Total Breast-Feeding Duration and Dental Caries in Healthy Urban Children

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ABSTRACT

OBJECTIVE: To determine if there is an association between longer breast-feeding duration and dental caries in healthy urban children.

METHODS: We conducted a cross-sectional study of urban children aged 1 to 6 years recruited through The Applied Research Group for Kids (TARGet Kids!) practice-based research network between September 2011 and August 2013. The main outcome measure was parental report of dental caries.

RESULTS: The adjusted predicted probability of dental caries was 7%, 8%, 11%, and 16% with total duration of breast-feeding duration of 12, 18, 24, and 36 months, respectively. In the adjusted logistic regression analyses, relative to breast-feeding 0 to 5 months, the odds of dental caries with total breast-feeding duration >24 months was 2.75 (95% confidence interval 1.61–4.72).

CONCLUSIONS: Among healthy urban children, longer breast-feeding duration was associated with higher odds of dental caries. These findings support heightened awareness and enhanced anticipatory guidance for preventive dental care, particularly among children who breast-feed beyond 2 years of age.

KEYWORDS: breast feeding; dental caries; early childhood; nutrition; oral health

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WHAT'S NEW

Childhood dental caries is a public health challenge. Longer total breast-feeding duration is associated with dental caries. Findings support heightened awareness and enhanced anticipatory guidance for preventive dental care particularly among children who breast-feed beyond 2 years of age.

DENTAL CARIES IS the most common chronic disease of childhood and a public health challenge.[1] Caries can affect both physical and psychosocial aspects of child well-being,[2] resulting in pain, poor nutritional status, behavioral problems, and poor learning.[3] The pathogenesis of dental caries include frequent consumption of carbohydrates that can be metabolized by cariogenic bacteria, inadequate oral hygiene to remove or disrupt cariogenic biofilms or plaque, and inadequate exposure to fluoride.[4]

Breast-feeding has been hypothesized to contribute to the development of dental caries.[5] However, the contribution of extended breast-feeding duration is unclear. The World Health Organization recommends exclusive breast-feeding for the first 6 months of life with introduction of complementary foods at 6 months and continued breast-feeding up to 2 years and beyond,[6] based on systematic review evidence.[7] Similar recommendations have been endorsed by the United States,[8] Canada,[9] and the United Kingdom.[10] Correlating factors for childhood dental caries and early breast-feeding cessation are alike including low socioeconomic status, ethnic and racial minorities, maternal smoking, young mothers, and low parental education.[11]

The benefit of breast-feeding on infant health has been clearly demonstrated. However, in developed countries, less consensus exists around the optimal duration.[12,13] Total breast-feeding duration is highly variable,[14] with little evidence to guide practice beyond the first year of life.[15–17] With previous conflicting findings, a better understanding

of the relationship between longer total breast-feeding duration and caries may assist parents and clinicians in optimizing the benefits of breast-feeding while minimizing risks.

Given the importance of both breast-feeding and the prevention of caries, the primary objective of this study was to determine whether there is an association between longer total breast-feeding duration and caries in young healthy urban Canadian children. The secondary objective was to assess factors that might modify the association between total breast-feeding duration and caries.

METHODS

This was a cross-sectional study of healthy urban children aged 1 to 6 years who attended routine primary health care visits at The Applied Research Group for Kids (TARGet Kids!) participating pediatric or family medicine primary care practice in Toronto, Canada, between September 2011 and August 2013, a jurisdiction with fluoridated drinking water. TARGet Kids! is a primary care practice–based research network in Toronto, Canada, created to examine health and development trajectories of infants and preschool-age children. It is a partnership between researchers at the Hospital for Sick Children and St Michael's Hospital, primary care physicians in the Section of Community Paediatrics of the Department of Paediatrics, and the Department of Family and Community Medicine at the University of Toronto.[18]

SUBJECT RECRUITMENT AND DATA COLLECTION

Healthy children were recruited between September 2011 and August 2013 by research personnel embedded in 7 pediatric and family medicine practices. Children were excluded if they had a condition affecting growth (eg, failure to thrive, cystic fibrosis), a chronic illness (excluding asthma), or severe developmental delay. Data were collected at one time point for each subject through a standardized parent-completed survey instrument based on the Canadian Community Health Survey.[19] MediData Rave (MediData Solutions, New York, NY, USA) was used as the secure electronic data capture system and data repository for all TARGet Kids! data.[18]

EXPOSURE AND OUTCOME VARIABLES

The primary exposure variable was total breast-feeding duration, which was determined from the response to the question, "For how long has your child been breast-fed?" Maternal recall has been found to be a valid and reliable estimate of breast-feeding duration for recall up to 3 years.[20] Those who had never breast-fed were classified as having total breast-feeding duration of 0 months. Those currently breast-feeding were classified as having total breast-feeding duration equal to the child's current age.

