods, socio-economic status, Medicaid, preventive dentistry

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Introduction

Dental caries is an infectious, transmissible, bacterial disease affecting children and adults of all races, ethnicities and socio-economic levels.[1,2] It is a major public health problem both within the U.S. and around the world, and has devastating effects including pain, infection, nutritional insufficiencies, learning and speech problems, and even death.[3] While disturbances in the balance between bacteria and host are the factors traditionally responsible for caries development, factors such as family, economic and social conditions also have a substantial impact on the development of the disease.[4,5] Current research has demonstrated that multiple risk factors are responsible for the occurrence and prevalence of caries, including frequent sugar consumption, improper oral hygiene, high levels of oral bacteria, cariogenic feeding practices, socio-economic status, minority status and inconsistent oral health care access.[3,4,6-10]

Early childhood caries (ECC) is defined as caries in children younger than 72 months of age, and disproportionately affects low-income families.[4,11-14] Populations with low-income levels and high utilization of Medicaid insurance have been shown to have an increased risk of ECC development.[15] Preventive dental care and education is critical for parents of high-risk children to identify current dental health concerns and prevent future problems.[12] However, within the U.S., only 40% of low-income children have received preventive dental care compared to 54% of higher income children.[16] Many barriers affect access to dental services for disadvantaged children including a lack of providers, cost of services, as well as culture and oral health beliefs.[12,17] Consequently, the prevention of ECC in high risk, Medicaid-enrolled children remains a challenge for health care personnel in the fields of dentistry and medicine.[5,8]

An anticipatory approach emphasizing oral health promotion is likely to have the greatest positive effect on children's oral health.[5] Preventive care visits can be utilized to educate parents and caregivers on proper oral hygiene techniques as well as known behavioral and social risk factors for

ECC development.[6,9] Nutritional education should be provided during preventive care visits in order to ensure cariogenic feeding practices are avoided and proper dietary guidelines are being followed for optimal oral and overall heath. The goal of providing anticipatory guidance for the caregiver is to modify or eliminate practices and behaviors known to increase caries disease risk for the child.[4,8]

The American Academy of Pediatric Dentistry (AAPD) policy statement indicates the following should be provided by a dental home:[18]

- Comprehensive assessment
- Individualized preventive care based on caries and periodontal risk
- Anticipatory guidance related to growth and development including care of the child's soft and hard tissues
- Education of parents/caregivers on management of acute dental trauma
- Nutrition assessment and counseling
- Comprehensive care including preventive services according to AAPD guidelines
- Referral as needed to specialists

There is a lack of evidence evaluating the impact of an established dental home (as defined by the AAPD as "an ongoing relationship between the dentist and the patient, including all aspects of oral health care delivered in a comprehensive, continuously accessible, coordinated, and family-centered way") on ECC prevalence and risk, particularly in high-risk populations.[19] The purpose of this cross-sectional study was to explore:

1. The association between the establishment of a dental home and ECC prevalence in Medicaid-enrolled preschool children
2. Feeding practices associated with an increased prevalence of ECC in Medicaid-enrolled preschool children with an established dental home

Methods and Materials

An observational, cross-sectional study using a survey instrument was conducted at a dental center providing care to primarily children and adolescents in Manchester, NH. Data from the 2010 Census estimates 13.8% of Manchester residents have incomes at or below the Federal Poverty Level (FPL).[20] The New Hampshire Department of Health and Human Services (NHDHHS) indicates that of the 135,012 New Hampshire residents enrolled within the Medicaid program in 2010, 24,080 reside in Manchester, accounting for 12% of its total population.[20] Overall, from 2009 to 2010, there was a 5% increase in Medicaid enrollments throughout the state and the percentage of children enrolled reached 60.2% of all enrollees.[21]

The dental center used for the present study adheres to the policy of the AAPD regarding the expectations of care within an established dental home. Patients receive a prophylaxis and examination on a bi-yearly basis during 45-minute appointment times. The 4 general dentists and 5 dental hygienists provide all aspects of this policy including:[22]

- Individualized preventive dental health plans, specific to a child's caries risk assessment
- Anticipatory guidance about growth and development
- Education regarding proper oral hygiene techniques
- Individualized nutritional counseling

