**Background**

The World Health Organization is a strong advocate for breastfeeding as the optimal source of nutrition for infants. It recommends exclusive breastfeeding for the first six months of life, followed by continued breastfeeding for at least 24 months in combination with complementary foods (World Health Organization, 2011). The health benefits of breastfeeding are widely acknowledged, including reducing the risk of gastrointestinal and respiratory infections, atopic eczema, and other allergic diseases, as well as enhancing neuro-cognitive development, according to Horta, Loret de Mola, and Victora (2015). However, despite its many benefits, the American Academy of Pediatric Dentistry (AAPD) does not endorse extended breastfeeding beyond 12 months of age, as it is believed to increase the risk of early childhood cavities (American Academy of Pediatric Dentistry, 2011). Some studies have even suggested that human milk may be more cariogenic than cow milk, and therefore could increase the risk of cavities in infants especially after the first tooth eruption. An umbrella review conducted by Panchanadikar et al., (2022) revealed that breastfeeding beyond the age of 12 months, accompanied by nocturnal feeding, had a positive association with early childhood cavities. Similarly, Hallonsten et al., (1995) indicated that prolonged breastfeeding tends to establish unsuitable eating habits which constitutes a risk situation for developing cavities. While existing literature has explored the general relationship between prolonged breastfeeding and early childhood cavities risk, there is a gap in the literature that fail to carefully control for pertinent confounding factors needed to elucidate this issue and better inform infant feeding guidelines. Hence, this study aims to investigate whether the duration of breastfeeding is associated with the risk of cavities incidence (whether increased or decreased) among children aged 0-5 years while accounting for pertinent confounding factors using data from the 2021 National Survey of Children’s Health.

**Methods**

Study Design: This study utilized a retrospective cohort design to explore the association between breastfeeding duration and the development of cavities among children aged 0-5 years old.

Participants: The study included children who had ever breastfed and were aged between 0-5 years old. Children with chronic illnesses that could affect oral health, such as cerebral palsy, autism, and developmental delay were excluded from the study.

Source data and variables: Data used was from the 2021 National Survey of Children’s Health. The following variables were considered in primary analysis and as covariates: breastfeeding duration, presence of cavities, maternal age at birth, child’s race, highest level of education among adults, hard to cover basics like food and clothing, and insurance coverage.

Crude and adjusted odds ratios (ORs) were used to measure the association between breastfeeding duration and the development of cavities. The adjusted ORs were computed using logistic regression models, controlling for potential confounding variables such as maternal age at birth, child’s race, highest level of education among adults, hard to cover basics like food and clothing, and insurance coverage. Stratified analyses were performed to examine the relationship between breastfeeding duration and cavities among children of mothers who were ≤ 30 years old and > 30 years old at the time of birth. Missing data for potential covariates were accounted for using the case complete analysis approach and a 10% change in estimate strategy was used to select potential covariates to control for confounding.

All statistical analyses were performed using SAS Windows Environment version 9.4 (SAS Institute Inc., Cary, NC, USA).

**Results**

Table 1 summarizes the characteristics of the study population by breastfeeding duration group. The study population consisted of 14,253 children, with 70.28% breastfed for less than 12 months and 29.72% breastfed for 12 months or longer. The mean age of children in the breastfed <12 months group was 2.95 years, while the mean age in the breastfed ≥12 months group was 3.34 years. Maternal age at birth was slightly higher in the breastfed ≥12 months group compared to the breastfed <12 months group. There was no substantial difference between the two groups in terms of child's sex, race/ethnicity, family structure, and insurance coverage. However, a higher proportion of children breastfed for ≥12 months had decayed teeth or cavities compared to those breastfed for <12 months.