Our primary outcome measure was parental report of dental caries, which was determined from the response to the question, "How many dental cavities has your child had?" Parental or caregiver perception of preschool children's oral health has been previously used as a measure of oral health.[21–23]

Covariates were defined a priori and were identified through detailed review of the literature as potentially confounding the relationship between total breast-feeding duration and caries. Covariates included age, sex, maternal age, birth weight, maternal ethnicity, self-reported family income, single parent, maternal employment, household smoke exposure, bedtime bottle use, only child, sugar-sweetened beverage consumption, and snacking of sweets, candy, chips, or fried foods. Maternal ethnicity was determined from the country where the biological mother was born and was categorized as European, East Asian, South and Southeast Asian, and other (which included Arab, African, Latin American, mixed ethnicity, and Canadian aboriginal). Self-reported family income was determined from the response to the question, "What was your total family income before taxes last year?" and categorized as $0 to $59,999, $60,000 to $99,999, $100,000 to $149,999, and over $150,000 (in Canadian dollars). Household smoke exposure was determined from response to the question, "Does anyone in your household smoke cigarettes regularly?" Bedtime bottle use was determined from the question, "Does your child use a bottle in bed?" Sugar-sweetened beverage consumption was measured from parental report based on response to the question, "How many cups of sweetened drinks does your child have in a typical day?" Snacking was measured from the question, "How many servings of sweets or candy, chips, or fried snacks does your child have in a typical day?"

STATISTICAL ANALYSIS

Descriptive statistics were performed for the primary exposure, outcomes, and covariates. Univariate logistic regression was used to determine the unadjusted association between total breast-feeding duration and caries. Total breast-feeding duration was modeled as a continuous variable and as a categorical variable (0–5 months, 6–11 months, 12–23 months, and >24 months). For the primary analysis, multivariable logistic regression was performed to determine the odds of one or more teeth affected by caries, with total breast-feeding duration assessed as a continuous and categorical variable in separate models as above. The adjusted logistic regression model was used to predict the probability of caries with 12 months', 18 months', 24 months', and 36 months' total breast-feeding duration. All covariates (specified above) were thought to be clinically important and were included in the final models regardless of associated P values to prevent biased regression coefficients and falsely inflated R^2 values from data-driven variable selection techniques.[24] All covariates had <15% missing values, with the majority of covariates missing <10%. Multiple imputation was performed for missing data using chained equations.[25] The variance inflation factor was computed for each covariate to test for multicollinearity.

To explore factors that might modify the association between total breast-feeding duration and caries, two biologically plausible interactions were considered strategically

to achieve a balance between overfitting and interpretation. These included interactions between total breast-feeding duration and sex, and total breast-feeding duration and self-reported family income. Interactions were tested for significance using a likelihood ratio test through addition of hypothesized interactions to the main effects model. If the joint P value was large ($P > .30$), making the interactions unlikely, the interactions were removed from the final model.

To explore whether residual confounding by age might affect the relationship between longer total breast-feeding duration and dental caries, the correlation between age and total breast-feeding duration was assessed. Further, a sensitivity analysis was performed restricting the age range to 3 to 5 years for the primary analysis.

All parents of participating children consented to participate. Research ethics approval was granted through the Research Ethics Boards of the Hospital for Sick Children and St Michael's Hospital.

RESULTS

POPULATION

Parents of 2376 healthy children aged 1 to 6 years who attended well-child visits at primary care physician's offices from September 2011 to August 2013 consented to participate. Four hundred fifty-eight children had missing caries data and were excluded, leaving 1918 children who were included in the analysis. Children included in the study compared to those excluded were slightly older but otherwise appeared clinically similar (Table 1). Median age of included children was 45 months (range, 12–72 months), 52% were boys, and most children (90%) had received at least some breast-feeding. The median total breast-feeding duration was 12 months (range, 0–49 months). Among all study participants, 19% reported breast-feeding their child for a total duration of 0 to 5 months, 42% for 6 to 11 months, 30% for 12 to 23 months, and 9% for 24 months or longer. Almost 13% of children had a parent report of dental caries (Table 1).

