# **Association Between Autism Spectrum Disorder and Caregiver-Reported Dental Caries In Children**

by

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**Abstract**

**Objectives**: There is evidence that dental caries is both increased and decreased in children with autism spectrum disorder (ASD). Previous studies used limited sample sizes, were conducted in health-seeking populations or examined caregiver-reported child global oral health status. The purpose of this study was to examine the relationship between ASD and caregiver-reported dental caries status using a non-health-seeking sample of children that is nationally representative.

**Methods**: We used the 2016 National Survey of Children’s Health to perform a cross-sectional examination of the association between ASD and the probability of having caregiver-reported dental caries. Our final analytic sample excluded subjects with missing data for ASD and caregiver-reported dental caries. We used logistic regression controlling for child (age, gender, race/ethnicity, insurance coverage, preventive dental use) and family (caregiver education and federal poverty level) characteristics.

**Results**: Among the 45,155 children in our sample, 1,228 (2.5%) had ASD. A higher percentage of children had caregiver-reported dental caries when the children had ASD compared to no ASD (15% versus 10%, p<0.001). In our adjusted analysis, children with ASD had 1.4 greater odds of having caregiver-reported dental caries compared to children without ASD (95% CI 1.2-1.7), controlling for the aforementioned covariates.

**Conclusions**: Using a nationally representative sample, we found that children with ASD had significantly greater odds of having caregiver-reported dental caries compared children without ASD. This finding highlights that there is a public health importance on oral health education for families with children who have ASD as well as oral health services and policies tailored to the children with ASD.

**Keywords:** Dental Caries, Autism Spectrum Disorder, Child

**Table of Contents**

**Acknowledgements……………………………………………………………………………...ix**

1. **Introduction……………………………………………………………………............... 1**
2. **Methods…..……………………………………………………………………………… 2**
	1. **Data…………………………………………………………………………….... 2**
	2. **Variables………………………………………………………………………… 3**
	3. **Conceptual Model………….…………………………………………………… 4**
	4. **Analysis.…………………………………………………………………………. 5**
3. **Results…..……………………………………………………………………………….. 6**
4. **Discussion…………………………………………………………………………….... 10**
	1. **Public Health Implication...…………...………...……………………….…… 12**

**Bibliography...……….…………………………………………………………………...….… 14**

**List of Tables**

**Table 1.** Descriptive Factors for Children Age Two through Seventeen in the 2016 National Survey of Children's Health by Autism Spectrum Disorder (ASD) and No ASD Groups (N=45,155) **………………….…………………………………………………………………. 7**

**Table 2.** Logit Model Examining the Relationship between Autism Spectrum Disorder and the Odds of Caregiver–reported Dental Cariesπ for Children Age Two through Seventeen in the 2016 National Survey of Children's Health (N=45,155)**……………….………………………. 8**

**List of Figures**

**Figure 1.** Conceptual Model on the Relationship between Child Autism Spectrum Disorder and Child Dental Caries Experience.**….……………………..………………………………….** **5**

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1. **Introduction**

According to the American Psychiatric Association’s Diagnostic and Statistical Manual of Mental Disorders Fifth Edition, Autism spectrum disorder (ASD) is a developmental disability that includes deficits in social communication and social interaction, and the presence of restricted, repetitive patterns of behavior, interests, or activities that can persist throughout life.[1](#_ENREF_1) The earliest age of reliable diagnosis of ASD is two years old.[2](#_ENREF_2),[3](#_ENREF_3)

There is recent evidence that the prevalence of ASD in children is high and increasing.[4](#_ENREF_4) According to The Centers for Disease Control and Prevention (CDC), ASD occurs in one out of 59 children who are 8 year-olds using the most recent data from the Autism and Developmental Disabilities Monitoring Network in 2014.[5](#_ENREF_5) This is an increase from approximately one in 68 in 2010, one in 88 in 2008 and one in 110 in 2006.[6-8](#_ENREF_6) Because a high prevalence of ASD in American children, combined with the fact that dental caries is the most common chronic disease in childhood, it is important to know if ASD is contributing to the high level of dental caries in children.