This study population consisted of a convenience sample of 132 Medicaid-enrolled male and female children between 2 and 5 years of age attending their scheduled preventive appointment at the dental center during the study period. The established dental home group (n=101) inclusion criteria were those children who had preventive care and anticipatory guidance as outlined by the AAPD policy on a dental home within the last year at the dental center.[19] The no dental home group (n=31) inclusion criteria for children were those who had no history of preventive or restorative dental visits. Parental or guardian informed consent was obtained for the child's participation. The institutional review board at the affiliated university approved and oversaw the administration of the study.

Sampling Procedure and Data Collection

A survey instrument was adapted from the demographic, diet and nutritional sections of the National Health and Nutritional Examination Survey (NHANES) III.[22] The instrument consisted of questions regarding the child's demographics (2 items), feeding practices (14 items), dental history (3 items) and current parental knowledge of caries risk factors (1 item). The survey instrument was completed by the parent or guardian during the child's preventive appointment.

The validity of the questionnaire was assessed using a content validity index (CVI). Six experts in the fields of dentistry and nutrition evaluated the survey and determined the questions were an adequate representation of the study's research questions. Each expert employed a 4-point scale to calculate a value on the individual content (I-CVI) as well as the overall content (S-CVI). The content validity was deemed excellent if the I-CVI was 0.78 or higher for 3 or more experts and the S-CVI was 0.90 or higher.[23] For the study questionnaire, 4 or more experts agreed with each

item giving an overall I-CVI of 0.97. The S-CVI for the questionnaire was 0.93 indicating an overall excellent content validity.

A pilot survey (n=10) was conducted to pre-assess parent or caregiver survey completion time and ease of comprehension. Additionally, the pilot screenings were used to assess and implement standard practices for the dental hygienists providing the survey. The results of the pilot assessments were not included in the final study results.

The child's current dental health status was coded using an examination meeting the guidelines from the dental center and forms adapted from the World Health Organization's Basic Model of Oral Health Surveys.[24] Documented information included active caries, treated caries and oral hygiene status. All of the clinicians were calibrated prior to the beginning of the study to ensure accurate recording of data. Each clinician performed the data retrieval process on at least 5 patients and the results were compared and discussed, and methods modified until 100% agreement was attained to ensure consistent documentation. This training practice was modified from the CDC's Dental Examiners Procedures Manual developed for the NHANES.[22]

During the prophylaxis appointment, the dental center's odontogram was utilized to document any existing restorations and/or missing teeth. Throughout the clinical exam performed by the dentist, the areas of active caries were also recorded on the odontogram form. The data was then transferred from the odontogram to the decayed, missing and filled teeth (DMFT) index at the end of the questionnaire. The DMFT index for primary teeth was employed due to the age of the study participants. The clinical assessment form was also used to document the child's oral hygiene, indicating the presence of dental biofilm and/or gingivitis. The prophylaxis and exam was conducted using either the knee-to-knee technique with the parent or guardian or with the child in the dental chair, dependent upon patient behavior. A mouth mirror was utilized to identify dental biofilm, gingivitis, restored caries and missing teeth. The dental examination was conducted using an explorer, mouth mirror and radiographs, if possible, to diagnose active carious lesions.

The general dentists at the dental center employed visual, tactile (using an explorer) and radiographic (using bitewing and/or occlusal radiographs) means for caries detection. These techniques of caries detection are dependent upon patient behavior and, consequently, not all means were utilized for every patient. Surface demineralization or a white-spot lesion was not documented as a carious lesion but rather used as an educational tool for parents in terms of improving or modifying their child's nutrition or oral hygiene. Following the prophylaxis and exam, the child received a fluoride varnish application, oral hygiene instructions and nutritional counseling.

