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Adverse Birth Outcomes and Childhood Caries: A Cohort study

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Abstract

Objectives—To examine the association between adverse birth outcomes and dental caries in primary teeth.

Methods—This study included children in Khon Kaen, Thailand, who participated in the Prospective Cohort Study of Thai Children. Preterm was defined as a birth at <37 weeks gestation, low birthweight (LBW) as birthweight <2,500 grams, and small-for-gestational-age (SGA) as birthweight <10th percentile of expected weight for gestational age. Two calibrated dentists measured dental caries in primary teeth when the children were 3-4 years old using decayed, missing and filled surfaces (dmfs) index following the World Health Organization criteria. We used negative binomial regression with generalize linear models to estimate relative risks (RRs) and their 95% confidence intervals (CIs), adjusted for confounding factors. Of 758 children with gestational age data and 833 with birthweight data, the 544 (follow-up rate of 71.8% in preterm and 65.3% in LBW) who had dental data available were included in the analysis.

Results—Dental caries was observed in 480 children (88.2%), with a mean dmfs of 14.3 (standard deviation 12.8). The adjusted RR for dental caries was 0.61 (95%CI 0.43, 0.85) for preterm, 0.89 (95%CI 0.67, 1.21) for LBW, and 0.96 (95%CI 0.74, 1.26) for SGA.

Conclusions—There was an inverse association between preterm and childhood caries. LBW and SGA were not associated with dental caries in this population.

Keywords

preterm birth; low birthweight; small for gestational age; dental caries; primary teeth; children

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INTRODUCTION

Adverse birth outcomes, including preterm, low birthweight (LBW) and small-for-gestational-age (SGA), are important public health issues. Infants born with adverse birth outcomes are vulnerable to many serious medical problems, such as chronic lung disease[1], vision and hearing impairment[2], and adverse neurodevelopmental outcomes[3, 4]. Adverse birth outcomes also affect oral structures[5, 6] resulting in enamel defects, crown dilacerations, palatal distortion, and delayed eruption in primary and permanent dentitions.

Evidence relating adverse birth outcomes with dental caries is still limited and the results are inconsistent, although the relationship could be explained through several pathways. For example, disruption of enamel formation during intrauterine life may cause enamel hypoplasia and enamel opacity, which could render the teeth more susceptible to dental caries[7]. Furthermore, preterm and LBW could lead to a reduction of immune function, which in turn may allow early establishment of cariogenic bacteria in the mouth[8, 9]. Preterm and LBW infants are at a greater risk of breastfeeding difficulties due to the infant's immature oromotor skill and delayed maternal lactogenesis[10], and thus may need to start bottle-feeding early[11]. This could lead to improper infant feeding practices, nighttime bottle-feeding[12-14] and sleeping with bottle[15], all of which are established risk factors for dental caries. In addition, low socioeconomic status is associated with preterm and LBW as well as with dental caries[4-6]. The extent to which adverse pregnancy outcomes influence dental caries remains unclear.

Although several studies observed no association between preterm and dental caries[11, 16-21], the opposite was observed in a number of studies[18, 22-24]. Conflicting results were also documented for the association between LBW and dental caries[16, 18, 23]. Interestingly, evidence from longitudinal studies found that preterm with very LBW (≤1,500 grams) children were at a higher risk for enamel hypoplasia, but not for subsequent dental caries[20, 21]. The limitations of most previous studies include cross-sectional study design[18, 24], inappropriate time for caries assessment[17, 19, 25], inadequate control for important confounders[18], and the use of combined preterm and LBW as a single outcome despite their distinct biological mechanisms[11, 20, 21]. SGA is a better measure of fetal growth[26], but only a few studies examined the association between SGA and dental caries[18, 24].

In this study, we prospectively followed children from birth to 3-4 years of age to test the hypothesis that preterm, LBW, or SGA increases the risk of dental caries in primary teeth.

