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Changes in Oral Health Behaviors Associated With a Nursing Intervention in Primary Care

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Abstract

Objective. To describe changes in oral health behaviors following implementation of a nursing intervention targeting children at risk for early childhood caries at an urban 2-site primary care practice. *Methods*. Nurses used a proprietary Nursing Caries Assessment Tool (N-CAT) to identify behaviors associated with early childhood caries risk, then provided brief focused dental education, fluoride varnish applications, and dental referrals to children without a dental home. We used generalized estimating equation logistic regression models, adjusted for age at visit, to analyze changes in oral health behaviors over time including the following: (1) tooth brushing frequency, (2) use of fluoride toothpaste, and (3) adult help with brushing among children younger than 5 years of age who had at least 2 N-CATs documented during well care visits between April 2013 and June 2015. We also evaluated dietary habits including going to bed with a bottle or sippy cup and sugar-sweetened beverage consumption, as secondary study outcomes during the same time frame. *Results.* A total of 2097 children with a mean age of 15.8 (SD 7.6) months at the initial visit were included in the analysis; 51% were boys; 28% were black, 36% Hispanic/Latino, 5% white, 2% Asian, and 19% other; 75% were publicly insured. During the study period, significant ($P < .05$) improvements were noted across the 3 oral health behaviors studied among children younger than 18 months. *Conclusion*. Nursing interventions show promise for promoting preventive dental care in primary care settings and deserve further study.

Keywords

Dental, caries, children, fluoride, primary care

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Introduction

Early childhood caries (ECC) is defined as the presence of one or more decayed (non-cavitated or cavitated lesions), missing (due to caries), or filled teeth in children younger than 72 months of age.[1] ECC affects nearly one third of US children ages 2 to 5 years, with low-income and racial and ethnic minority children disproportionately affected.[2] Besides pain and infection, ECC can have lasting adverse effects on speech, social interactions, eating and growth, life quality, and health care costs.[3]

In 2008, the American Academy of Pediatrics (AAP) recommended that pediatricians routinely assess caries risk in all children, and that fluoride varnish (FV) be provided to those at risk for caries.[4] In 2014, the AAP endorsed FV applications for all children at the time of tooth eruption,[5] and in 2015, FV was added to the AAP's Preventive Health Care Schedule.[6]

Children's visits to physicians far outnumber visits to dentists, at 250:1 among children younger than 1 year.[4] Unfortunately, in practice, busy clinicians may have difficulty incorporating dental interventions into their

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daily workflow. A national survey revealed that while more than 90% of pediatricians believed they should monitor oral health, only 54% reported actually examining the teeth of more than half of their 0- to 3-year-old patients, citing lack of training (41%), insufficient time (35%), and billing concerns (34%) as barriers.[7]

However, nurses working in alignment with medical providers may be well positioned to perform many of these important tasks, including assessing caries risk, providing education, applying fluoride varnish, and making dental referrals.

The objective of this study was to describe changes in oral health behaviors (*primary outcome*) associated with the implementation of a nursing intervention in a diverse pediatric population at risk for ECC as captured through a Nursing Caries Assessment Tool (N-CAT); to our knowledge, no previous research has examined this question.

Methods

Design

In this retrospective longitudinal study, we queried the Boston Children's Hospital (BCH) Patient 360 clinical database to assess changes in our outcomes of interest between April 2013 and June 2015.

Setting

At Primary Care at Longwood (PC-L), nearly 100 medical providers (including pediatrics residents and nurse practitioners) and 34 nurses serve more than 16 000 children from diverse backgrounds; 65% are publicly insured.

At Primary Care at Martha Eliot (PC-ME), 27 medical providers and 12 nurses provide culturally competent care to over 6000 children, 90% of whom are Latino and 85% are publicly insured.

Intervention

Primary Care–Dental Taskforce. In 2010, we formed a taskforce with an overarching goal of developing, implementing, and evaluating strategies to improve the oral health education of primary care trainees and the oral health of children served by our large safety-net practice. This collaborative body, comprising pediatricians, nurses, the Dentist-in-Chief, a program coordinator, a biostatistician, and a data specialist, has met regularly since its inception and guided this study.