In the current literature, the findings related to the relationship between ASD and child dental caries are conflicting.[9-13](#_ENREF_9) There is evidence of a positive association between ASD and increased dental caries in children,[9-12](#_ENREF_9) no association between ASD and child dental caries[14](#_ENREF_14) and a lower incidence of dental caries in children with ASD.[15-18](#_ENREF_15)

Many of the studies on the relationship between ASD and child dental caries have challenges to the study design. These challenges include small sample sizes,[9](#_ENREF_9),[11](#_ENREF_11),[14](#_ENREF_14),[16](#_ENREF_16),[17](#_ENREF_17) or a study population that was selected from families seeking dental care for their child.[9](#_ENREF_9),[11](#_ENREF_11),[15](#_ENREF_15) Only one previous study was performed using a national dataset with a study population that was not seeking health care.[19](#_ENREF_19) In this study, the outcome measure was not caregiver-reported child dental caries but caregiver-reported oral health status determined using a five-level categorical variable ranging from excellent to poor.[19](#_ENREF_19)

To add clarity to our current understanding on the relationship between ASD and the child dental caries, we sought to examine the association between ASD and caregiver-reported child dental caries using a sample of children that was nationally representative and a model to account for child and family characteristics. We hypothesized that ASD was associated with worse caregiver-reported child dental caries due to the difficulty performing daily oral hygiene practices, high cariogenic diet and the consumption of medications that cause xerostomia.[9](#_ENREF_9),[11](#_ENREF_11),[13](#_ENREF_13),[14](#_ENREF_14),[20-25](#_ENREF_20)

1. **Methods**

**2.1 Data**

We used data from the 2016 National Survey for Children's Health (NSCH) to examine caregiver-reported dental caries in children with and without ASD. The NSCH was a cross-sectional and population-based study, conducted from June 2016 to January 2017 that was designed to evaluate national estimates on the health and well-being of children from birth through age 17 and their families and communities in the United States. Randomly selected addresses from civilian, non-institutionalized households were mailed instructions to access the survey online. After at least one reminder letter, households who had not accessed the online survey were mailed a paper-screening questionnaire. From each participating household, one child aged birth through 17 years was randomly selected to be the subject. The adult in the household who knew the most about the selected child’s health and health care needs was interviewed.

The weighted overall response rate for the 2016 NSCH was 40.7% with 50,212 completed questionnaires. We excluded caregiver-child dyads with the following characteristics: 1) missing data for the main exposure variable, ASD (n=280); 2) missing data for the main outcome variable, caregiver-reported dental caries (n=767); and 3) subjects under the two years-old, which is the earliest age for a reliable diagnosis of ASD (n=4,010). This resulted in a final analytic sample size of 45,155.

**2.2 Variables**

The main exposure variable, ASD, was defined by the caregiver, who responded positively to the question, “Has a doctor or other health provider ever told you that this child has Autism or Autism Spectrum Disorder (ASD)?” The main outcome variable, caregiver-reported dental caries, was determined as the caregiver response of “Decayed teeth or Cavities” to the question, “During the past 12 months, has this child had frequent or chronic difficulty with any of the following?”

We included seven child (age, gender, race/ethnicity, insurance coverage, preventive dental use) and family (caregiver education and federal poverty level) covariates in our analyses because of their known impact on dental caries. We coded child age as a three-level categorical variable: 2–5, 6-11 and 12-17 years. Child gender was a binary variable for male and female. We collapsed child race/ethnicity into a single variable with four categories: Hispanic, Non-Hispanic White, Non-Hispanic African American and Non-Hispanic Other. Child insurance type was coded as a three-level categorical variable: 1) Private: Purchased directly from an insurance company or obtained through a current or former employer or union; 2) Public: Medicaid, Medical Assistance, or any kind of government assistance plan for those with low incomes or a disability, Tricare or other military health care and Indian Health Service; and 3) Uninsured. Child preventive dental use was coded as a binary variable based on the caregiver response to the question, “During the past 12 months, did this child see a dentist or other oral health care provider for preventive dental care, such as check-ups, dental cleanings, dental sealants, or fluoride treatments?” We coded federal poverty level (FPL) as a 4-level categorical variable defined as family income less than 100% FPL, 100 to 199% FPL, 200 to 399% FPL and greater than 400% FPL). Caregiver education was coded as a 4-level categorical variable: 1) Less than high school; 2) High school or General Educational Development examination; 3) Some college or technical school; and 4) College degree or higher.