METHODS

We conducted a study in children who participated in the Prospective Cohort Study of Thai Children (PCTC)[27, 28]. PCTC is a population-based birth cohort study that recruited mothers at 28-38 weeks of gestation and intended to follow the children until 24 years of age. Participants were selected from 5 different regions across Thailand. The project aimed to evaluate the effects of pre- and perinatal factors, child rearing practices, and early environment on child health and development in later life. The PCTC started in 2000 and was discontinued in 2005 due to lack of funding and for administrative reasons.

We followed 860 children who participated in the PCTC in Kranuan district of Khon Kaen province in northeast Thailand. These constituted all children who were born in the district between January 20, 2001 and January 20, 2002, excluding those whose family planned to migrate from the district. Fluoride concentration in the drinking water of this rural to semi-urban district ranged from 0.02 to 0.28 ppm[29]. This study was approved by the Khon Kaen University Ethics Committee for Human Research (HE552207). Written informed consent was obtained from the parents on behalf of the children.

Exposure Measurements

Of 860 children, 758 (88.2%) had information on gestational age and 833 (96.7%) had birthweight data. Gestational age was determined by a physician using ultrasound in 651 (85.9%) and last menstrual period in 107 (14.1%) children. For the 831 (99.7%) children delivered at the hospitals, the babies were weighed by nurses after birth. Two children who were delivered at home were weighed by a research assistant during a home visit within 3 days. We defined preterm, LBW and SGA, respectively, as a birth at <37 weeks gestation, birthweight <2,500 grams, and birthweight <10th percentile of the expected weight for gestational age according to the method proposed by Mikolajczyk et al.[30] using the mean birth weight at 40 weeks of gestation of PCTC cohort.

Oral Examination

Caries assessment was performed when the children were 3-4 years of age. Two dentists conducted full mouth examinations without radiograph in a field setting. Dental caries was measured using decayed, missing and filled surfaces (dmfs) index following the World Health Organization (WHO) criteria[31]. The children were examined in a supine position using a blunt UNC-15 probe (Hu-Friedy, IL, USA), a mouth mirror, and under natural light. Enamel defects were evaluated using criteria modified from Developmental Defect of Enamel (DDE) Index[32]. Before actual examinations, the two examiners were calibrated with children at the same age until their intra- and inter-examiner agreements were more than 90 percent. All parents or caregivers received a dentist's note regarding their child's oral health condition. An instruction to see dentist in a nearby community hospital was provided if the child required treatment.

Questionnaire Interview

We used a structured questionnaire to interview mothers or caregivers seven times: in the second to the third trimester of pregnancy (recruitment), 21 days, 3, 12, 18 months, and 2 and 3 years after birth. The interviews were performed by six research assistants. Information on socio-demographic characteristics, maternal pre-pregnancy height and weight, alcohol drinking, smoking and complications during pregnancy were gathered at recruitment. Family income in Thai Baht was categorized by quartile. Maternal occupation was grouped into 4 categories: farmer or agriculturalist; laborer; professional (e.g. doctor, nurse or lawyer) or office worker; and unemployed, which included housewives and students. Pre-pregnancy body mass index (BMI) was calculated as weight in kilograms over height in meters squared (kg/m^2). Maternal BMI was categorized by Asian criteria-based BMI cutoffs developed by the WHO as <18.5 for underweight, 18.5 to 22.9 for normal-weight, 23 to 27.5 for overweight, and greater than 27.5 for obese women[33].

Information on duration of breastfeeding and age when the infant started bottle feeding were extracted from the questions that asked about current breast or bottle feeding, and age of weaning, which were gathered when the child was 21 days of age and updated at each follow-up until 3 years. Frequency of sleeping with milk feeding was asked at 1 year of age. Frequency of sweet consumption, age when started brushing, frequency of brushing, fluoride toothpaste, fluoride supplement use, and utilization of dental services were collected at the oral examination visit. Sweets, snacks, and beverages included soft drinks, chocolate, candies, jelly, and snacks (e.g. chips, crispy fried noodles).

