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

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Version  Post-print/Accepted manuscript


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Total breastfeeding duration and dental caries in healthy urban children

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**Key Words:** Nutrition, oral health, early childhood

**Short title:** Breastfeeding duration and dental caries in healthy children

**Word Count:**

Abstract: 155
**Funding Source:** Overall support for the TARGet Kids! program was provided by the Canadian Institutes of Health Research Institute (CIHR) of Human Development, Child and Youth Health and the Institute Nutrition Metabolism and Diabetes, as well as the St. Michael’s Hospital Foundation. The Paediatric Outcomes Research Team is supported by a grant from The Hospital for Sick Children Foundation. Funding agencies had no role in the design and conduct of the study, collection, management, analyses or interpretation of the results of this study or in the preparation, review, or approval of the manuscript.

**Financial Disclosure:** There are no financial relationships relevant to this article to disclose from all identified authors. Dr. Peter Wong wrote the first draft of the manuscript. Authors did not receive an honorarium, grant, or other form of payment to produce the manuscript.

**Conflict of Interest:** There are no conflicts of interest or financial relationships relevant to this study to disclose from all identified authors.

**Abbreviations:**
- CI – confidence interval
- OR – odds ratio
- WHO – World Health Organization
ABSTRACT

Objectives: To determine if there is an association between longer breastfeeding 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 breastfeeding duration of 12, 18, 24, and 36 months, respectively. In the adjusted logistic regression analyses, relative to breastfeeding 0-5 months, the odds of dental caries with total breastfeeding duration >24 months was 2.75 (95% CI: 1.61-4.72).

Conclusions: Among healthy urban children, longer breastfeeding 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 breastfeed beyond 2 year of age.

WHAT’S NEW

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

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 fluorides\(^4\). Breastfeeding has been hypothesized to contribute to the development of dental caries\(^5\), however the contribution of extended breastfeeding duration is unclear. The World Health Organization (WHO) recommends exclusive breastfeeding for the first 6 months of life with introduction of complementary foods at 6 months and continued breastfeeding 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 United Kingdom\(^10\). Correlating factors for childhood dental caries and early breastfeeding cessation are alike including low socioeconomic status, ethnic and racial minorities, maternal smoking, young mothers, and low parental education\(^11\).

The benefit of breastfeeding on infant health has been clearly demonstrated, however in developed countries less consensus exists around the optimal duration\(^12,13\). Total breastfeeding 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 breastfeeding duration and caries may assist parents and clinicians in optimizing the benefits of breastfeeding while minimizing risks.
Given the importance of both breastfeeding and the prevention of caries, the primary objective of this study was to determine whether there is an association between longer total breastfeeding duration and caries in young healthy urban Canadian children. The secondary objective was to assess factors that might modify the association between total breastfeeding duration and caries.
METHODS

This was a cross-sectional study of healthy urban children, aged 1 to 6 years who attended routine primary healthcare visits at a TARGet Kids! (The Applied Research Group for Kids) participating paediatric 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 Toronto18.

Subject Recruitment and Data Collection

Healthy children were recruited between September 2011 and August 2013 by research personnel embedded in 7 paediatric and family medicine practices. Children were excluded if they had a condition affecting growth (e.g. 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 Survey19. MediData Rave (MediData Solutions, New York, NY, USA) was used as the secure electronic data capture system and data repository for all TARGet Kids! data18.

Exposure and Outcome Variables
The primary exposure variable was total breastfeeding duration which was determined from the response to the question, “For how long has your child been breastfed?”.

Maternal recall has been found to be a valid and reliable estimate of breastfeeding duration for recall up to 3 years$^{20}$. Those who had never breastfed were classified as having total breastfeeding duration of 0 months. Those currently breastfeeding were classified as having total breastfeeding 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’s 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 breastfeeding 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 consumption. Maternal ethnicity was determined from the country where biological mother was born and 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 $0$-$59 999, $60 000$-$99 999, $100 000$-$149 999, and over $150 000$ 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 breastfeeding duration and caries. Total breastfeeding duration was modeled as (1) a continuous variable and (2) 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 breastfeeding 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 breastfeeding duration. All covariates (specified above) were felt to be clinically important and were included in the final models regardless of associated p-values to prevent biased regression coefficients and falsely inflated R² values from data driven variable selection techniques. All covariates had less than 15% missing values with majority of covariates missing below 10%. Multiple imputation was performed for
missing data using chained equations (MICE)\textsuperscript{25}. The variance inflation factor (VIF) was computed for each covariate to test for multicollinearity.