Oral Health Training. Medical providers and nurses at both sites received an initial 1-hour in-person oral health training by a pediatric dentist from the BCH Department of Dentistry and annually for the next 5 years. They also complete the *Smiles for Life National Oral Health Curriculum's* online module on "Caries Risk Assessment, Fluoride Varnish, and Counseling"[8] during their clinic orientation; nurses complete additional hands-on training and demonstrate FV application competency. Nurses are taught to identify obvious dental decay (DD) and urgent oral problems such as dental trauma or abscesses requiring prompt attention. However, the brief nursing visual assessment to screen for acute problems performed in concert with FV applications in the primary care clinic is not intended to replace a comprehensive examination by a dentist. Thus, children are routinely referred for dental care, including for a first dental visit by age 18 months to 2 years. Oral health topics are periodically reinforced through "Dental Pearls" emailed to clinical staff and by dental residents rotating through primary care 4 months each year.

Caries Risk Assessment. In 2011, in alignment with the prevailing recommendation to provide FV applications to children at risk for caries, we adapted a caries risk assessment tool developed by the American Academy of Pediatric Dentistry[9] and created a brief instrument to identify behaviors associated with risk for caries development, and to facilitate targeted patient education that could be integrated into the workflow of nurses in our busy practice. Of note, at the time of this project, no validated caries risk assessment tools existed; in addition, instrument validation was beyond the scope of this project.

We designed our N-CAT as a patient engagement and teaching instrument to be administered primarily by nurses, but written at a sixth grade level of education to also allow self-administration by families. We included items to assess *protective* factors such as using fluoride toothpaste, as well as *cariogenic risk* factors such as drinking sugar-sweetened beverages (SSB) or going to bed with a bottle or sippy cup with anything but water. Last, we included an item requesting nurses to document the condition of children's teeth as visualized during FV application.

We piloted tested, then iteratively refined our English-language N-CAT, with feedback from nurses informing the process.

We launched the N-CAT as a powerform in the electronic medical record (EMR) at PC-L in April 2013 and at PC-ME in September 2013. Later, a written form (Figure 1) was implemented. At the discretion of the nurses, some patients completed the paper N-CAT, and nurses then entered the data into the EMR.

Fluoride Varnish Application. Nurses administered the N-CAT and offered FV application to children at risk for

NURSING CARIES RISK ASSESSMENT TOOL (N-CAT)

Oral health is important for your child's overall well-being. We want to make sure your child's mouth is as healthy as possible! To get started, please answer questions **1-9** below by checking off the box that applies most.

Name: _____

Date of Birth: _____

Today's date: _____

1. When did you last see a dentist?

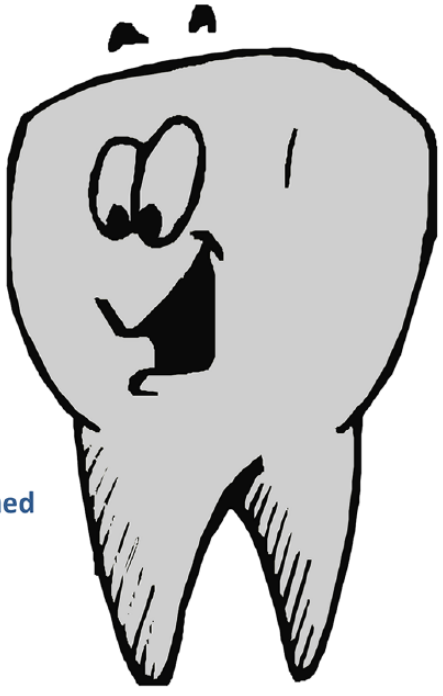
- ☐ Within the past 6 months
- ☐ 7-12 months ago
- ☐ More than 1 year ago or never

2. How many times a day does tooth brushing occur?

- ☐ 2 or more
- ☐ Once
- ☐ Less than once

3. Is fluoride toothpaste used?

- ☐ Yes
- ☐ Sometimes
- ☐ No



4. Does an adult help your child with tooth brushing?

- ☐ Yes
- ☐ Sometimes
- ☐ No

5. Is your child currently on any long-term use of sweetened (chewable or liquid) medication?

- ☐ No
- ☐ Yes

(continued)