Statistical Analysis

Of 758 children with gestational age data and 833 with birthweight data, 544 (follow-up rate of 71.8% in preterm and 65.3% in LBW) who had dental data available were included in the analyses. We performed statistical analyses separately for preterm, LBW, and SGA. We used Chi-square or Fisher's exact tests to compare characteristics of participants according to their birth outcome status. The primary outcome was dmfs. We used relative risks (RRs) with 95% confidence intervals (95% CIs) to estimate the associations between adverse birth outcomes and dental caries. We used negative binomial regression with a generalized linear framework to model dmfs as a count variable with over-dispersion. The number of surfaces at risk in a continuous form was determined as the offset in the regression model. This model was fitted for over-dispersion of dmfs, and we assumed that dmfs in this study had no excess zero values[34]. We used robust estimation to estimate standard errors of regression coefficients. We identified potential confounding factors based on evidences from existing literature. Duration of breastfeeding and age when bottle-feeding starts were determined as factors on a causal pathway between adverse birth outcomes and dental caries. Thus, we did not include these variables in the multivariable analysis. We included variables in the final model if they were either a significant caries predictor or a confounder. A change-in-estimate method was used to determine inclusion of confounders. Confounders that changed regression coefficients more than 10% were included in the multivariable analyses. In our multivariable models, family income and pre-pregnancy BMI were included as continuous variables. Secondary outcomes included early childhood caries (ECC), defined as dmfs >0, and severe ECC, which was dmfs ≥5 or having ≥1 decayed or filled surface of anterior tooth[35]. We used log-binomial regression analyses to examine the associations for our secondary outcomes. Missing data were assumed to be at random and the analyses included only the available data.

Sample size was estimated following the method proposed by Kneene and collegues[36]. Based on a previous study in Thai children[37], we assumed caries incidence was 1 surface per year and negative binomial parameter was 5. This study had 80% power at a 5% significance level to detect an association with a magnitude of effect 30% or above. All statistical analyses were performed using STATA version 12.0 (Stata Corp, College Station, TX).

RESULTS

Characteristics of Mothers and Children

We examined dental caries in 544 children, which corresponded to a response rate of 71.8% for children with gestational age data, and 65.3% for children with birthweight data. The mean age of children was 3.7 (standard deviation, SD = 0.4) years at the examination visit. Table 1 compares the characteristics of children with and without oral examination. The characteristics of mothers and children between these two groups were similar.

In our cohort, the adverse birth outcome prevalence was 10.8% for preterm, 9.4% for LBW, and 7.7% for SGA. Table 2 compares the characteristics between children with and without each outcome. Baseline characteristics between preterm and full-term children were not significantly different, except that preterm children were significantly more likely to be LBW, and to use dental service than those born full-term. LBW children were more likely to be born from younger (<20 years) or older (>35 years) mothers, and from mothers who smoked during pregnancy than normal birthweight (NBW) children. Children with SGA were also more likely to be born from younger or older mother than those who were appropriate-for-gestational age (AGA).

Based on the entire study sample, 61.8% were breastfed ≥12 months, and 46.7% started bottle-feeding at <6 months of age. At 12 months of age, 59.2% were reported to be sleeping while milk feeding >3 times a week. At 3-4 years of age, 93.9% consumed sweets >3 times per week. About 73% of children started brushing before or at 12 months of age, but less than half (48.6%) reported daily brushing. More preterm and LBW had shorter duration of breastfeeding (<6 months) than full-term and NBW, respectively. However, most behaviors were similar between children with and without adverse birth outcomes (Table 2).

Association between Adverse Birth Outcomes and Caries Occurrence

At 3-4 years of age, 480 children (88.2%) presented with at least one carious surface, with an overall mean dmfs of 14.3 (SD = 12.8). Most were untreated with only one child having dental fillings, and none having missing teeth due to caries. The dmfs was lower in preterm than in full-term children (12.9, SD = 15.1 versus 14.4, SD = 12.3, respectively). LBW and NBW children had similar level of dmfs (14.6, SD = 13.7 versus 14.2, SD = 12.8, respectively), while children who were born SGA had a higher dmfs than AGA children (16.8, SD = 12.7 versus 14.1, SD = 12.7, respectively). There were no associations between dental caries and any of the adverse birth outcomes in our unadjusted analysis. After adjustment for confounders, however, preterm was associated with a significantly lower risk for dental caries (RR 0.61, 95%CI 0.43, 0.85). LBW and SGA were not associated with dental caries even after adjustment for confounders (Table 3).

