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Title: Effect of low birth weight on the first tooth eruption

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ABSTRACT

Background: Low birth weight is one of the adverse pregnancy outcomes which has been suggested to affect oral structure and development including delayed tooth eruption. Deciduous teeth are very important to the growth of infants in terms of speaking, chewing and holding space for the permanent teeth. There are many factors which may influence time of the first tooth eruption including genetic, gender, ethnicity, social economic status, nutrition, and neonatal factors. However, there are not many studies examining the association between low birth weight and the time of first tooth eruption.

Objective: To evaluate the association between low birth weight and time of first tooth eruption in infants.

Methods: Data from the Prospective Cohort Study of Thai Children was used to obtain birth weight of infants. This is a large birth cohort study conducted on more than 4,000 infants born from 2000 to 2002 and their parents or caregivers in Thailand. Dental records of children were followed by questionnaires from at six months and twelve months of age. Cox proportional regression analysis were applied to obtain the hazard ratio of having the first tooth eruption between low birth weight and normal birth weight infants.

Results: The median age of first tooth eruption was 8 months. 12.51% of participants are low birth weight. At a given time, children born with low birth weight had 83% probability of having the first tooth erupted comparing to normal BW (95% confidence interval 0.72 to 0.95).

Conclusion: Low birth weight prolonged the time of the first tooth eruption in infants.

Keywords: Deciduous teeth, eruption, low birth weight, infants

INTRODUCTION

Deciduous dentition plays a very important role in dental development of infants because deciduous teeth not only hold space in the jaws for permanent teeth and align them into correct position (Sajjadian et al., 2010), but also help infants to chew and speak in a proper way. There are many factors which may influence time of the first tooth eruption including genetic, gender, ethnicity, social economic status, nutrition (Adler, 1963; Kutesa et al., 2013; Lee et al., 1965; Moslemi, 2004; Sajjadian et al., 2010), and neonatal factors (Sajjadian et al., 2010; Viscardi et al., 1994). Among them, role of birth weight (BW) has not yet been widely investigated although some previous studies have reported the association between time of the first tooth eruption and birth weight (Fadavi et al., 1992; Haddad and Correa, 2005; Kutesa et al., 2013; Lawoyin et al., 1996; Sajjadian et al., 2010; Viscardi et al., 1994).

Low BW is one of the adverse pregnancy outcomes which is defined as a newborn infant weighed at birth less than 2,500 grams (WHO). Previous studies have shown that low BW may have an impact on oral structure and development including defects in palatal morphology, enamel formation, and delayed tooth eruption (Paulsson et al., 2004; Seow, 1997; Viscardi et al., 1994).

Assessing the association between low BW and time of tooth eruption would help in convincing pregnant women to improve maternal nutrition during their pregnancy that could make their infants have a better dentition. However, little was known about this association in Thai population. Hence, we conducted this study to examine the association between low birth weight and time of the first tooth eruption in Thai infants.

MATERIALS AND METHODS

Study design

This paper is a part of the Prospective Cohort Study of Thai Children (PCTC). The PCTC is a large birth cohort study which was conducted on more than 4,000 infants born from October 2000 to September 2002 and their parents or caregivers in five different regions in Thailand (Sangsupawanich et al., 2007; Tengtrisorn et al., 2005). Participants were recruited from one selected district in each of four regions (including the North (Nan province), Northeast (Khon Kaen province), Central (Kanchanaburi), and South (Songkla province) of Thailand) and the capital Bangkok. These samples had to meet the criteria including being accessible year-round, 800 to 900 newborns on average each year, all residents intend to live in the study area for at least 5 years, and having a long-term commitment with the project by a hospital director (and associates). The babies who were born between October 15, 2000 and September 14, 2002 were recruited in the study.

All participants signed the written informed consent after obtaining verbal permission. PCTC project was approved by the National Ethics Committee of the Ministry of Public Health of Thailand. This study was approved by the Khon Kaen University Ethics Committee for Human Research.

Independent variables and outcomes

Data were collected not only from mothers, fathers, other family members and children, but also from secondary data regarding community and demographic variables. Many methods of data collection were used in PCTC study including in-person interview using questionnaire, diary records, medical records, and extraction from existing data.

This study focused on low BW and the time of first tooth eruption in infants. Originally, BW was recorded as a continuous variable. Based on definition of World Health Organization (WHO), BW was categorized into two subgroups which are low BW (less than 2,500 grams) and normal BW (equal to or greater than 2,500 grams).

Main outcome was the time to eruption of the first tooth which was extracted from the questionnaires at 6 months and 12 months.

Potential bias

Other demographic variables were also taken into account for controlling potential bias including mother's education level, income, maternal age, passive smoking, alcohol consumption, child's gender, gestational age (GA), and study site. Deletion method was applied to handle for unavoidable missing values.