NURSING CARIES RISK ASSESSMENT TOOL (N-CAT)

6. Does your child go to bed with a bottle or sippy cup with anything other than water?

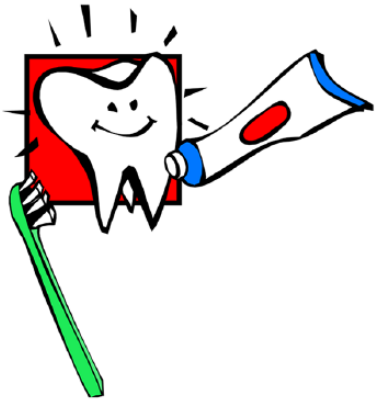
- ☐ No
- ☐ Yes with plain milk or sugar-free beverage
- ☐ Yes, with juice, formula, flavored milk, sugar-sweetened beverage

7. How frequently are sugar sweetened beverages consumed?

- ☐ Less than once a day
- ☐ 1-2 times a day
- ☐ 3 or more times a day

8. In the last 3 years, has your child or anyone in your immediate family had cavities?

- ☐ No/unsure
- ☐ Yes, parent or sibling
- ☐ Yes, child himself/herself



9. Does your child breastfeed through the night?

- ☐ No/unsure
- ☐ Yes, 1-2 times per night
- ☐ Yes, 3 or more times per night

Thank you! Almost done…

Please hand this form to your nurse so that your child's mouth can be examined

To be assessed by Nurse:

10. Visual condition of teeth?

- ☐ Unable to visualize/no teeth present/no decay
- ☐ Signs caries/decay present (e.g., white/brown spots)

Figure 1. Nursing Caries Assessment Tool (N-CAT).

caries who had not received FV within the prior month. They then applied a 0.25 mL application of 3M ESPE 5% Sodium Fluoride White Varnish to the surfaces of the primary dentition as per the manufacturer's instructions. Families were advised to refrain from brushing and flossing, and to avoid consuming hard, crunchy, sticky, or hot foods until the next day. Contraindications to FV included ulcerative gingivitis/stomatitis. Families declining FV were excluded from the study.

Patient Education. Targeted education in response to risk behaviors identified through the N-CAT was a core element of our intervention. Nurses used a laminated pictorial flipchart to show families how cavities form, the sugar content of commonly consumed drinks and snacks, the link between bedtime bottle/sippy cup use and caries, and tooth brushing techniques including appropriate use of fluoridated toothpaste (smear for children $<$3 years, pea-size for ages $>$3 years).[10] In addition, nurses provided families with a patient education handout reviewing key points about brushing with adult supervision, and contact information for the BCH dental clinic. Age-appropriate toothbrushes and sample-sized tubes of fluoride toothpaste are available in the clinic, and generally provided to children during well visits by medical providers or nurses.

Referral System. All children were encouraged to schedule routine dental care, and high-risk children without a dental home were referred by nurses for follow-up at the BCH Dental Clinic; routine referrals were ordered through the EMR system; urgent referrals were completed by phone.

Nurses typically spend a total of 5 to 10 minutes completing the N-CAT, providing brief dental education and completing dental referrals in the EMR.

Study Subjects

The study population included children with $\geq$2 N-CATs completed during well visits between April 2013 and June 2015; eligible children were 9 months to 3.99 years at PC-L and 9 months to 4.99 years at PC-ME.

Outcomes

Our primary outcome of interest was change in oral health behaviors, including the following: (1) tooth brushing frequency, (2) use of fluoride toothpaste, and (3) adult help with brushing, as assessed via the N-CAT. Secondary (dietary) outcomes included the following: (1) going to bed with a bottle/sippy cup and (2) frequency of SSB consumption, also assessed via the N-CAT. In addition, we tracked nursing visual assessments of oral health, including presence of visible DD at each visit. Referrals for dental follow-up are central to our longitudinal quality improvement work and will be reported separately.