Table 4 shows the associations of adverse birth outcomes with ECC and severe ECC. Preterm was inversely associated with the occurrence of ECC and severe ECC, but no association was found for LBW and SGA.

DISCUSSION

In this prospective cohort study, we found a significantly inverse association between preterm and dental caries in primary teeth after adjusting for confounders. The mean dmfs score was 39% lower for preterm children than in children delivered full-term. However, we did not find the associations of LBW and SGA with dental caries occurrence at 3-4 years of age. Our findings were similar to a recent cross-sectional study in Japan that reported a marginally significant negative association between preterm and prevalence of caries in 3-year-old children (prevalence ratio: 0.60, 95% CI 0.36, 1.02), and also found no association of LBW and SGA with dental caries[24]. A limitation of the Japanese study was that it was conducted in a low caries prevalence population (20.7%), which might have reduced statistical power to detect a significant association. Moreover, the investigators did not collect primary data of dental caries and birth outcomes specifically for the study but rather asked the parents/guardians to transfer existing data from their maternal and child health handbook to a self-administered questionnaire. This could have introduced non-differential measurement error and biased the observed association towards the null.

Compared with other studies on preterm, our findings are similar with a Brazilian study which reported lower caries prevalence and experience in preterm than in full-term children[22]. The limitation of this study was the lack of control for confounding. In a US study using the Third National Health and Nutritional Examination Survey (NHANES III) data[16], in bivariate analysis, post-term birth was significantly associated with greater risk for dental caries in primary teeth, while preterm was not. However, the result was not statistically significant after adjusting for confounders. A study based on the Norwegian Mother and Child Cohort study also observed no association between preterm and dental caries in primary teeth[19]. However, because the Norwegian study was conducted in a population with a very low preterm rate (2%) and low caries rate (10.9%), it was unlikely to have adequate power to detect the association, if one existed.

Our findings for LBW are in line with the majority of previous studies, which reported no association between LBW and dental caries[16, 17, 29, 25]. The lack of statistical significance in previous studies might be due to improper timing for caries assessment. For example, inclusion of 2-year-old children[16, 25] might have biased the results toward the null because recently erupted teeth and teeth still erupting would have inadequate time for caries development. Saraiva and colleagues analyzed the data of 2- to 5-year-old children obtained from the NHANES III and did not find an association between LBW and dental caries[18]. After excluding 2-year-old children; however, the findings became statistically significant showing an inverse association between LBW and dental caries. A cohort study in the UK reported a similar finding that higher weight at birth was associated with a slightly greater risk of caries at 5 years of age[23]. Several mechanisms were proposed to explain this counterintuitive inverse association. The authors concluded that the observed association was not clinically significant and might not be considered causal. Further investigation to elucidate this relationship is therefore warranted.

LBW is a crude measure of intrauterine growth restriction (IUGR) as it may be the result of either preterm or IUGR. The risk associated with LBW could thus be confounded by gestational age. Therefore, it has been proposed that SGA should be used to represent a condition in which a fetus unable to grow at normal rate inside uterus[26]. Two previous cross-sectional studies[18, 35] examined the association of SGA with dental caries in primary teeth and reported inconsistent findings. Whereas Saraiva et al.[18] observed an inverse association between SGA and caries, Tanaka and Miyake[35] reported no association, similar to our findings. We conducted additional analyses to examine the associations of adverse birth outcomes with ECC and severe ECC. The findings confirmed an inverse association for preterm, and no association for LBW (Table 4).

The inverse association between preterm and dental caries, but not with LBW and SGA, could be explained by several reasons. Preterm children maybe more closely monitored with their parents receiving more health and oral health instructions from healthcare professionals than LBW and SGA infants, many of whom are full-term. As shown in Table 2, preterm children in our study were significantly more likely to use dental service than those born full-term. This could lead to a better oral health status among preterm children. Another explanation could be that a delayed tooth eruption in preterm children[38, 39] might result in less exposure time and thus less dental caries at oral examination visit. To verify this, we analyzed the data on age at first tooth eruption obtained from a questionnaire administered at year one. However, the findings suggest that delayed tooth eruption was an unlikely explanation because we observed no differences in age at first tooth eruption neither between children with and without adverse birth outcomes, nor between those with and without caries.