Data Analysis

To investigate the association between ECC prevalence in Medicaid-enrolled preschool children and the establishment of a dental home, general and demographic characteristics data were compared between the 2 groups (established dental home vs. no dental home) (Table I). Categorical and binary variables were compared utilizing global chi-square tests of independence, with continuous variables compared using nonparametric Mann-Whitney U tests.[25,26] Feeding practices were compared between the 2 groups using chi-square tests of independence (Figures 1, 2, 3). Note that adjustments for multiple comparisons were not performed due to a priori specification of comparisons.[27]

As an indicator of the presence of caries, DMFT index was dichotomized into DMFT>0 and DMFT=0. Univariate logistic regression associating dichotomized DMFT index with establishment of a dental home was performed, with "Multivariate Model I" including age and gender as covariates using multivariate logistic regression (Table II).[28] For "Multivariate Model II," a model selection procedure was performed among candidate covariates age, sex, child breastfed, age bottle usage ended, usage of a sippy-cup, daily servings of milk, soda, and juice, partaking in snacking, age of first dental appointment, presence of biofilm, and presence of gingivitis. To assess and control for potential confounding as well as identify strong predictors of outcome, inclusion in the "Multivariate Model II" required meeting one or more of the following criteria: whether inclusion or exclusion of the variable from the univariate model changed the adjusted odds ratio for established dental home by ≥10%, or inclusion in a stepwise logistic regression model met the pre-specified alpha threshold (alpha=0.05).[29,30] Variables that changed the adjusted odds ratio by ≥10% were forced into the stepwise model. The final model included age, gender, daily serving of juice, age of first dental appointment, presence of biofilm, and presence of gingivitis (Table II). To investigate the associations of feeding practices on DMFT index in the established dental home group, over-dispersion corrected univariate Poisson regressions via a scaling factor were performed (Table III).[31] Statistical analyses were performed in STATA® statistics/data analysis software version 11.2.

Table I: Demographic and Characteristic of Study Population

	No Dental Home (n=31)	Established Dental Home (n=101)
Mean Age, Months (SD)	47.77 (13.92)	48.77 (13.87)
Gender, n (Percent Male)	17 (54.8%)	54 (53.5%)
Ever Breastfed, n (Percent)	17 (54.8%)	35 (34.7%)*
On-Demand, n (Percent)	14 (45.2%)	29 (28.7%)
Stopped Breastfeeding*		
1 To 12 Months, n (Percent)	15 (48.4%)	33 (32.7%)
13 To 24 Months, n (Percent)	2 (6.5%)	2 (2.0%)
Bottle Feeding		
Still Using, n (Percent)	4 (12.9%)	3 (3.0%)
Stopped Bottle Feeding		
1 To 12 Months, n (Percent)	17 (54.8%)	72 (71.3%)
13 To 24 Months, n (Percent)	8 (25.8%)	22 (21.8%)
>25 Months, n (Percent)	2 (6.5%)	2 (2.0%)
Child Put To Bed With Sippy Cup		
With Milk, n (Percent)	14 (45.2%)	30 (29.7%)
With Juice, n (Percent)	8 (25.8%)	15 (14.9%)
With Milk and Juice, n (Percent)	6 (19.4%)	9 (8.9%)
Child Drinking Throughout The Day		
Milk, n (Percent)	13 (41.9%)	28 (27.7%)
Juice, n (Percent)	11 (35.5%)	26 (25.7%)
Child Snacking Throughout The Day	29 (93.5%)	80 (79.2%)
Time To Finish Drink ≥1 Hour	7 (22.6%)	14 (13.9%)
Age At First Dental Visit*		
<1 Year, n (Percent)	0 (0%)	24 (23.8%)
1 To 2 Years, n (Percent)	8 (25.8%)	67 (66.3%)
3 To 4 Years, n (Percent)	9 (29.0%)	7 (6.9%)
4 To 5 Years, n (Percent)	14 (45.2%)	3 (3.0%)
Frequency Of Dental Visits		
Every 6 Months, n (Percent)	n/a	96 (95.0%)
Dental Biofilm Present, n (Percent)	30 (96.8%)	80 (79.2%)*
Gingivitis Present, n (Percent)	22 (71.0%)	45 (44.6%)*
New Caries, n (Percent)	n/a	30 (29.7%)
Mean DMFT Index (SD)	5.19 (4.32)	1.80 (2.90)**
DMFT=0, n (Percent)	7 (22.6%)	58 (57.4%)*