Statistical Analysis

Categorical measures are presented as counts with percentages and continuous measures are presented as medians (25th percentiles, 75th percentiles) or means (standard deviation). Because patients had repeated measures over time, longitudinal analysis was performed with generalized estimating equation logistic regression models to test whether the change over the study period for the response of interest was statistically significant. To address the issue of association of the N-CAT responses over time being affected by age, we adjusted models for age at visit. As a result, the changes over time for the N-CAT responses were independent of age changes over time.

All tests were 2-sided and a $P < .05$ was considered statistically significant. SAS (version 9.4, SAS Institute, Cary, NC) software was used.

Ethical Approval and Informed Consent

The Boston Children's Hospital Institutional Review Board reviewed and approved this protocol (IRB# P00018656).

Results

A total of 5613 children completed 13 451 well visits at the 2 sites between April 2013 and June 2015. Out of these, 4197 children (7628 visits) had an N-CAT documented, with 2100 children having only 1 N-CAT, and 2097 children (accounting for 5,528 visits) with at least 2 N-CATs completed.

Demographic characteristics of the 2097 children included in the analysis are shown in Table 1. Participants at the initial visit had a mean age of 15.8 (SD 7.6) months; 51% were boys, 28% were black, 36% Hispanic/Latino, 5% white, 2% Asian, and 19% other. Seventy-five percent were publicly insured, and 34% spoke Spanish or a language other than English.

Changes in oral health behaviors are shown in Table 2. Results did not differ substantially by location and are not reported separately (available by request).

Tooth Brushing Frequency

The percentage of children in the entire study cohort reported to be "brushing teeth 2 or more times each day"

Table 1. Participant Demographics.

Characteristic	Total N = 2097
Age at first visit (months)	
Median (IQR)	12.8 (9.8, 18.8)
Mean (SD)	15.8 (7.6)
Minimum-maximum	9.0-49.5
Age at first visit groups (months), n (%)	
<12	728 (35)
12-17	771 (37)
18-23	230 (11)
24-35	285 (13)
36+	83 (4)
Gender, n (%)	
Male	1072 (51)
Female	1025 (49)
Racial and ethnic composition, n (%)	
Hispanic	746 (36)
Non-Hispanic	
Black	581 (28)
White	111 (5)
Asian	46 (2)
Other or multiple race	395 (19)
Unable to collect	218 (10)
Language, n (%)	
English	1327 (63)
Spanish	543 (26)
Other	168 (8)
Unable to collect	59 (3)
Insurance across visits, n (%)	
Only public	1570 (74.9)
Any private	519 (24.7)
Unable to collect	8 (0.4)
Location at first visit, n (%)	
Longwood	1606 (77)
Martha Elliot	491 (23)
Time from first to second visit (months)	
Median (IQR)	4.6 (3.0, 9.0)
Mean (SD)	6.4 (4.4)
Minimum-maximum	0.1-23.9
Time from second to third visit (months), n = 924	
Median (IQR)	4.4 (3.0, 6.9)
Mean (SD)	5.6 (3.5)
Minimum-maximum	1.1-21.9
Time from first to third visit (months), n=924	
Median (IQR)	8.5 (6.2, 12.0)
Mean (SD)	9.7 (4.4)
Minimum-maximum	3.8-24.9

Abbreviation: IQR, interquartile range; SD, standard deviation.

increased from 42.5% at baseline to 58.2% at visit 2, and 60.8% at visit 3 during the study period. The percentage of children "brushing teeth at least once a day" also increased serially (28.8%, 31.3%, 32.9%), while the percentage of children *not* brushing their teeth at least once a day declined from 28.7% at baseline to 10.6% at visit 2, and 6.4% at visit 3. These changes in percentages over time were statistically significant independent of age changes over time ($P < .001$). Subgroup analyses by age category showed that these findings were significant for infants (<12 months) and children ages 12 to 17 months. However, while similar trends were noted among older children, results were not statistically significant.