There was evidence of association between breastfeeding duration and cavities (p <.0001, *see Table 2*). The results show that children who were breastfed for ≥ 12 months had a significantly higher risk of having decayed teeth or cavities compared to those breastfed for < 12 months in the crude (OR=1.641, p<0.0001) and adjusted models (OR=1.778, p<.0001). The adjusted models were sequentially adjusted for covariates, and the results show that child's race, highest level of education among adults were selected as confounders based on the 10% forward change in estimate strategy. In comparison, utilizing a complete case analysis approach for missing covariate data, Table 3 presents the results of the complete case analysis for the association between breastfeeding duration and decayed teeth or cavities among children aged 0-5, with adjusted models including child's race, highest level of education among adults, hard to cover basics like food and clothing, and insurance coverage. The results are similar to those in Table 2, with children breastfed for 12 months or more having a significantly higher risk of decayed teeth compared to those breastfed for less than 12 months, both in the crude and adjusted models. The adjusted odds ratios for the longer breastfeeding duration are slightly higher in Table 3 compared to Table 2, indicating a slightly stronger association when only considering complete cases. Additionally, the adjusted models in Table 3 include the additional variable of hard to cover basics like food and clothing and insurance coverage which was not included in the adjusted models of Table 2. However, the main findings regarding the association between breastfeeding duration and decayed teeth or cavities remain consistent between the two tables.

Table 4 shows the association between breastfeeding duration and cavities stratified by maternal age at birth. The odds ratios (OR) with 95% confidence intervals (CI) are presented for each stratum. The results indicate that for mothers aged 30 years or younger, children breastfed for 12 months and more had a significantly higher odds of decayed teeth or cavities compared to those breastfed for less than 12 months (OR=1.66, 95% CI=1.36-2.02). Similarly, for mothers older than 30 years, children breastfed for 12 months and more had a significantly higher odds of decayed teeth or cavities compared to those breastfed for less than 12 months (OR=1.77, 95% CI=1.44-2.17). Since the odds ratio estimates are not similar, it can be said that there is evidence of effect modification by maternal age at birth between breastfeeding and cavities.

**Table 1. Characteristics of study population by breastfeeding duration group**

|  |  |  |
| --- | --- | --- |
| **Characteristics** | **Breastfed < 12 months**  **(n = 10017; 70.28%%)** | **Breastfed ≥ 12 months**  **(n = 4236; 29.72%%)** |
| Age of child (years) | 2.95± 1.47 | 3.34 ± 1.28 |
| Maternal age at birth (years) | 30.88 ± 5.17 | 31.53 ± 4.75 |
| Child’s sex, *n (%)*  Male  Female | 5096 (50.87%)  4921 (49.13%) | 2149 (50.73%)  2087(49.27%) |
| Child’s race/ethnicity, *n (%)*  White  Black/African American  American Indian/Alaska Native  Asian  Native Hawaiian & Other Pacific Islander  Two or more races | 7895 (78.82%)  522 (5.21%)  63 (0.63%)  582 (5.81%)  72 (0.72%)  883 (8.82%) | 3297 (77.83%)  183 (4.32%)  24 (0.57%)  298 (7.03%)  28 (0.66%)  406 (9.58%) |
| Highest level of education among adults, *n (%)*  Less than high school  High school  Some college / Associate degree  College degree or higher | 168 (1.68%)  1030 (10.28%)  1883 (18.80%)  6936 (69.24%) | 71 (1.68%)  240 (5.67%)  591 (13.95%)  3334 (78.71%) |
| Family Structure, *n (%)*  Two biological/adoptive parents currently married  Two biological/adoptive parents not currently married  Two parents (at least one not biological/adoptive) currently married  Two parents (at least one not biological/adoptive) not currently married  Single mother  Single father  Grandparent household  Other relation | 7579 (77.79%)  579 (5.94%)  43 (0.44%)  62 (0.64%)  993 (10.19%)  302 (3.10%)  156 (1.60%)  29 (0.30%) | 3459 (83.63%)  196 (4.74%)  11 (0.27%)  12 (0.29%)  330 (7.98%)  98 (2.37%)  28 (0.68%)  2 (0.05%) |
| Insurance coverage, *n (%)*  Yes  No | 9678 (96.96%)  303 (3.04%) | 4095 (96.90%)  131 (3.10%) |
| Decayed teeth or cavities, *n (%)*  Yes  No | 526 (5.26%)  9465 (94.74%) | 353 (8.36%)  3870 (91.64%) |

Data are presented as mean ± SD except where noted.