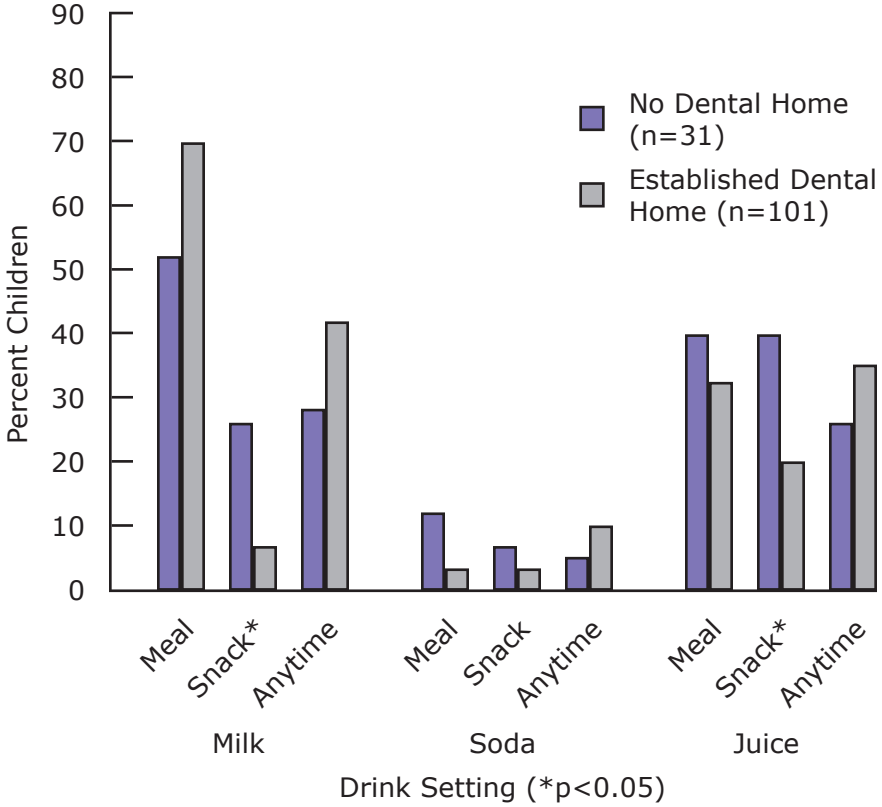
*$p<0.05$ No Dental Home compared with Established Dental Home via global Chi-square test of independence
**$p<0.05$ No Dental Home compared with Established Dental Home via Nonparametric Mann-Whitney U test

Results

As per the descriptive univariate analyses comparing the established dental home and no dental home groups, the mean age for the 2 groups were similar at 48.7 months and 47.7 months, respectively (Table I). Additionally, both groups had comparable distributions by gender, with 53.5% male in the established dental home group and 54.8% male in the no dental home group. Questions regarding breastfeeding and bottle usage revealed multiplicative univariate differences. A larger percentage of children in the no dental home group were breastfed on-demand (45.2%) and were still using a bottle (12.9%) compared to the established dental home group (28.7% and 3%, respectively). In regards to age at first dental appointment, 66.3% of the established dental home group visited

the dentist for the first time between 1 and 2 years of age, whereas the greatest percentage of the no dental home group had their first visit between 4 and 5 years of age, 45.2% ($p<0.05$). A greater percentage of the no dental home group presented with dental biofilm (96.8%) and gingivitis (71%) compared to the established dental home group (79.2% and 44.6%, respectively) ($p<0.05$). Mean DMFT index scores differed significantly, with index 5.19 for the no dental home group and 1.8 for the established dental home group ($p<0.05$). A total of 57.4% of children with an established dental home had DMFT scores of zero, compared with 22.6% in the no dental home group ($p<0.05$).

Figure 1: Comparison of Setting for Beverage Consumption between Groups



Comparing feeding practices in the 2 groups revealed statistically significant multiplicative differences. Children with no dental home were more likely to drink milk and juice during snack time ($p<0.05$) (Figure 1), to have more than 6 servings of sodas per day and drink more than 4 servings of juice per day ($p<0.05$) (Figure 2). Figure 3 illustrates those in the no dental home group more likely to consume 3 servings of sticky snacks, including dried fruit or gummy fruit snacks, per day ($p<0.05$).