Our study had several strengths. First, we collected a wide range of information with detailed data on infant feeding practices, sweet consumption, oral hygiene practices, and fluoride use, which we could use to control for confounding. Second, the prospective design allowed us to collect the information of these confounding factors several times during follow-up period so we could obtain accurate information and minimize recall bias. Third, our study was conducted in 3- to 4-year-old children (average age 3.7 years). This is the ideal time to assess caries in primary teeth because it provides sufficient time duration for the new caries to develop, which is at least 2 years after tooth eruption[23]. Fourth, we measured the outcome at tooth surface level, which increased our statistical power. We used negative binomial regression to handle over-dispersion of data and no excess zero of our dental data.

This study also has a number of limitations. Our cohort was limited to children with moderate to late preterm (born between 32 to <37 weeks gestation). Although the study was limited to a Thai population, we expect the finding can be generalized to other populations because the biological processes relating adverse birth outcomes to dental caries should be the same in other populations. Our sample accounted for 64.8% of the entire recruited cohort. We evaluated the potential for selection bias by comparing the characteristics between children who participated and did not participate in the oral examination. No significant differences were observed between the two groups. This suggests that the non-participation was unlikely to produce spurious association or affect generalizability. Regarding the limitation of outcome measurements, we examined dental caries without radiograph and white spot lesion was not scored. Although the examiners were trained and calibrated before data collection, we did not check the reliability of examiners during the examinations. Another limitation was the lack of information on potential confounders such as mother's oral health and level of cariogenic bacteria in saliva.

Disruption of enamel formation during prenatal period can cause enamel defects predisposing the teeth to dental caries. Nonetheless, we could not evaluate the association between adverse birth outcomes and enamel defects because of the small number of enamel defects in our study (4.4 % of children having enamel defects). The small number could be due to incomplete data collection or because the affected surfaces were superimposed by dental caries at the examination visit. Further prospective studies should investigate the association between enamel defects and subsequent caries.

Our study was conducted in children with high caries prevalence (88.2%). This could be considered as either a strength or limitation. On the one hand, the high prevalence generally increases statistical power. On the other hand, it could mask the real effect of adverse birth outcomes on dental caries. For example, if SGA children were more likely to have dental caries because of enamel defects, these children would have earlier development of dental caries. But because of the high prevalence, as children get older most of them would also develop dental caries. The observed association between SGA and caries could therefore be diluted.

In conclusion, this study suggests an inverse association between preterm and dental caries in primary teeth. Our findings do not support the hypothesis that LBW or SGA has a higher risk for early childhood caries.

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Table 1

Comparison of characteristics between children with and without oral examination at 3 years of age

	Children with oral examination (n=544	Children without oral examination (n= 295)	p-value
Maternal characteristics at second trimester of pregnancy			
Age (years), %			0.91
< 20	96 (17.7)	55 (19.0)	
20-35	417 (77.1)	220 (75.8)	
> 35	28 (5.2)	15 (5.2)	
Education, %			0.35
Primary school or lower	347 (64.9)	175 (60.3)	
High school	156 (29.2)	92 (31.7)	
College or University	32 (5.9)	23 (8.0)	
Family annual income (Baht), %			0.37
Less than 42,850	138 (25.5)	86 (29.5)	
42,851 - 83,820	136 (25.1)	74 (25.3)	
83,821 - 159,300	137 (25.3)	76 (26.0)	
159,301 - 1,008,000	130 (24.1)	56 (19.2)	
Occupation, %			0.28
Farmer/agriculturist	312 (57.7)	152 (52.4)	
Laborer	86 (15.9)	50 (17.2)	
Professional or office worker	87 (16.1)	46 (15.9)	
Others	56 (10.3)	42 (14.5)	
Pre-pregnancy BMI, %			0.13
Underweight	103 (19.8)	74 (26.0)	
Normal weight	312 (60.0)	160 (56.1)	
Overweight or Obese	105 (20.2)	51 (17.9)	
Smoked cigarettes, % Yes	4 (0.8)	1 (0.4)	0.49
Drank alcohol, % Yes	23 (4.4)	6 (2.2)	0.11
Child characteristics at birth			
Preterm birth, %	53 (10.8)	35 (13.1)	0.36
Low birth weight, %	51 (9.4)	39 (13.3)	0.09
Small-for-gestational-age, %	42 (7.7)	27 (9.1)	0.51
Male, %	273 (50.2)	133 (44.4)	0.16