**Table 2. Association between Breastfeeding Duration and Decayed Teeth or Cavities among Children aged 0-5: Results of Crude and Adjusted Models**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Breastfeeding duration group | Decayed teeth or cavities | | Crude OR | Adjusted OR | RRc | p-value |
| Yes | No |
| ≥ 12 months of breastfeeding | 353 | 3870 | 1.641 |  |  | <.0001 |
| < 12 months | 526 | 9465 | 1.0 (ref) |  |  |  |
| + Child’s race  + Highest level of education among adults  + Hard to cover basics like food and clothing  + Insurance coverage  ≥ 12 months of breastfeeding + Highest level of education among adults  < 12 months  + Child’s race  + Hard to cover basics like food and clothing  + Insurance coverage  ≥ 12 months of breastfeeding + Highest level of education among adults + Child’s race  < 12 months  + Hard to cover basics like food and clothing  + Insurance coverage |  |  | 1.831  1.0 (ref)  1.778  1.0 (ref) | 1.636  1.831  1.712  1.641  1.778  1.824  1.792  1.821  1.789 | 1.00  0.89  0.96  1.00  1.03  1.00  1.02    0.97  0.99 | <.0001  <.0001 |

**Table 3. Association between Breastfeeding Duration and Decayed Teeth or Cavities among Children aged 0-5: Results of Complete Case Analysis and Adjusted Models**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Breastfeeding duration group | Decayed teeth or cavities | | Crude OR | Adjusted OR | RRc | p-value |
| Yes | No |
| **Complete Case Analysis** | | | | |  |  |
| ≥ 12 months of breastfeeding | 353 | 3870 | 1.641 |  |  | <.0001 |
| < 12 months | 526 | 9465 | 1.0 (ref) |  |  |  |
| + Child’s race  + Highest level of education among adults  + Hard to cover basics like food and clothing  + Insurance coverage  ≥ 12 months of breastfeeding + Highest level of education among adults  < 12 months  + Child’s race  + Hard to cover basics like food and clothing  + Insurance coverage  ≥ 12 months of breastfeeding + Highest level of education among adults + Hard to cover basics like food and clothing  < 12 months  + Child’s race  + Insurance coverage  ≥ 12 months of breastfeeding + Highest level of education among adults + Hard to cover basics like food and clothing + Insurance coverage  < 12 months  + Child’s race |  |  | 1.836  1.0 (ref)  1.829  1.0 (ref)  1.819  1.0 (ref) | 1.637  1.836  1.712  1.640  1.781  1.829  1.795  1.819  1.832  1.829 | 1.00  0.89  0.96  1.00  1.03  1.01  1.03    1.01  0.99  0.99 | <.0001  <.0001  <.0001 |

**Table 4. Association Between Breastfeeding Duration and Cavities Stratified by Maternal Age at Birth: Odds Ratios with 95% Confidence Intervals**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Stratum characteristic | Breastfeeding duration | | Decayed teeth or cavities | | | OR (95% CI) |
| Yes | | No |
| Maternal age at birth (≤ 30 years) | < 12 months of breastfeeding | 295 | | 4271 | | Ref  1.66 (1.36 – 2.02) |
| ≥ 12 months of breastfeeding | 176 | | 1538 | |
| Maternal age at birth (>30 years) | < 12 months of breastfeeding | 219 | | 5097 | | Ref  1.77 (1.44 – 2.17) |
| ≥ 12 months of breastfeeding | 174 | | 2291 | |

SAS CODE

libname epproj "C:\Users\HP\OneDrive\Desktop\EP 850\";

**data** proj1;

set epproj.nsch\_2021\_topical;

/\*restricted dataset to 0-5 year olds\*/

where FORMTYPE = 'T1';