Table 1. Population Characteristics

Characteristic	Included (n = 1918)	Excluded (n = 458)
Age, mo, mean (SD)*	44.73 (16.75)	30.19 (14.15)
Maternal age, y, mean (SD)	35.66 (4.42)	35.12 (4.71)
Birth weight, kg, mean (SD)	3.27 (0.71)	3.20 (0.74)
Maternal ethnicity, n (%)		
European	1273 (66)	267 (58)
East Asian	139 (7)	24 (5)
South Asian	95 (5)	38 (8)
Southeast Asian	58 (3)	24 (5)
Other†	289 (15)	85 (19)
High school/public school, n (%)	155 (8)	54 (12)
Male, n (%)	995 (52)	244 (53)
Single parent, n (%)	91 (5)	26 (6)
Mother unemployed, n (%)	362 (19)	107 (23)
Smoker at home, n (%)	195 (10)	58 (13)
Bedtime bottle use, n (%)	190 (10)	85 (19)
Only child, n (%)	443 (23)	171 (37)
Sugar-sweetened beverage, c, mean (SD)	0.81 (1.00)	0.76 (1.16)
Snacking, serving, mean (SD)	0.64 (0.81)	0.61 (0.93)
Total breast-feeding duration, mo, mean (SD)	11.79 (7.83)	10.74 (6.98)
Breast-feeding 0–5 mo, n (%)	363 (19)	104 (23)
Breast-feeding 6–11 mo, n (%)	798 (42)	194 (42)
Breast-feeding 12–23 mo, n (%)	572 (30)	133 (29)
Breast-feeding 24 mo or beyond, n (%)	169 (9)	25 (5)
Dental caries, yes, n (%)	242 (12.62)	N/A

*Statistically different at $P < .05$.

†Other includes Arab, African, Latin American, mixed ethnicity, and North American aboriginal.

ASSOCIATION BETWEEN TOTAL DURATION OF BREAST-FEEDING AND DENTAL CARIES

For the primary analysis, the adjusted odds of parent reported dental caries for each additional month total breast-feeding duration was 1.04 (95% confidence interval [CI] 1.02–1.04; $P < .001$). Relative to total breast-feeding duration 0 to 5 months, the odds of caries with total breast-feeding duration 6 to 11 months was 1.17 (95% CI 0.73–1.88), 12 to 23 months was 1.52 (95% CI 0.97–2.38), and >24 months was 2.75 (95% CI 1.61–4.72, $P < .001$) (Table 2). The predicted probability of caries with total breast-feeding duration of 12 months was 0.07 (95% CI 0.05–0.10), 18 months was 0.08 (95% CI 0.06–0.12), 24 months was 0.11 (95% CI 0.07–0.15), and 36 months was 0.16 (95% CI 0.10–0.25) (Fig).

Statistically significant covariates included child age (odds ratio [OR] 1.07, 95% CI 1.04–1.08, $P < .001$), maternal age (OR 0.96, 95% CI 0.93–1.0, $P = .05$), East Asian ethnicity (OR 2.39, 95% CI 1.49–3.84, $P < .001$), and Southeast Asian ethnicity (OR 2.15, 95% CI 1.03–4.50, $P = .04$) (Table 2). A likelihood ratio test between the main effects model with both hypothesized interaction terms (sex and self-reported family income) yielded $P > .30$, which was sufficiently high to exclude hypothesized interactions, and they were therefore not included in the final model.

To explore residual confounding of the relationship between longer total breast-feeding duration and dental caries by child age, no statistically significant correlation was identified between child age and total duration of breast-feeding (Pearson correlation coefficient 0.06, 95% CI 0.02–0.10). Further, repeating the primary analysis restricting the age range to 3 to 5 years resulted in similar parameter estimates as the primary analysis, suggesting minimal residual confounding by age (data not shown).

DISCUSSION

Our study identified an association between longer total breast-feeding duration and increased odds of parent-reported dental caries in a population of healthy urban children. Relative to total breast-feeding duration of 0 to 5 months, there was a 2.75 times increased odds of caries with total breast-feeding duration of 24 months or longer. This relationship did not appear to depend on sex or family income.