To explore factors that might modify the association between total breastfeeding duration and caries, two biologically plausible interactions were considered strategically to achieve a balance between overfitting and interpretation. These included interactions between total breastfeeding duration and sex, and total breastfeeding 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 (\( p > 0.30 \)), 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 breastfeeding duration and dental caries, the correlation between age and total breastfeeding duration was assessed. Further, a sensitivity analysis was performed restricting the age range to 3-5 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 and 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 male, and most children (90%) had received at least some breastfeeding. The median total breastfeeding duration was 12 months (range 0-49 months). Among all study participants, 19% reported breastfeeding their child for a total duration of 0-5 months; 42% for 6-11 months; 30% for 12-23 months; and 9% for 24 months or longer. Almost 13% of children had a parent report of dental caries (Table 1).

**Association between total duration of breastfeeding and dental caries**

For the primary analysis, the adjusted odds of parent reported dental caries for each additional month total breastfeeding duration was 1.04 (95% CI: 1.02-1.04; \( p < .001 \)). Relative to total breastfeeding duration 0-5 months, the odds of caries with total breastfeeding duration 6-11 months was 1.17 (95% CI: 0.73-1.88), 12-23 months was 1.52 (95% CI: 0.97-2.38), and > 24 months was 2.75 (95% CI: 1.61-4.72, \( p < 0.001 \)) [Table 2]. The predicted probability of caries with total breastfeeding 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) [Figure 1].

Statistically significant covariates included child age (OR 1.07, 95% CI: 1.04-1.08, \( p < .001 \)), maternal age (OR 0.96, 95% CI: 0.93-1.0, \( p = 0.05 \)), 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 \( p > 0.30 \) which was sufficiently high to exclude hypothesized interactions and therefore they were not included in the final model.

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

**DISCUSSION**

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

Breastfeeding 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 breastfeeding duration\(^27,28\). Adjusted analyses in recent studies both in developed and developing countries have had conflicting results for the
relationship between breastfeeding and increased risk of dental caries. A 9-year longitudinal cohort study of 509 American children reported breastfeeding <6 months compared with >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, breastfeeding for 6-7 months relative to formula feeding was associated with increased odds of dental caries at 30 months – OR: 1.78 for exclusive breastfeeding (95% CI: 1.45-2.17) and OR: 1.39 for partial breastfeeding (95% CI: 1.14-1.70) although the association was not statistically significant with longer follow-up\(^{30} \).

Several older studies have suggested increased risk of dental caries with breastfeeding beyond 12 months of age. In two studies of Brazilian children, breastfeeding for more than 24 months was associated with increased odds of severe dental caries\(^{17,31} \). Likewise, in two Japanese cross-sectional studies, total breastfeeding duration >18 months 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 breastfeeding up to 12 months was not associated with caries but nighttime breastfeeding was associated with caries (OR: 35, 95% CI: 6-186)\(^ {34} \). However, in a cross-sectional study of 1576 North American children aged 2-5 years using NHANES (1999-2000) data, no association was found between any breastfeeding and caries, although children who breastfed >12 months were more likely to have caries than children who breastfed <12 months (OR: 1.68)\(^ {16} \). Our study results are consistent with the few studies that have examined breastfeeding duration beyond 1 year of age and dental caries. Our findings highlight the association between breastfeeding duration beyond 2 years of age and dental caries.
Preventive dental health recommendations include oral health assessments during first year of life, brushing daily with 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\textsuperscript{35}. The nature of dental caries with longer breastfeeding duration is likely multifactorial\textsuperscript{11}. First, breast milk may be more cariogenic than cow milk consumed after the first year\textsuperscript{36}. Second, nighttime breastfeeding 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\textsuperscript{37}. Third, consumption of non-fluoridated water may play a role in the mechanism.

Strengths of this study include a relatively large sample of healthy urban children with numerous participants breastfeeding to 2 years of age and beyond allowing us to study longer total breastfeeding duration. Further, children were included up to 6 years of age, which allowed for longer accrual of dental caries. This study definition of total breastfeeding duration included both exclusive and non-exclusive breastfeeding which may be relevant to current breast feeding policy objectives\textsuperscript{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, hence causality cannot be inferred. The presence of dental caries may have led to recommendations to discontinue breastfeeding resulting in reverse causality. Although preschool children’s oral health correlates well with parental perception of oral health\textsuperscript{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, non-fluoridated water consumption, microbial oral flora, or maternal oral health status. Breastfeeding at night versus during the daytime only was not measured in this cohort. As nighttime bottle-feeding is a known risk factor for caries, it is possible that the associations described are due to nighttime breastfeeding, versus any specific cariogenic properties of human milk.

**CONCLUSION**

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

The authors thank all participating families for their time and involvement in TARGet Kids! and are grateful to all practitioners who are currently involved in the TARGet Kids! research network. Steering Committee: Tony Barozzino, Brian Chisamore, Mark Feldman, Moshe Ipp. Research Team: Kathleen Abreo, Tarandeep Malhi, Antonietta Pugliese, Megan Smith, Laurie Thompson. Applied Health Research Centre: Gerald Lebovic, Magda Melo, Patricia Nguyen. Mount Sinai Services Laboratory: Azar Azad. No compensation was received for contribution.
REFERENCES