/\*applying exclusion criteria\*/

/\*exculsion criteria was those who have never breastfed and those who have had a history of chronic illness

affecting oral health like cerebral palsy, autism and developmental delay\*/

if K6Q40 =**2** then delete;

if K2Q61A =**1** then delete;

if K2Q61B =**1** or K2Q61B= **2** then delete;

if K2Q36A=**1** then delete;

if K2Q36B =**1** or K2Q36B=**2** then delete;

if K2Q35A=**1** then delete;

if K2Q35B =**1** or K2Q35B=**2** then delete;

/\*setting coded missing values to missing\*/

if BREASTFEDEND\_DAY\_S in (**.M**,**.L**,**.N**,**.D**) then BREASTFEDEND\_DAY\_S = **.**;

if BREASTFEDEND\_MO\_S in (**.M**,**.L**,**.N**,**.D**) then BREASTFEDEND\_MO\_S=**.**;

if BREASTFEDEND\_WK\_S in (**.M**,**.L**,**.N**,**.D**) then BREASTFEDEND\_WK\_S=**.**;

/\*Convert weeks and days at which breastfeeding was stopped to months\*/

BREASTFEDSTOP\_DAYMONTHS = BREASTFEDEND\_DAY\_S/**30**;

BREASTFEDSTOP\_WKSMONTHS = BREASTFEDEND\_WK\_S/**4**;

/\*operationalizing the variable, BREASTFEDSTOP\_NEW\*/

if BREASTFEDSTOP\_DAYMONTHS=**.** and BREASTFEDSTOP\_WKSMONTHS=**.** and BREASTFEDEND\_MO\_S=**.** then BREASTFEDSTOP\_NEW=**.**;

else if BREASTFEDSTOP\_DAYMONTHS=**.** and BREASTFEDSTOP\_WKSMONTHS=**.** and BREASTFEDEND\_MO\_S ^=**.** then BREASTFEDSTOP\_NEW= BREASTFEDEND\_MO\_S;

else if BREASTFEDSTOP\_DAYMONTHS =**.** and BREASTFEDSTOP\_WKSMONTHS ^=**.** and BREASTFEDEND\_MO\_S ^=**.** then BREASTFEDSTOP\_NEW= BREASTFEDEND\_MO\_S + BREASTFEDSTOP\_WKSMONTHS;

else if BREASTFEDSTOP\_DAYMONTHS ^=**.** and BREASTFEDEND\_MO\_S ^=**.** then BREASTFEDSTOP\_NEW= BREASTFEDEND\_MO\_S + BREASTFEDSTOP\_DAYMONTHS;

label BREASTFEDSTOP\_NEW="Age in months breastfeeding was stopped";

/\*operationalizing the variable, BREASTFED\_DUR\*/

if K6Q41R\_STILL=**.** and BREASTFEDSTOP\_NEW=**.** then do;

BREASTFED\_DUR=**.**;

end;

else if K6Q41R\_STILL = **2** and BREASTFEDSTOP\_NEW <**12** then do;

BREASTFED\_DUR=**1**;

end;

else if K6Q41R\_STILL = **2** and BREASTFEDSTOP\_NEW >=**12** then do;

BREASTFED\_DUR=**2**;

end;

label BREASTFED\_DUR="Breastfeeding duration at cessation";

if CAVITIES in (**.L**,**.M**,**.N**,**.D**) then CAVITIES\_new = **.**;

else if CAVITIES = **2** then CAVITIES\_new = **0**;

else CAVITIES\_new = **1**;

label CAVITIES\_new="Difficulty Cavities Past 12 months (recoded)";

if MOMAGE in (**.L**,**.M**,**.N**,**.D**) then MOMAGE\_new=**.**;

else if MOMAGE <=**30** then MOMAGE\_new = **1**;

else MOMAGE\_new = **2**;

label MOMAGE\_new = "Maternal age categorized";

if K9Q40 in (**.L**,**.M**,**.N**,**.D**) then K9Q40\_new=**.**;

else if K9Q40 = **2** then K9Q40\_new = **0**;