Table 2

Unadjusted comparisons of adverse birth outcomes to normal birth outcomes by baseline characteristics of study participants (n=544)

	n	PT (n=53)	FT (n=437)	LBW (n=51)	NBW (n=489)	SGA (n=42)	AGA (n=514)
Maternal characteristics at second trimester of pregnancy							
Age (years), %							
< 20	96	24.5	16.3	27.4	16.7[a]	26.2	17.3[a]
20-35	417	69.8	78.5	62.8	78.8	61.9	78.3
> 35	28	5.7	5.3	9.8	4.5	11.9	4.4.6
Education, %							
Primary school or lower	347	64.1	65.1	54.0	66.1	63.4	65.0
High school	156	30.2	28.9	42.0	27.9	34.2	28.7
College or University	32	5.7	6.0	4.0	6.0	2.4	6.3
Family annual income (Baht), %							
Less than 42,850	138	34.0	25.5	25.4	25.5	35.7	24.7
42,851 - 83,820	136	24.5	26.6	19.6	25.9	23.8	25.3
83,821 - 159,300	137	17.0	25.0	27.5	24.9	19.1	25.9
159,301 - 1,008,000	140	24.5	22.9	27.5	23.7	21.4	24.1
Occupation, %							
Farmer/agriculturist	312	43.4	60.9	49.0	58.8	59.5	57.6
Laborer	86	16.0	14.9	19.6	15.4	14.3	16.0
Professional or office worker	87	20.8	14.9	13.7	16.3	9.5	16.6
Unemployed	56	18.8	9.3	17.7	9.5	16.7	9.8
Pre-pregnancy BMI, %							
Underweight	103	17.7	20.1	23.4	19.6	32.5	18.8
Normal weight	312	62.7	59.7	57.4	60.1	55.0	60.4
Overweight or Obese	105	19.6	20.2	19.2	20.3	12.5	20.8
Smoked cigarettes, % Yes	4	2.0	0.5[c]	4.4	0.4[b]	0.0	0.8
Drank alcohol, % Yes	23	7.8	3.5	4.3	4.2	0.0	4.8
Adverse birth outcomes							
PT, %				31.7	8.5[a]	4.8	11.4

	n	PT (n=53)	FT (n=437)	LBW (n=51)	NBW (n=489)	SGA (n=42)	AGA (n=514)
LBW, %		25.5	6.4[a]			59.5	5.2[a]
Boy, %	273	54.7	50.1	37.2	51.3	42.9	50.8
Child characteristics from birth to 3-4 years of age							
Duration of breastfed (months), %							
<6	121	24.5	19.7	31.4	21.3	19.1	22.6
6-11	87	13.2	15.3	11.8	16.2	4.7	16.7
12-17	179	32.1	34.8	31.3	33.1	38.1	32.7
≥18	157	31.2	30.2	25.5	29.4	38.1	28.0
Age started bottle feeding (months), %							
< 6	253	45.3	45.3	43.1	46.8	31.0	47.9
6-11	105	18.9	19.1	13.7	19.9	19.0	19.3
12-17	160	33.9	30.6	41.2	28.5	44.2	28.3
≥18	24	1.9	5.0	2.0	4.7	4.8	4.5
Sleeping while milk feeding at 1 year old (times per week) , %							
never	155	28.3	28.3	27.4	28.8	19.1	29.5
1-3	66	17.0	11.5	15.7	11.5	21.4	11.1
>3	321	54.7	60.2	56.9	59.7	59.5	59.4
Age at brushing start (months), %							
≤6	68	22.2	26.9	32.0	25.1	26.1	25.2
7-12	125	44.4	47.6	32.0	48.5	47.8	47.2
>12	74	33.4	25.5	36.0	26.4	26.1	27.6
Child characteristics at 3-4 years of age							
Frequency of brushing (times per week), %							
not brushing	5	0.0	1.0	2.2	0.9	2.5	0.9
not everyday	247	58.7	49.6	47.8	50.3	45.0	51.6
everyday	238	41.3	49.4	50.0	48.8	52.5	47.5
Sweet consumption (times per week), %							
≤3	33	5.5	9.4	3.9	6.4	7.1	5.8
4-6	243	45.3	47.2	60.8	42.9	54.8	44.0
7-9	194	36.4	32.1	21.6	37.0	26.2	36.4