Univariate logistic regression associating dichotomized DMFT index (DMFT>0 vs. DMFT=0) with establishment of a dental home (yes vs. no) produced a statistically significant odds ratio (OR) of 0.22 with 95% Confidence Interval (CI) 0.08 to 0.55 (Table II), showing a very strongly associated protective effect of establishment of a dental home on presentation of caries. Adjustment for age and gender via multivariate logistic regression further lowered the OR for establishment of a dental home to 0.15 (95% CI: 0.05 to 0.42) shown as "Multivariate Model I" in Table II. As per the model selection procedure to identify strong predictors of outcome and adjust for confounding, the OR for establishment of a dental home was further lowered to 0.10 (95% CI: 0.02 to 0.40) after adjusting for age, gender, daily serving of juice, age of first dental appointment, presence of biofilm and presence of gingivitis, shown as "Multivariate Model II" in Table II.

Of the over-dispersion corrected univariate Poisson regressions performed to assess the associations of feeding practices on DMFT index in the established dental home group, several practices were found to be strongly statistically associated with a multiplicative increase in DMFT index. Such feeding practices include: drinking juice frequently during the day ($e\beta=1.19$, 95% CI: 1.04 to 1.36), eating candy frequently during the day ($e\beta=1.21$, 95% CI: 1.01 to 1.45) consuming milk at mealtime ($e\beta=1.80$, 95% CI: 1.25 to 2.59), having juice during snack time ($e\beta=1.78$, 95% CI: 1.33 to 2.38) and drinking from a glass ($e\beta=1.82$, 95% CI: 1.29 to 2.58), as shown in Table III. Drinking from a sippy cup also showed a univariate multiplicative decrease in DMFT index ($e\beta=0.44$, 95% CI: 0.24 to 0.80).

Discussion

Oral health is essential to general health and well-being.[32] However, significant oral health disparities remain among certain socioeconomic groups within the U.S. population.[3,32] The disparities in access to both medical and dental care have significant and lifelong effects on the oral and overall health of children and adolescents.[32] Since family, economic and social conditions have a substantial impact on the development of ECC, an approach emphasizing health-promoting behaviors at the individual level is likely to have the greatest positive effect on children's oral health.[4,5] Consequently, the establishment of a dental home, especially for high-risk, low-income children is critical for educating parents and caregivers on the known risk factors associated with ECC

Figure 2: Comparison of Frequency of Beverage Consumption Between Established Dental Home and No Dental Home