**2.3 Conceptual Model**

In the absence of an existing conceptual model on the relationship between ASD and child dental caries in the literature, we developed a model to communicate our approach to evaluating the relationship between ASD and caries (Figure 1). This model was based on the findings from the previous literature.[9](#_ENREF_9),[11](#_ENREF_11),[12](#_ENREF_12),[19](#_ENREF_19),[20](#_ENREF_20),[23](#_ENREF_23),[25-27](#_ENREF_25) In this model, dental caries in children with ASD was mediated through daily oral hygiene practices, xerostomia-causing medications and a high cariogenic diet.[9](#_ENREF_9),[11](#_ENREF_11),[13](#_ENREF_13),[14](#_ENREF_14),[20-25](#_ENREF_20)We excluded these variables from the model because they mediated the effect of ASD on child dental caries. We controlled for both socio-demographic characteristics related to both the child and the family as well as the child’s use of oral health services (Figure 1).[20](#_ENREF_20),[26](#_ENREF_26),[27](#_ENREF_27) For example, we controlled for the child’s use of preventive oral health care services because parents of children with ASD reported greater barriers to accessing care in the dental office compared to their typically-developing peers[20](#_ENREF_20),[28](#_ENREF_28) and children with children with special health care needs were significantly less likely to use preventive dental care than children without special health care needs.[29](#_ENREF_29)



**Figure 1**. Conceptual Model on the Relationship between Child Autism Spectrum Disorder and Child Dental Caries Experience.

 **2.4 Analysis**

We present unweighted frequencies and percentages to describe the study sample’s demographic and dental health-related characteristics. Descriptive statistics, such as chi square tests, were used to compare each characteristic for children with and without ASD. We used a logistic regression model to estimate the odds of having caregiver-reported dental caries, adjusting for the aforementioned variables. We used the survey (svy) command to account for the complex survey design when determining model estimates. Analyses were conducted using STATA 14 (College Station, TX: StataCorp LP). This study was conducted in accord with prevailing ethical principles and was determined to be exempt by our institution’s Institutional Review Board.

The marginal percentage point difference in caregiver-reported dental caries due to ASD was calculated as the estimated probability of having caregiver-reported dental caries using the method of recycled predictions and delta-method standard errors. Using the method of recycled predictions, the marginal percentage point difference describes the difference in proportion of children with caregiver-reported dental caries if all children had ASD compared to if all children did not all have ASD.

**3.0 Results**

 Among 45,155 children in our sample, the majority were 12 to 17 years-old (41%), male (51%), non-Hispanic White (70 %), had private health insurance (73%), had a preventive dental visit in last year (80%), lived in a household where the caregiver’s highest education was a college degree or higher (61%) and lived in a household with the family income as 400% or more FPL (43%) (Table 1).

 Caregivers reported that 1,228 (2.5%) children had ASD (Table 1). ASD was associated with all of the socio-demographic variables included in this study – child age, child gender, child insurance coverage, caregiver’s highest education and family FPL (p<0.01) – with the exception of child race/ethnicity and child’s last preventive dental visit (p>0.05) (Table 1).

 In our descriptive findings, we found a higher percentage of caregivers-reported dental caries among children with ASD compared to children without ASD (15% versus 10%, p<0.001) (Table 1). In our unadjusted analysis, children with ASD had significantly higher odds of having caregiver-reported dental caries [Odds ratio 1.8, 95% CI 1.5-2.1]. After controlling for child age, child gender, child race/ethnicity, child insurance coverage, child preventive dental use, caregiver education and family FPL, children with ASD had 1.4 times greater odds of having caregiver-reported dental caries compared to children without ASD (95% CI 1.2-1.7) (Table 2).

 With respect to the marginal effect of having ASD on caries, children with ASD were 2.9% more likely to have caregiver-reported dental caries compared to children without ASD (p<0.01). The 95% confidence interval for the average differential effect of caregiver-reported dental caries for children with ASD compared to children without ASD ranged from 1.51% to 4.32%.