Use of Fluoride Toothpaste

The percentage of children in the whole cohort whose parents answered "Yes" to the question "Are you using fluoride toothpaste?" increased significantly from 50.7% at baseline to 74.6% at visit 2, and 83.4% at visit 3, while the percentage of caregivers answering "No" to the question decreased from 37.7% at baseline to 13.2% at visit 2, and 7.1% at visit 3. These changes in percentages over time were statistically significant independent of age changes over time ($P < .001$). Analyses by age category demonstrated these findings to be significant among infants (<12 months) as well as among children ages 12 to 17 months. The positive trend in fluoride toothpaste use persisted but did not reach significance among older children.

Adult Help With Brushing

"Adult help with brushing" among children in the cohort as a whole increased over the study period, from 71.7% at baseline to 87.5% at visit 2, and 90.0% at visit 3. Conversely, the percentage of children "not receiving adult help with brushing" decreased from 23.6% at baseline to 6.1% at visit 2, and 3.4% at visit 3. These changes in percentages over time were statistically significant independent of age changes over time ($P < .001$). When analyzed by age category, findings were again significant among infants <12 months and children aged 12 to 17 months, but not among older children.

Changes in dietary behaviors are shown in Table 3.

Going to Bed With Bottle

Approximately one third of study children were reported to be going to "bed with a bottle or sippy cup with anything but water" at baseline, and this percentage did not change substantially over time.

SSB Consumption

With regard to SSB consumption, increasing consumption over time was noted, but it was not statistically significant

Table 2. Changes in Oral Health Behaviors Over Visits.

N-CAT Question/Response	Visit 1, n (%)	Visit 2, n (%)	Visit 3, n (%)	*P*
Number of times teeth are brushed each day				
Total n	1923	2027	897	
<1	551 (28.7)	214 (10.6)	57 (6.4)	<.001
1	554 (28.8)	634 (31.3)	295 (32.9)	
2 or more	818 (42.5)	1179 (58.2)	545 (60.8)	
Age <12 months				
<1	325 (54.7)	141 (20.1)	33 (7.5)	<.001
1	137 (23.1)	238 (34.0)	155 (35.0)	
2 or more	132 (22.2)	321 (45.9)	255 (57.6)	
Age 12-17 months				
<1	201 (27.2)	59 (8.0)	24 (6.4)	<.001
1	242 (32.7)	257 (34.6)	128 (34.0)	
2 or more	297 (40.1)	426 (57.4)	224 (59.6)	
Age 18-23 months				
<1	18 (7.9)	8 (3.5)	0	.448
1	75 (32.8)	64 (28.3)	10 (16.1)	
2 or more	136 (59.4)	154 (68.1)	52 (83.9)	
Age 24-35 months				
<1	5 (1.8)	5 (1.8)	0	.383
1	82 (29.4)	62 (22.4)	2 (12.5)	
2 or more	192 (68.8)	210 (75.8)	14 (87.5)	
Age ≥36 months				
<1	2 (2.5)	1 (1.2)	0	.495
1	18 (22.2)	13 (15.9)	0	
2 or more	61 (75.3)	68 (82.9)	0	
Fluoride toothpaste used				
Total n	2087	1995	836	<.001
No	787 (37.7)	264 (13.2)	59 (7.1)	
Sometimes/unsure	241 (11.6)	242 (12.1)	80 (9.6)	
Yes	1059 (50.7)	1489 (74.6)	697 (83.4)	
Age <12 months				
No	444 (61.2)	147 (21.9)	30 (7.70	<.001
Sometimes/unsure	72 (9.9)	84 (12.5)	50 (12.8)	
Yes	209 (28.8)	440 (65.6)	312 (79.6)	
Age 12-17 months				
No	281 (36.7)	90 (12.2)	27 (7.4)	<.001
Sometimes/unsure	113 (14.8)	100 (13.5)	22 (6.0)	
Yes	371 (48.5)	551 (74.4)	318 (86.7)	
Age 18-23 months				
No	42 (18.3)	19 (8.4)	2 (3.2)	.837
Sometimes/unsure	22 (9.6)	25 (11.1)	8 (12.9)	
Yes	166 (72.2)	182 (80.5)	52 (83.9)	
Age 24-35 months				
No	19 (6.7)	7 (2.6)	0	.291
Sometimes/unsure	23 (8.1)	31 (11.3)	0	
Yes	243 (85.3)	237 (86.2)	15 (100.0)	
Age ≥36 months				
No	1 (1.2)	1 (1.2)	0	.377
Sometimes/unsure	11 (13.4)	2 (2.4)	0	
Yes	70 (85.4)	79 (96.3)	0	