Table 2. Association Between Total Breast-feeding Duration and Dental Caries

Characteristic	Unadjusted OR (95% CI; *P*)	Adjusted OR (95% CI; *P*)
Total breast-Feeding duration (per month)	1.04 (1.02–1.06; <.001)*	1.04 (1.02–1.06; <.001)*
Total breast-feeding duration		
0–5 mo (reference)	…	…
6–11 mo	1.06 (0.69–1.62; .80)	1.17 (0.73–1.88; .50)
12–23 mo	1.21 (0.82–1.80; .34)	1.52 (0.97–2.38; .07)
≥24 mo	2.75 (1.69–4.48; <.001)*	2.75 (1.61–4.72; <.001)*
Age, (mo)	1.07 (1.06–1.08; <.001)*	1.07 (1.05–1.08; <.001)*
Maternal age, y	0.98 (0.95–1.01; .24)	0.96 (0.93–1.00; .04)*
Birth weight, kg	1.10 (0.88–1.37; .39)	1.10 (0.86–1.40; .46)
Ethnicity		
European (reference)	…	…
East Asian	2.32 (1.51–3.57; <.001)*	2.39 (1.49–3.84; <.001)*
South Asian	0.93 (0.47–1.82; .83)	0.64 (0.30–1.37; .25)
Southeast Asian	2.41 (1.29–4.50; .01)*	2.15 (1.03–4.50; .04)*
Other	0.95 (0.64–1.43; .81)	0.92 (0.58–1.45; .72)
High school/public school	1.35 (0.86–2.12; .20)	1.17 (0.67–2.05; .57)
Sex, male	1.27 (0.97–1.66; .09)	1.34 (1.00–1.79; .05)*
Self-reported family income (Canadian $)		
0–59,999	0.89 (0.63–1.27; .53)	0.97 (0.66–1.41; .86)
60,000–99,999	1.30 (0.84–1.99; .24)	1.23 (0.70–2.18; .47)
100,000–149,999	1.04 (0.67–1.61; .87)	0.88 (0.54–1.43; .60)
Over 150,000 (reference)	…	…
Single parent	1.61 (0.93–2.78; .09)	1.45 (0.75–2.82; .27)
Mother unemployed	1.25 (0.90–1.73; .18)	1.07 (0.72–1.57; .74)
Smoker at home	0.81 (0.51–1.31; .40)	0.72 (0.42–1.22; .21)
Bedtime bottle use	0.85 (0.53–1.37; .51)	1.47 (0.83–2.63; .19)
Only child	0.51 (0.35–0.75; <.001)*	0.77 (0.50–1.18; .24)
Sugar-sweetened beverage (cup)	1.16 (1.03–1.31; .01)*	0.98 (0.84–1.14; .79)
Snack (serving)	1.36 (1.18–1.56; <.001)*	1.15 (0.96–1.37; .12)

OR indicates odds ratio; and CI, confidence interval.
*Statistically significant.

Breast-feeding has been hypothesized to be one of many factors that contribute to the development of dental caries.[26] However, systematic reviews have been inconclusive, with limited data on longer breast-feeding duration.[27,28] Adjusted analyses in recent studies both in developed and developing countries have had conflicting results for the relationship between breast-feeding and increased risk of dental caries. A 9-year longitudinal cohort study of 509 American children reported that breast-feeding <6 months compared to >6 months was associated with increased odds of dental caries (OR 15.58, 95% CI not given; $P = .005$) at 5 years of age.[29] Conversely, in a Japanese longitudinal study, breast-feeding for 6 to 7 months relative to formula feeding was associated with increased odds of dental caries at 30 months. The OR for exclusive breast-feeding was 1.78 (95% CI 1.45–2.17) and for partial breast-feeding was 1.39 (95% CI 1.14–1.70), although the association was not statistically significant with longer follow-up.[30]

Several older studies have suggested an increased risk of dental caries with breast-feeding beyond 12 months of age. In two studies of Brazilian children, breast-feeding for more than 24 months was associated with increased odds of severe dental caries.[17,31] Likewise, in two Japanese cross-sectional studies, >18 months' total breast-feeding duration was also associated with an increased risk of dental caries (OR 1.66, 95% CI 1.33–2.06[32] and OR 6.37, 95% CI 2.50–16.24[33]). In a retrospective cohort study of Southeast Asian children, daytime breast-feeding up to 12 months was not associated with caries, but nighttime breast-feeding was associated with caries (OR 35, 95% CI 6–186).[34] However, in a cross-sectional study of 1576 North