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| **Table 1**. Descriptive Factors for Children Age Two through Seventeen in the 2016 National Survey of Children's Health by Autism Spectrum Disorder (ASD)**\*** and No ASD Groups (N=45,155).  |
| **Variable** |  | **ASD****(n=1,228)** |  | **No ASD****(n=43,927)** |  | **p value**¥ |
|  |  | n | % |  | n | % |  |  |
|  |  |  |
| **Caregiver-reported “decayed teeth or cavities” in the past 12 months**α |  | <0.001 |
|  Yes |  | 181 | 14.7 |  | 4,184 | 9.5 |  |  |
|  No |  | 1,047 | 85.3 |  | 39,743 | 90.5 |  |  |
| **Child Age**  |  |  |  |  |  |  |  | <0.001 |
|  2-5 |  | 150 | 12.2 |  | 10,050 | 22.9 |  |  |
|  6-11 |  | 449 | 36.6 |  | 14,272 | 32.5 |  |  |
|  12-17 |  | 629 | 51.2 |  | 19,605 | 44.6 |  |  |
| **Child Gender**  |  |  |  |  |  |  |  | <0.001 |
|  Male  |  | 992 | 80.8 |  | 22,122 | 50.4 |  |  |
|  Female  |  | 236 | 19.2 |  | 21,805 | 49.6 |  |  |
| **Child Race/Ethnicity**  |  |  |  |  |  |  |  | 0.11 |
|  Hispanic |  | 134 | 11.0 |  | 4,811 | 11.0 |  |  |
|  Non-Hispanic white |  | 861 | 70.0 |  | 30,849 | 70.2 |  |  |
|  Non-Hispanic African American |  | 89 | 7.2 |  | 2,545 | 5.8 |  |  |
|  Non-Hispanic other |  | 144 | 11.7 |  | 5,722 | 13.0 |  |  |
| **Child Insurance Coverage** |  |  |  |  |  |  |  | <0.001 |
|  Uninsured |  | 30 | 2.4 |  | 1,594 | 3.6 |  |  |
|  Privateγ |  | 668 | 54.6 |  | 32,385 | 74.0 |  |  |
|  Public∞ |  | 526 | 43.0 |  | 9,802 | 22.4 |  |  |
|  Missing |  | 4 |  |  | 146 |  |  |  |
| **Child Preventive Dental Visit in Past Year**μ **Table 1 Continued** |  |  |  |  |  |  |  | 0.82 |
|  Yes |  | 1,051 | 85.6 |  | 37,694 | 85.8 |  |  |
|  No |  | 177 | 14.4 |  | 6,233 | 14.2 |  |  |
| **Caregiver Education**  |  |  |  |  |  |  |  | 0.004 |
|  Less than High School |  | 31 | 2.6 |  | 964 | 2.2 |  |  |
|  High school/GEDη |  | 168 | 13.9 |  | 5,374 | 12.5 |  |  |
|  Some college/ technical school |  | 314 | 26.0 |  | 9,680 | 22.6 |  |  |
|  College degree or higher |  | 693 | 57.5 |  | 26,861 | 62.6 |  |  |
|  Missing |  | 22 |  |  |  1,133 |  |  |  |
| **Federal Poverty Level** (FPL) |  |  |  |  |  |  |  | <0.001 |
|  <100% FPL |  | 185 | 15.1 |  | 4,222 | 9.6 |  |  |
|  100-199% FPL |  | 230 | 18.7 |  | 6,958 | 15.8 |  |  |
|  200-399% FPL |  | 353 | 28.7 |  | 13,603 | 31.0 |  |  |
|  400% or more FPL |  | 460 | 37.5 |  | 19,144 | 43.6 |  |  |
| **\***Autism Spectrum Disorder was defined by the caregiver as a positive response to the question, “Has a doctor or other health provider ever told you that this child has Autism or Autism Spectrum Disorder (ASD)?”**¥**Chi square tests were used to compare each variable for children with and without Autism.α Caregiver responded positively to “Decayed teeth or Cavities” in response to the question, “During the past 12 months, has this child had frequent or chronic difficulty with any of the following?”γ Private insurance was defined as insurance through an employer or insurance company∞ Public insurance was defined as Medicaid, Medical Assistance, Tricare or other military health care and Indian Health Serviceμ Child preventive dental visit in past yearwas defined as a positive caregiver response to the question “During the past 12 months, did this child see a dentist or other oral health care provider for preventive dental care, such as check-ups, dental cleanings, dental sealants, or fluoride treatments?”