(continued)

Table 2. (continued)

N-CAT Question/Response	Visit 1, n (%)	Visit 2, n (%)	Visit 3, n (%)	*P*
Adult help with brushing				
Total, n	2086	1974	830	
No	492 (23.6)	121 (6.1)	28 (3.4)	<.001
Sometimes	98 (4.7)	126 (6.4)	55 (6.6)	
Yes	1496 (71.7)	1727 (87.5)	747 (90.0)	
Age <12 months				
No	318 (43.9)	64 (9.6)	17 (4.4)	<.001
Sometimes	26 (3.6)	32 (4.8)	25 (6.4)	
Yes	380 (52.5)	570 (85.6)	349 (89.3)	
Age 12-17 months				
No	150 (19.6)	28 (3.8)	11 (3.0)	<.001
Sometimes	41 (5.4)	41 (5.6)	24 (6.6)	
Yes	574 (75.0)	662 (90.6)	330 (90.4)	
Age 18-23 months				
No	17 (7.4)	8 (3.5)	0	.215
Sometimes	10 (4.4)	14 (6.2)	6 (10.0)	
Yes	203 (88.3)	204 (90.3)	54 (90.0)	
Age 24-35 months				
No	4 (1.4)	8 (3.0)	0	.261
Sometimes	19 (6.7)	25 (9.3)	0	
Yes	262 (91.9)	236 (87.7)	14 (100.0)	
Age ≥36 months				
No	3 (3.7)	13 (15.9)	0	.771
Sometimes	2 (2.4)	14 (17.1)	0	
Yes	77 (93.9)	55 (67.1)	0	

Abbreviation: N-CAT, Nursing Caries Assessment Tool.

Table 3. Changes in Dietary Behaviors Over Visits.

N-CAT Question/Response	Visit 1, n (%)	Visit 2, n (%)	Visit 3, n (%)	*P*
Adult help with brushing				
Total, n	2086	1974	830	
No	492 (23.6)	121 (6.1)	28 (3.4)	<.001
Sometimes	98 (4.7)	126 (6.4)	55 (6.6)	
Yes	1496 (71.7)	1727 (87.5)	747 (90.0)	
Age <12 months				
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Sometimes	26 (3.6)	32 (4.8)	25 (6.4)	
Yes	380 (52.5)	570 (85.6)	349 (89.3)	
Age 12-17 months				
No	150 (19.6)	28 (3.8)	11 (3.0)	<.001
Sometimes	41 (5.4)	41 (5.6)	24 (6.6)	
Yes	574 (75.0)	662 (90.6)	330 (90.4)	
Age 18-23 months				
No	17 (7.4)	8 (3.5)	0	.215
Sometimes	10 (4.4)	14 (6.2)	6 (10.0)	
Yes	203 (88.3)	204 (90.3)	54 (90.0)	

(continued)

Table 3. (continued)

N-CAT Question/Response	Visit 1, n (%)	Visit 2, n (%)	Visit 3, n (%)	*P*
Age 24-35 months				
No	4 (1.4)	8 (3.0)	0	.261
Sometimes	19 (6.7)	25 (9.3)	0	
Yes	262 (91.9)	236 (87.7)	14 (100.0)	
Age ≥36 months				
No	3 (3.7)	13 (15.9)	0	.771
Sometimes	2 (2.4)	14 (17.1)	0	
Yes	77 (93.9)	55 (67.1)	0	

Abbreviation: N-CAT, Nursing Caries Assessment Tool.

($P = .05$). The percentage of children consuming "1 to 2 servings per day" increased from 37.2% at baseline to 41.6% at visit 2, and 43% at visit 3, while the percentage of children consuming "3 or more servings per day" increased from 11.5% at baseline to 15.6% at visit 2, and 15.7% at visit 3.

Presence of visible DD is reported in Table 4.