	n	PT (n=53)	FT (n=437)	LBW (n=51)	NBW (n=489)	SGA (n=42)	AGA (n=514)
≥10	74	12.8	11.3	13.7	13.7	11.9	13.8
Fluoride supplement use[d], yes%	283	65.8	65.3	71.4	64.5	74.3	64.8
Fluoride toothpaste use, yes%	455	89.8	91.8	90.7	91.4	91.9	91.3
Utilization of dental service, yes%	104	26.0	19.6[a]	16.3	19.6	19.1	19.3

PT = Preterm birth; FT = Full term birth; LBW = Low birthweight; NBW = Normal birthweight; SGA = Small-for-gestational-age; AGA = Appropriate-for-gestational-age

[a]P<0.05; Chi-square test

[b]P<0.05; Fisher's exact test

[c]P>0.05; Fisher's exact test

[d]Variable missing 20.0%

Table 3

Association between adverse birth outcomes and development of dental caries

Adverse Birth Outcomes	Unadjusted RRs [95% CI]	Adjusted RRs [95% CI]
Preterm birth	0.90 [0.65, 1.24]	0.61 [0.43, 0.85][a]
Full term birth	1.0	1.0
Low birthweight	1.02 [0.79, 1.34]	0.89 [0.67, 1.21][b]
Normal birthweight	1.0	1.0
Small-for-gestational-age	1.19 [0.92, 1.54]	0.96 [0.74, 1.26][b]
Appropriate-for-gestational age	1.0	1.0

RR = relative risk, 95% CI = 95% confidence interval

[a]adjusted for maternal age, occupation of mother, family income, fluoride supplement use, sleeping while milk feeding, and frequency of sweet consumption, utilization of dental service, and child gender

[b]adjusted for maternal age, occupation of mother, family income, fluoride supplement use, sleeping while milk feeding, frequency of sweet consumption, and child gender

Table 4

Association between adverse birth outcomes and early childhood caries (ECC) and severe ECC (S-ECC)

		ECC (n=480)			S-ECC (n=455)	
Adverse Birth Outcomes	**% ECC**	**Unadjusted RRs [95% CI]**	**Adjusted RRs [95% CI]**	**% S-ECC**	**Unadjusted RRs [95% CI]**	**Adjusted RRs [95% CI]**
Preterm birth	77.4	0.39 [0.19, 0.80]	0.35 [0.14, 0.87][a]	75.5	0.53 [0.27, 1.04]	0.38 [0.17, 0.85][a]
Full term birth	89.7	1.0	1.0	85.4	1.0	1.0
Low birthweight	84.3	0.70 [0.31, 1.55]	0.55 [0.22, 1.39][b]	80.4	0.79 [0.38, 1.64]	0.64 [0.28, 1.43][b]
Normal birthweight	88.6	1.0	1.0	83.9	1.0	1.0
Small-for-gestational-age	92.9	1.79 [0.54, 5.99]	1.56 [0.46, 5.26][c]	85.7	1.18 [0.49, 2.91]	1.01 [0.41, 2.51][c]
Appropriate-for-gestational age	87.9	1.0	1.0	83.5	1.0	1.0

RR = relative risk, 95% CI = 95% confidence interval

[a]adjusted for pre-pregnancy BMI, frequency of sweet consumption, and child's gender

[b]adjusted for fluoride toothpaste use, and child's gender

[c]adjusted for breastfeeding duration and child's gender