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| **Table 2**. Logit Model Examining the Relationship between Autism Spectrum Disorder and the Odds of Caregiver–reported Dental Cariesπ for Children Age Two through Seventeen in the 2016 National Survey of Children's Health (N=45,155). |
| **Variable** |  | **Odds Ratio** |  | **95% Confidence****Interval** |  | **p value**μ |
|  |  |  |  |  |  |  |
| **Autism Spectrum Disorder\*** |  |  |  |  |  |  <0.001 |
|  No |  | Referent |  |  |  |  |
|  Yes |  | 1.41 |  | 1.19, 1.66 |  |  |
| **Child Age** |  |  |  |  |  | <0.001 |
|  2-5 |  | Referent |  |  |  |  |
|  6-11 |  | 1.82 |  | 1.66, 2.00 |  |  |
|  12-17 |  | 1.08 |  | 0.98, 1.18 |  |  |
| **Child Gender** |  |  |  |  |  | 0.01 |
|  Female |  | Referent |  |  |  |  |
|  Male |  | 1.05 |  | 0.98, 1.12 |  |  |
| **Child Race/Ethnicity** |  |  |  |  |  | <0.001 |
|  Non-Hispanic White |  | Referent |  |  |  |  |
|  Hispanic  |  | 1.09 |  | 0.99, 1.21 |  |  |
|  Non-Hispanic African American**Table 2 Continued** |  | 0.93 |  | 0.81, 1.06 |  |  |
|  Non-Hispanic Other |  | 1.21 |  | 1.11, 1.33 |  |  |
| **Child Insurance Coverage**  |  |  |  |  |  | <0.001 |
|  Uninsured |  | Referent |  |  |  |  |
|  Private γ |  | 0.54 |  | 0.47, 0.63 |  |  |
|  Public α |  | 0.86 |  | 0.74, 0.99 |  |  |
| **Child Preventive Dental Visit in Past Year** β |  |  |  | <0.001 |
|  No |  | Referent |  |  |  |  |
|  Yes |  | 1.49 |  | 1.34, 1.66 |  |  |
| **Caregiver Education** |  |  |  |  |  | <0.001 |
|  Less than high school |  | Referent |  |  |  |  |
|  High school/GED δ |  | 1.06 |  | 0.91, 1.23 |  |  |
|  Some college/technical school |  | 1.02 |  | 0.89, 1.18 |  |  |
|  College degree or higher |  | 0.78 |  | 0.68, 0.91 |  |  |
| **Federal Poverty Level (FPL)** |  |  |  |  |  | <0.001 |
|  <100% FPL |  | Referent |  |  |  |  |
|  100-199% FPL |  | 0.88 |  | 0.86, 1.07 |  |  |
|  200-399% FPL |  | 0.88 |  | 0.79, 0.99 |  |  |
|  400% or more FPL% |  | 0.65 |  | 0.58, 0.74 |  |  |
| **Constant** |  | 0.11 |  | 0.09, 0.14 |  | <0.001 |
| π  Caregiver responded positively to “Decayed teeth or Cavities” in response to the question, “During the past 12 months, has this child had frequent or chronic difficulty with any of the following?”**μ** For categorical variables, the Wald test was used for this maximum likelihood estimation model, which can be interpreted in a similar manner as an F test.\*Autism was defined by the caregiver, who responded positively to the question, “Has a doctor or other health provider ever told you that this child has Autism or Autism Spectrum Disorder (ASD)?”γ Private insurance was defined as insurance through an employer or insurance companyα Public insurance was defined as Medicaid, Medical Assistance, Tricare or other military health care and Indian Health Serviceβ Child preventive dental visit in past yearwas defined as a positive caregiver response to the question “During the past 12 months, did this child see a dentist or other oral health care provider for preventive dental care, such as check-ups, dental cleanings, dental sealants, or fluoride treatments?”δ General Educational Development (GED) is a high school equivalency examination. |

η General Educational Development (GED) is a high school equivalency examination. |

**4.0 Discussion**

Using a national dataset on children in the United States, we found a statistically significant difference between the odds of having caregiver-reported dental caries for children with ASD compared to children without ASD. We propose three potential explanations for this main finding, which are both guided by our conceptual model and supported by the previous literature: 1) challenges to optimal oral hygiene; 2) cariogenic diet; and 3) xerostomic medications.