else K9Q40\_new = **1**;

label K9Q40\_new=" If anyone uses cigarette in household recoded";

if FAMILY\_R in (**.M**,**.L**,**.N**,**.D**) then FAMILY\_R =**.**;

if ACE1 in (**.M**,**.L**,**.N.**,**.D**) then ACE1=**.**;

if HIGRADE\_TVIS in (**.M**,**.L**,**.N.**,**.D**) then HIGRADE\_TVIS=**.**;

if SC\_RACE\_R in (**.M**,**.L**,**.N.**,**.D**) then SC\_RACE\_R=**.**;

if CURRCOV in (**.M**,**.L**,**.N.**,**.D**) then CURRCOV=**.**;

**run**;

/\*QCing my newly created varibales and checking for consistency with ones already in dataset\*/

**proc** **freq** data=proj1;

tables BREASTFEDSTOP\_NEW;

**run**;

**proc** **print** data=proj1;

var BREASTFEDEND\_DAY\_S BREASTFEDEND\_MO\_S BREASTFEDEND\_WK\_S BREASTFEDSTOP\_DAYMONTHS BREASTFEDSTOP\_WKSMONTHS BREASTFEDSTOP\_NEW;

**run**;

**proc** **freq** data=proj1;

tables K6Q41R\_STILL;

**run**;

**proc** **freq** data=proj1;

tables BREASTFED\_DUR;

**run**;

**proc** **freq** data=proj1;

tables MOMAGE;

**run**;

**proc** **print** data=proj1;

var MOMAGE\_new MOMAGE;

**run**;

**proc** **freq** data=proj1;

tables K9Q40 K9Q40\_new;

**run**;

**proc** **freq** data=proj1;

tables BREASTFED\_DUR \* CAVITIES\_new/nocol nocum nopercent;

**run**;

/\*Constructing Table 1\*/

**proc** **means** data=proj1;

var SC\_AGE\_YEARS;

where BREASTFED\_DUR=**1** ;

**run**;

**proc** **means** data=proj1;

var SC\_AGE\_YEARS;

where BREASTFED\_DUR=**2**;

**run**;

**proc** **means** data=proj1;

var MOMAGE;

where BREASTFED\_DUR=**1** ;

**run**;

**proc** **means** data=proj1;

var MOMAGE;

where BREASTFED\_DUR=**2**;

**run**;

**proc** **freq** data=proj1;

tables BREASTFED\_DUR \* SC\_SEX/nocol nocum nopercent;

**run**;

**proc** **freq** data=proj1;

tables BREASTFED\_DUR \* SC\_RACE\_R/nocol nocum nopercent;

**run**;

**proc** **freq** data=proj1;

tables BREASTFED\_DUR\*HIGRADE\_TVIS/nocol nopercent nocum;

**run**;

**proc** **freq** data=proj1;

tables BREASTFED\_DUR\*FAMILY\_R/nocol nopercent nocum;

**run**;

**proc** **freq** data=proj1;

tables BREASTFED\_DUR\*CURRCOV/nocol nopercent nocum;

**run**;

**proc** **freq** data=proj1;

tables BREASTFED\_DUR\*CAVITIES\_new/nocol nopercent nocum;

**run**;

/\*Confounder assessment - complete case analysis\*/

/\*Remove subjects with missing data on any covariates of interest for estimation of crude\*/

**data** proj1cca;

set proj1;

if ACE1=**.** then delete;

if HIGRADE\_TVIS=**.** then delete;

if SC\_RACE\_R=**.** then delete;

if CURRCOV=**.** then delete;

**run**;

**proc** **freq** data=proj1cca;

tables SC\_RACE\_R ACE1 HIGRADE\_TVIS CURRCOV /missing;

**run**;

**proc** **logistic** data=proj1cca desc;

class BREASTFED\_DUR (param=ref ref='1');

model CAVITIES\_new=BREASTFED\_DUR;