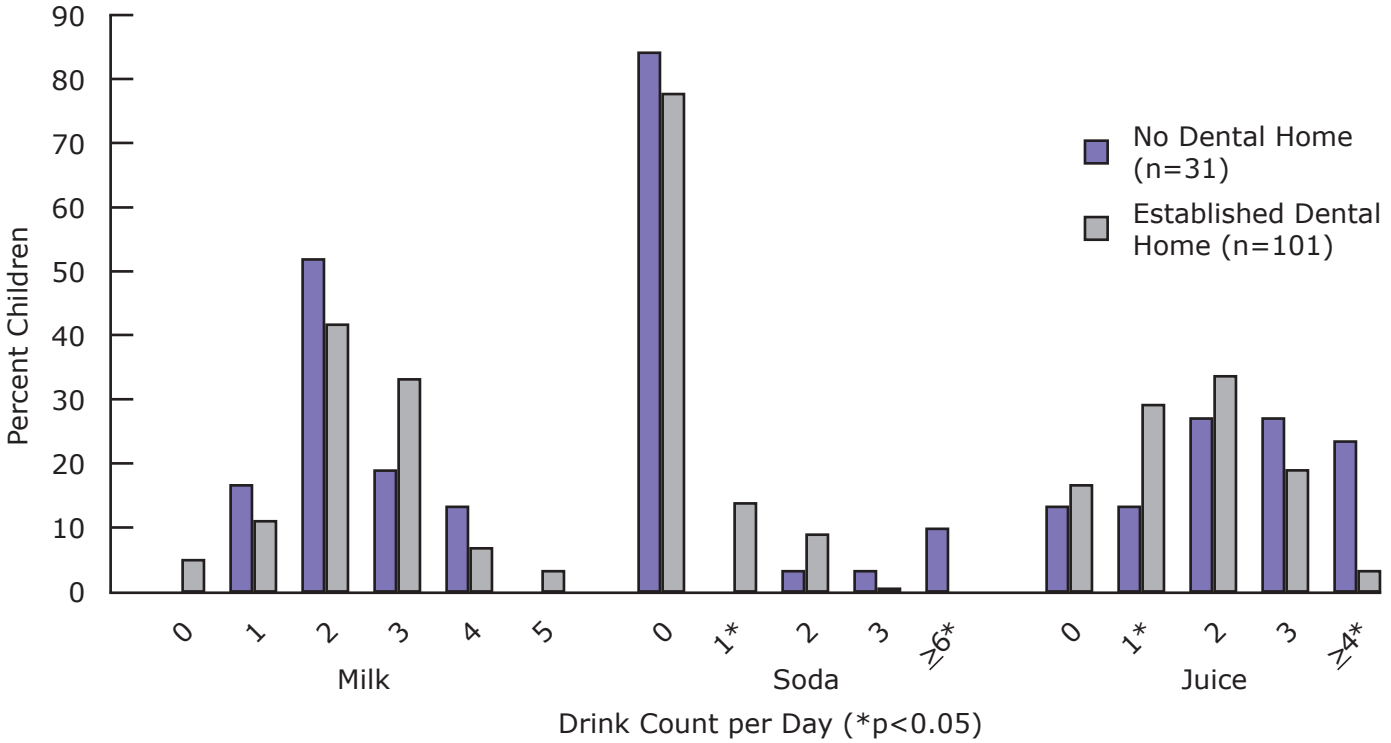
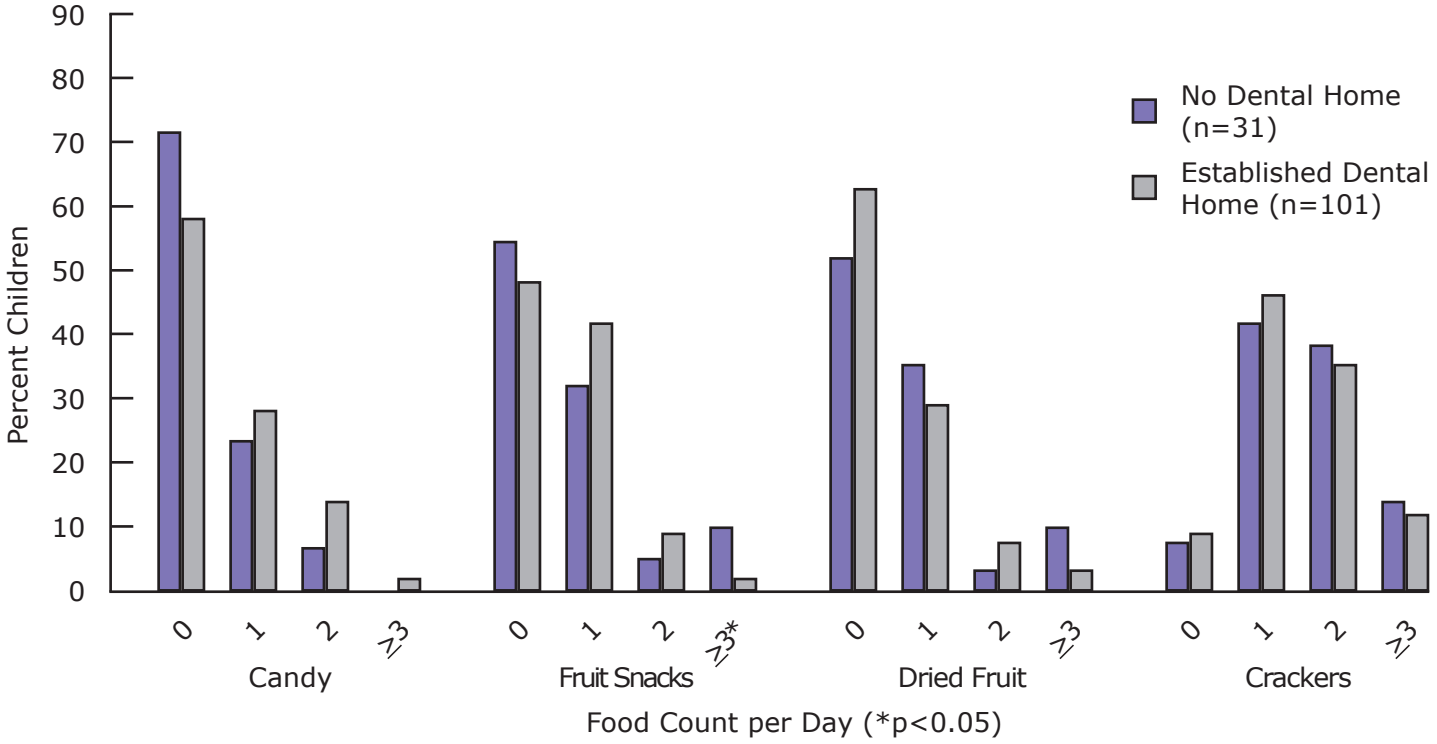