Children with ASD may have an increased risk of dental caries due to challenges to optimal oral hygiene.[9](#_ENREF_9),[11](#_ENREF_11),[14](#_ENREF_14),[20](#_ENREF_20) Children with ASD may not have the manual dexterity needed to brush teeth properly.[9](#_ENREF_9),[20](#_ENREF_20) They may also be less cooperative with caregivers for oral hygiene activities, resulting in lesser quality and more irregular tooth brushing.[9](#_ENREF_9),[20](#_ENREF_20) In addition, children with ASD may have a greater sensory aversion to the taste of toothpaste and the feeling of a toothbrush in their mouth.[30](#_ENREF_30) Stein and colleagues (2011) found that children “with Autism had greater behavioral difficulties and sensory sensitivities that parents believed interfered with their children’s oral care” compared with children with other disabilities.[30](#_ENREF_30)

In addition to oral hygiene, children with ASD may have increased dental caries due to a cariogenic diet.[9](#_ENREF_9),[13](#_ENREF_13),[20-24](#_ENREF_20) Firstly, children with ASD may have diet preferences that are cariogenic.[9](#_ENREF_9),[13](#_ENREF_13),[21-23](#_ENREF_21) According to Marshall and colleagues in 2010, children with ASD prefer sweetened foods.[9](#_ENREF_9) There is also evidence that caregivers may use cariogenic foods as a reward for good behavior for children with ASD.[9](#_ENREF_9) Children with ASD may also pose challenging behaviors to caregivers striving to provide a healthy diet by resisting foods and drinks that are less cariogenic. For example, children with ASD may have sensory sensitivities in the oral cavity and food selection preferences, which may result in an aversion to new foods and a limited diet of high cariogenic foods.[20-23](#_ENREF_20) In addition to preferring cariogenic foods, children with ASD may hold food in the mouth for a prolonged period of time instead of swallowing due to poor tongue coordination.[23](#_ENREF_23),[24](#_ENREF_24) This practice of holding food in the mouth increases the exposure of the oral bacteria to a carbohydrate sources and therefore increases the child’s caries risk.

Another possible explanation for high dental caries in children with ASD is that the children may be given xerostomic medications to manage their ASD symptoms.[14](#_ENREF_14),[25](#_ENREF_25) The most common drug classes used to manage ASD in children are antidepressants, stimulants, and antipsychotics; all of which may cause xerostomia.[14](#_ENREF_14),[25](#_ENREF_25) In addition to the xerostomia effects, sugar may be added to medication, which would also be cariogenic.

While these three topics may mediate the relationship between ASD and dental caries in children, there is currently is no adjusted mediation model in the literature to test this hypothesis. Future studies can examine whether the relationship between ASD and dental caries is mediated by these three behavioral and modifiable characteristics. If these modifiable topics are found to mediate the relationship, then the increased level of dental caries in children with ASD can be avoided by managing these behaviors.

Our findings should be viewed in light of the study limitations. First, this study was based on a cross-sectional design, which has limitations to causal inference. Secondly, our main exposure variable was based on the caregiver’s self-report. The diagnosis of ASD was not verified by medical records and could therefore be inaccurate. Third, our main outcome variable was based on the caregiver’s self-report. Caregiver-reported data may be inaccurate, particularly when our main outcome involved observing the dentition of a child with ASD that may have an aversion to stimulus in the oral cavity. This caregiver-reported outcome was not verified by an examination by a trained clinician. Finally, our analytic model controlled for multiple covariates using data available in the national dataset, but may still be subject to endogeneity, such as omitted variable bias.

While there were limitations to this study, the major strengths included the use of a nationally-representative sample of children, examining “decayed teeth or cavities” versus global oral health status as the main outcome, and using an analytic approach based on a conceptual model that was informed by the current literature. Overall, our main result, that ASD is associated with an increase in caregiver-reported dental caries adds to the larger body of literature that shows a positive relationship between ASD and dental caries in children.

**4.1 Public Health Implication**

Our study has several limitations and opportunities for future research. First, our analysis was limited to an association based on the cross-sectional study design. Second, mothers may have a reporting bias in favor of better health, which would result in an over-estimation of concordance in this study because most of the children had no previous caries experience. Third, future research can examine caries trends and concordance stratified by age cohort, particularly because of the strong relationship between caries and age combined with the potential reporting bias toward overestimating health. Fourth, fathers and other caregivers are important in determining a child’s oral health, so future research should include them. Fifth, the results of our study may have limited generalizability to other populations in the United States. Sixth, our results are dependent on the definition of concordance developed for this study. Future research is needed to examine the relationship between this definition of concordance and oral health outcomes in children. Finally, the findings from our study, combined with both a conceptual framework and the results in previous literature, can be used in future research to develop multivariate model on the predictors of mother-child concordance. If we are able to identify the factors that predict concordance and develop interventions that give mothers the best situation possible to maximize awareness of her child’s oral health, then both preventative oral health behaviors and timely dental treatment may be improved, particularly for young children vulnerable to caries.

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