Most (91.6%) children in our study were not found to have obvious DD by nurses. However, approximately 3% to 4% of the total cohort had new DD documented at each of the 3 visits (3.5% of 2088 children at visit 1, 4.7% of 2008 children at visit 2, and 3.5% of 863 children at visit 3). In terms of caries pattern, 57 (2.7%) children had DD only at visit 1, 74 (3.5%) only at visit 2, and 25 (1.2%) only at visit 3. Fifteen (0.7%) children had DD at both visits 1 and 2, and 5 (0.2%) had DD at both visits 2 and 3; no child had DD noted at all 3 visits. Nurses reported not being able to visualize the teeth (or the child not having teeth to assess) in 31.6% of children at visit 1, 27.0% at visit 2, and 23.4% at visit 3.

Discussion

Our nurse-led intervention was associated with significant improvements in the use of fluoride toothpaste, brushing frequency, and adult help with brushing in a diverse group of children at risk for ECC, with the greatest impact observed among those younger than 18 months, likely in association with frequent clinical contact. Children are scheduled for routine health care maintenance visits every few months during the first 2 years of life (vs annually or less often for older children),[11] providing excellent opportunities for teaching and reinforcement of desired health behaviors during clinical interactions. Our findings are consistent with previous research documenting a "dose effect for behavioral interventions," with more frequent contact generally being linked with higher effectiveness and better outcomes in the management of other chronic health conditions including obesity,[12,13] diabetes mellitus,[14] and asthma.[15]

The positive trend in oral health behaviors seen with children younger than 18 months continued among older children, but did not reach significance, likely due to insufficient statistical power to detect changes with the smaller numbers of children in the older groups. For example, the percentage of children "brushing teeth at least twice a day" increased serially among children ages 18 to 23 months (59.4%, 68.1%, 83.9%), 24 to 35 months (68.8%, 75.8%, 87.5%), and 36 months and older (75.3%, 82.9%), but children in these age groups comprised only 11%, 13%, and 4% of the total sample size at the initial visit, respectively. Likewise, the percentage of children reported to be "using fluoride toothpaste" increased serially among children ages 18 to 23 months (72.2%, 80.5%, 83.9%), 24 to 35 months (85.3%, 86.2%, 100%), and 36 months and older (85.4%, 96.3%), but the sample size in these age groups dwindled to only 52, 15, and 0 children at the third visit, respectively.

However, it is also possible that the above finding could reflect decreased parental vigilance and increased deferral of oral hygiene tasks as children get older. A recent qualitative study with the parents of young children from low-income backgrounds revealed that while most parents stated they had intentions to brush their children's teeth themselves twice every day as part of a family routine, many ended up simply "reminding their children to brush or watching them brush due to difficulties in managing their children's challenging behaviors and the environmental context of their stressful lives."[16] Nevertheless, improvements in tooth brushing behaviors and fluoride toothpaste use in the youngest of our high-risk children in association with oral health intervention by nurses are important findings because multiple studies have shown that brushing with fluoride toothpaste results in significant reduction in caries rates in children younger than 6 years.[17]

Table 4. Presence of Dental Decay (DD).

N-CAT Question/Response	Visit 1, n (%)	Visit 2, n (%)	Visit, n (%)	*P*
Visual condition of teeth	2088	2008	863	
Obvious caries/DD present	72 (3.5)	94 (4.7)	30 (3.5)	.413
No obvious caries/DD present	1356 (64.9)	1372 (68.3)	631 (73.1)	
Unable to visualize teeth/no teeth present	660 (31.6)	542 (27.0)	202 (23.4)	
Visual condition of teeth (excluding age at visit <12)	1395	2000	863	
Obvious caries/DD present	69 (5.0)	94 (4.7)	30 (3.5)	.076
No obvious caries/DD present	936 (67.1)	1369 (68.5)	631 (73.1)	
Unable to visualize teeth/no teeth present	390 (28.0)	537 (26.9)	202 (23.4)	
(DD) Pattern, n (%), With DD Noted, 2097 Total	Visit 1, DD Noted?	Visit 2, DD Noted?	Visit 3, DD Noted?	
57 (2.7)	Yes	No	No	
15 (0.7)	Yes	Yes	No	
5 (0.2)	No	Yes	Yes	
74 (3.5)	No	Yes	No	
25 (1.2)	No	No	Yes	
1921 (91.6)	No	No	No	

Abbreviation: N-CAT, Nursing Caries Assessment Tool.