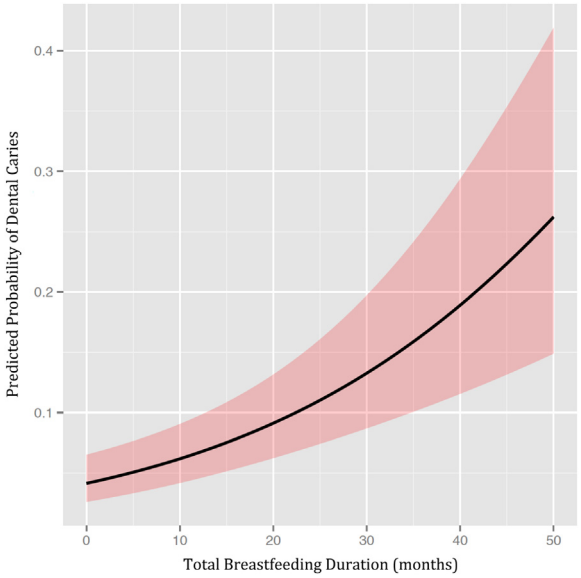

Figure. *Predicted probability of dental caries. Plot generated from adjusted logistic regression model. Solid line represents adjusted predicted probability of developing dental caries as function of total breast-feeding duration. Shaded area represents 95% confidence intervals for predicted probabilities.*

American children aged 2 to 5 years using National Health and Nutrition Examination Survey (1999–2000) data, no association was found between any breast-feeding and caries, although children who breast-fed for >12 months were more likely to have caries than children who breast-fed for <12 months (OR 1.68).[16] Our study results are consistent with the few studies that have examined breast-feeding duration beyond 1 year of age and dental caries. Our findings highlight the association between breast-feeding duration beyond 2 years of age and dental caries.

Preventive dental health recommendations include oral health assessments during the first year of life, brushing daily with the correct amount of toothpaste, applying fluoride varnish in high-risk individuals, reducing behaviors that promote early transmission of dental caries causing bacteria, and discouraging frequent sweet drinks, especially at nighttime.[35] The nature of dental caries with longer breast-feeding duration is likely multifactorial.[11] First, breast milk may be more cariogenic than cow's milk consumed after the first year.[36] Second, nighttime breast-feeding may disturb saliva flow to self-clean and buffer fermenting cariogenic substrates, provide growth-promoting carbohydrates in breast milk, and create proliferation of cariogenic bacteria.[37] Third, consumption of nonfluoridated water may play a role in the mechanism.

Strengths of this study include a relatively large sample of healthy urban children with numerous participants breast-feeding to 2 years of age and beyond, allowing us to study longer total breast-feeding duration. Further, children were included up to 6 years of age, which allowed for longer accrual of dental caries. This study definition of total breast-feeding duration included both exclusive and nonexclusive breast-feeding, which may be relevant to current breast-feeding policy objectives.[38] Finally, clinically rich data allowed for adjustment of numerous biologically plausible confounders.

This study has a number of limitations. This study was cross-sectional, and hence causality cannot be inferred. The presence of dental caries may have led to recommendations to discontinue breast-feeding resulting in reverse causality. Although preschool children's oral health correlates well with parental perception of oral health,[21,22] dental caries assessment relied on parent report, which may not represent actual dental caries. This study was not able to adjust for unmeasured potential confounders, such as infant feeding patterns, early introduction of complementary foods, dental hygiene practices, fluoride supplementation, nonfluoridated water consumption, microbial oral flora, or maternal oral health status. Breast-feeding at night versus during the daytime only was not measured in this cohort. Because nighttime bottle feeding is a known risk factor for caries, it is possible that the associations described are due to nighttime breast-feeding, versus any specific cariogenic properties of human milk.

CONCLUSIONS

Children with longer total breast-feeding duration may be at increased risk of dental caries. These findings emphasize the importance of oral health anticipatory guidance, particularly for those who breast-feed beyond 2 years of age, to minimize caries risk and maximize the well-documented benefits of breast-feeding. Longitudinal studies of longer durations of breast-feeding, infant feeding patterns, and oral hygiene practices are needed.

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