**run**;

**%macro** logistic(var);

proc logistic data=proj1cca desc;

class BREASTFED\_DUR (param=ref ref='1') &var;

model CAVITIES\_new = BREASTFED\_DUR &var;

run;

**%mend**;

\*categorical variables\*;

%***logistic*** (ACE1);

%***logistic*** (HIGRADE\_TVIS);

%***logistic*** (SC\_RACE\_R);

%***logistic*** (CURRCOV);

**%macro** logistic (var);

proc logistic data=proj1cca desc;

class BREASTFED\_DUR (param=ref ref='1') &var;

model CAVITIES\_new = BREASTFED\_DUR HIGRADE\_TVIS &var;

run;

**%mend**;

\*categorical variables\*;

%***logistic*** (ACE1);

%***logistic*** (SC\_RACE\_R);

%***logistic*** (CURRCOV);

**%macro** logistic (var);

proc logistic data=proj1cca desc;

class BREASTFED\_DUR (param=ref ref='1') &var;

model CAVITIES\_new = BREASTFED\_DUR ACE1 HIGRADE\_TVIS &var;

run;

**%mend**;

\*categorical variables\*;

%***logistic*** (SC\_RACE\_R);

%***logistic*** (CURRCOV);

**%macro** logistic (var);

proc logistic data=proj1cca desc;

class BREASTFED\_DUR (param=ref ref='1') &var;

model CAVITIES\_new = BREASTFED\_DUR ACE1 HIGRADE\_TVIS SC\_RACE\_R &var;

run;

**%mend**;

\*categorical variables\*;

%***logistic*** (CURRCOV);

/\*Confounder assessment using original sample size\*/

**proc** **logistic** data=proj1 desc;

class BREASTFED\_DUR (param=ref ref='2');

model CAVITIES\_new=BREASTFED\_DUR;

**run**;

**%macro** logistic(var);

proc logistic data=proj1 desc;

class BREASTFED\_DUR (param=ref ref='1') &var;

model CAVITIES\_new = BREASTFED\_DUR &var;

run;

**%mend**;

\*categorical variables\*;

%***logistic*** (ACE1);

%***logistic*** (HIGRADE\_TVIS);

%***logistic*** (SC\_RACE\_R);

%***logistic*** (CURRCOV);

%***logistic*** (FAMILY\_R);

**%macro** logistic (var);

proc logistic data=proj1 desc;

class BREASTFED\_DUR (param=ref ref='1') &var;

model CAVITIES\_new = BREASTFED\_DUR HIGRADE\_TVIS &var;

run;

**%mend**;

\*categorical variables\*;

%***logistic*** (ACE1);

%***logistic*** (SC\_RACE\_R);

%***logistic*** (CURRCOV);

**%macro** logistic (var);

proc logistic data=proj1 desc;

class BREASTFED\_DUR (param=ref ref='1') &var;

model CAVITIES\_new = BREASTFED\_DUR SC\_RACE\_R HIGRADE\_TVIS &var;

run;

**%mend**;

\*categorical variables\*;

%***logistic*** (ACE1);

%***logistic*** (CURRCOV);

**%macro** logistic (var);

proc logistic data=proj1 desc;

class BREASTFED\_DUR (param=ref ref='1') &var;

model CAVITIES\_new = BREASTFED\_DUR ACE1 HIGRADE\_TVIS CURRCOV &var;

run;

**%mend**;

\*categorical variables\*;

%***logistic*** (SC\_RACE\_R);

/\*Looking at EMM of the CAVITIES\_new - BREASTFED\_DUR by CURRCOV (Insurance coverage)\*/

**proc** **freq** data=proj1;

tables CAVITIES\_new BREASTFED\_DUR CURRCOV/missing;

**run**;

**proc** **freq** data=proj1;

tables CAVITIES\_new \* BREASTFED\_DUR/cmh;

where MOMAGE\_new=**1**;

**run**;

**proc** **freq** data=proj1;

tables CAVITIES\_new \* BREASTFED\_DUR/cmh;

where MOMAGE\_new=**2**;

**run**;