Figure 3: Comparison of Snacking Practices Between Established Dental Home and No Dental Home



development, including frequent sugar consumption, inadequate oral hygiene, high levels of oral bacteria and cariogenic feeding practices.[3,4,6-10] The care provided through a dental home may also decrease the prevalence of recurrent caries. The current research has indicated over 50% of low-income children exhibit recurrent caries post restorative treatment.[33] However, among the patients in the established dental home group with DMFT scores of 1 or higher, only 29.7% presented with new carious lesions.

Table II: Univariate and Multivariate Logistic Regression Models for Caries Prevalence (DMFT>0 vs DMFT=0); Recall Patients (n=101)

Univariate Model	
	Odds Ratio (95% CI)
Established Dental Home	0.22 (0.08 , 0.55)*
Multivariate Model I	
	Odds Ratio (95% CI)
Established Dental Home	0.15 (0.05 , 0.42)*
Age	1.07 (1.04 , 1.11)*
Female	0.78 (0.35 , 1.72)
Multivariate Model II	
	Odds Ratio (95% CI)
Established Dental Home	0.10 (0.02 , 0.40)*
Age	1.09 (1.04 , 1.14)*
Female	0.84 (0.35 , 2.01)
Juice serving per day	1.34 (0.92 , 1.95)
Age at first dental visit	0.53 (0.27 , 1.04)
Presence of Biofilm	3.29 (0.73 , 14.76)
Presence of Gingivitis	1.10 (0.47 , 2.61)

*p<0.05 for parameter estimate

This study explored the association of an established dental home on ECC prevalence and cariogenic feeding practices in high-risk populations. While it revealed significant consistencies with the current literature about specific feeding practices and ECC prevalence in high-risk populations,[3,4,7] it also investigated the association of dental home establishment and oral hygiene, caries status, and cariogenic feeding behaviors. In accordance with the literature, the results demonstrated significant relationships between higher DMFT scores and a frequent consumption of sticky snacks (candy) and sugary drinks (juice), as well as prolonged drinking sessions.[3,4,6,7,10] Children with an established dental home had a lower prevalence of caries, and lower rates of biofilm and gingivitis. Logistic regression analysis showed a very strong protective effect for establishment of a dental home on caries status. The above findings add further evidence for the effectiveness of oral hygiene education and anticipatory guidance provided at preventive care visits on prevention of adverse oral health outcomes.

The current study also reveal significant differences in specific feeding behaviors between the 2 groups, with the no dental home group exhibiting more cariogenic practices than the established dental home group. This finding suggests the anticipatory guidance and nutritional counseling implemented at the children's' routine preventive dental appointments may play an important role in feeding practices adopted by parents, particularly in high-risk populations.