In terms of dietary behaviors, approximately one third of children in our study were reported to be going to "bed with a bottle or sippy cup with anything but water" at baseline, and this percentage did not change substantially over time. The difficulty in extinguishing this prevalent behavior has been well documented by previous research, including a randomized controlled trial that saw no change in parental behavior despite an intensive intervention by pediatricians and clinic staff who used a script, pictures of severe ECC, and a dental model of caries, to provide counseling at the 4-, 6-, 9-, and 12-month visits.[18]

Additionally, we did not find improvement in children's reported intake of SSB. In fact, increasing consumption levels were noted, though not statistically significant ($P = .05$). Notably, the percentage of children consuming "1 to 2 servings per day" increased from 37.2% at baseline to 41.6% at visit 2, and 43% at visit 3, and the percentage of children consuming "3 or more servings per day" increased from 11.5% at baseline to 15.6% at visit 2, and 15.7% at visit 3. Similarly, a 2012 survey of parents of children ages 12 months to 5 years found that the majority had introduced juice before their child was 12 months old, and also that parents perceived juice to be as healthy as fresh fruit, with these findings being more prevalent among families enrolled in the Women, Infants, and Children program[19] (which offered juice allowances in amounts exceeding AAP recommendations until recent package revisions[20]). These results are troubling beyond the direct impact of SSBs on dentition, weighing in the context of overall health, given the known association of SSBs with obesity and comorbidities such as diabetes mellitus.

Other research has shown that infants sucking on a sucrose-sweetened solution demonstrate stronger and more frequent sucking, decreased crying, increased facial muscle relaxation and smiling, and better pain tolerance during procedures.[21] In fact, substantial evidence indicates that variability in sweet taste preference and intake may be mediated by complex interactions between genetic encoding, neurobiological processes, and environmental contexts.[22-24] Indeed, multiple factors including taste experiences, cultural background, child temperament, parenting stress, and other psychosocial determinants likely influence family SSB intake, especially in the context of sleep routines; effective solutions will likewise require a thoughtful family-centered, multifaceted approach.

The rates of dental caries noted by nurses in our study are lower than national estimates of childhood caries. However, our statistics reflect nursing detection of obvious DD rather than dentists' diagnoses of incipient caries, which are undoubtedly more prevalent but challenging to ascertain in young children without proper instrumentation and lighting in primary care settings.

Strengths and Limitations

This study has limitations inherent to any retrospective observational study. Only association, not causation, was assessed from the results. The health behaviors assessed by the N-CAT rely on parental report, which may introduce some reporting bias, as parents may have

increased awareness of the "right" or preferred answer after having the educational intervention at the previous visit. In spite of the limitations, this longitudinal analysis allowed us to efficiently analyze large amounts of clinically relevant data in a "real world" environment. Future studies are needed to confirm these results.

Conclusion

In summary, our nursing-led intervention was associated with improved oral health behaviors among vulnerable young children. Future studies should consider a "common risk factors" approach to modify dietary behaviors and optimize both dental and general health outcomes.

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Author Contributions

JC: conceptualized the study, interpreted study data, drafted the initial manuscript, revised, and finalized the manuscript as submitted.
RW and MWN: conceptualized and designed the study, developed the data collection instruments, coordinated and supervised data collection, critically reviewed the manuscript, and approved the final manuscript as submitted.
RW: developed the data collection instruments and teaching tools, reviewed the manuscript and approved the final manuscript as submitted.
AF, JCY, and KW: supervised data collection, carried out the initial analyses, critically reviewed the manuscript, and approved the final manuscript as submitted.
MF, TM, and JB: coordinated and supervised data collection, critically reviewed the manuscript, and approved the final manuscript as submitted.
JEC: facilitated the data collection, critically reviewed the manuscript, and approved the final manuscript as submitted.

Declaration of Conflicting Interests

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