Table III: Association Between Feeding Practices and DMFT Score Among Established Dental Home Group (n=101) (Univariate Poisson Regression for DMFT index)

Parameter Estimates: Outcome DMFT Index	
Food/Drink Count per Day	
Milk	0.87 (0.76 to 1.01)
Soda	0.80 (0.62 to 1.03)
Juice	1.19 (1.04 to 1.36)*
Candy	1.21 (1.01 to 1.45)*
Fruit Snacks	0.90 (0.73 to 1.14)
Dried Fruit	1.04 (0.86 to 1.26)
Crackers	1.03 (0.87 to 1.22)
Drink Setting	
Milk	
Meal	1.80 (1.25 to 2.59)*
Snack	1.03 (0.74 to 1.44)
Anytime	0.88 (0.63 to 1.23)
Soda	
Meal	0.67 (0.39 to 1.13)
Snack	0.23 (0.07 to 0.70)*
Anytime	0.73 (0.36 to 1.48)
Juice	
Meal	1.25 (0.93 to 1.68)
Snack	1.78 (1.33 to 2.38)*
Anytime	0.74 (0.51 to 1.06)
Drinking Session ≥1 Hour	0.56 (0.32 to 0.98)*
Clinical Knowledge	
Juice	1.58 (1.01 to 2.47)*
Milk	1.28 (0.87 to 1.88)
Brush	1.16 (0.81 to 1.66)
Bottle	0.93 (0.68 to 1.27)
Snack	0.93 (0.68 to 1.27)
Food	0.85 (0.61 to 1.18)
Drinking Method	
Glass	1.82 (1.29 to 2.58)*
Sippy Cup	0.44 (0.24 to 0.80)*
Straw	1.26 (0.79 to 2.00)
Glass and Straw	0.69 (0.28 to 1.67)
Glass and Sippy Cup	0.27 (0.07 to 1.09)
Glass, Sippy Cup and Straw	0.041 (0.13 to 1.27)

*p<0.05 for univariate parameter estimate

However, there was one finding regarding a dietary practice that did not coincide with what has been demonstrated in the literature. The regression analysis showed consuming milk at mealtime was associated with a multiplicative increase in DMFT score (eβ=1.82, 95% CI: 1.29 to 2.58). One possible explanation could be that the consumption of milk at mealtime had an added amount of sugar, such as flavored milk, soy, rice or almond milk. This is an area that would benefit from further research and investigation.

It is important to address the limitations in this study. Like any observational study, structural biases including residual confounding, selection bias, and data misclassification and misspecification are a possibility. The present study may lack statistical power to identify important statistical associations due to the study's limited sample size. The study cohort was created using a convenience sample, calling into question the generalizability of the study results to broader populations. The present study was also a cross-sectional study, greatly limiting the ability to "tease-out" the direction of causality and limiting the analysis to associational measures. Additionally, the definition of a dental home within the study population was operationalized as having made at least one previous visit to the dental center. The goals of the dental home may not be achievable with one visit to the dental office.

The results suggest the establishment of a dental home, especially among high-risk, low-income populations, is strongly associated with a decreased prevalence of ECC and reduced cariogenic feeding practices. Consequently, the collaboration between dentistry and medicine is a significant aspect in the prevention and management of ECC and the education of its risk factors. Therefore, in accordance with recommendations from the CDC, the AAPD and the American Academy of Pediatrics (AAP), all children should establish a dental home no later than 1 year of age.[34-37] The AAP also advises that a child's first caries risk assessment be completed by their health professional at 6 months of age, especially if they are considered high risk for dental caries.[35,36] Pediatricians and physicians must also be aware of the clinical manifestations of dental disease and be prepared to educate families on its risk factors and consequences.[4] It is also beneficial for pediatric health professionals to understand the etiological caries process, including enamel demineralization, and have the ability to identify the behavioral and dietary habits putting a child at higher risk of dental disease.[4]

Conclusion

The findings of this study will not only aid in developing a stronger partnership between medicine and dentistry in promoting oral health, but also in the implementation of new policies regarding protocols of preventive dental care. General and pediatric dentists can use the current research to design policies specific for their pediatric population to strengthen their preventive program's nutritional counseling, parental anticipatory guidance and oral hygiene instruction.

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