Statistical analysis

Description analysis was utilized to describe the baseline characteristics of infants and their families. Cox proportional regression was used to estimate the hazard ratio (HR) of time to eruption between low BW and normal BW groups. We applied the backward stepwise procedure to achieve the best fitted model. All data were analyzed using Stata SE statistical software version 12.0 (Stata Corp, College Station, TX). A p-value of less than 0.05 was set as a statistically significant level for all tests.

RESULTS

A total of 4,116 participants from five different areas were included in this study (figure 1).

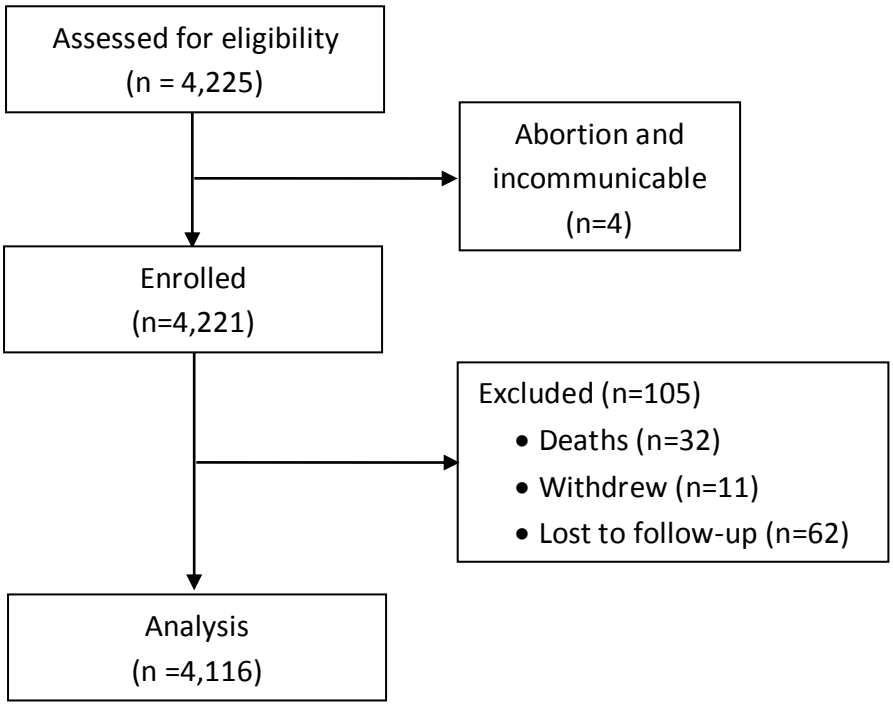

Figure 1. The inclusion flow chart

Demographic Characteristics

Among 4,116 infants, approximately 50% were girls. 94.7% of infants followed the study at 6 months and 12 months. The med age of mothers was 27.0 ± 6.2 years old. Other demographic characteristics are shown in table 1.

Table 1. Demographic characteristics presented as percentage unless specified otherwise

Characteristics	Total (n)	Sites (%)*				
		North (n=759)	Northeast (n=1,061)	Central (n=853)	South (n=772)	Bangkok (n=671)
Mothers						
Age (years)						
Youth (14 – 24)	1,546	41.9	36.3	52.8	34.3	19.1
Adult (25 – 48)	2,570	58.1	63.7	47.2	65.7	80.9
Mean ± SD	27.0 ± 6.2	26.3 ± 6.1	27.5 ± 6.5	24.9 ± 5.5	27.4 ± 6.3	29.3 ± 5.9
Min – Max	14 – 48	14 – 48	14 – 46	14 – 43	14 – 47	15 – 46
Highest education						
Illiterate	211	3.95	5.56	1.06	14.51	0.15
Primary school	1,925	60.74	59.75	59.91	28.11	15.20
High school	1,151	25.16	26.01	29.66	28.63	31.30
Vocational training	339	5.40	4.05	4.57	11.01	19.52
University and higher	399	3.29	3.49	2.58	15.03	29.66
Others	10	0.13	0.19	0.35	0.39	0.15
Alcohol drinking						
No	3,670	88.1	91.0	90.9	91.3	82.9
Yes	152	2.9	1.1	3.5	2.3	10.4
Passive smoking						
No	818	20.0	12.7	12.7	30.8	27.6
Yes	2,433	56.8	68.2	64.4	50.3	50.8
Infants						
Gender						
Boys	2,025	46.9	51.6	48.4	48.6	49.8
Girls	2,040	52.3	47.5	51.1	49.4	48.0
Gestational age						
Term birth	3,558	90.0	82.5	79.3	90.4	93.3
Preterm birth	558	10.0	17.5	20.7	9.6	6.7
Breast feeding						
No	385	10.1	2.5	7.4	13.6	17.0
Yes	3,466	86.6	94.6	87.9	80.8	64.2

** Numbers do not always match the totals because of missing values*

Low BW among five study sites

The average prevalence of low BW among five study sites was 12.51% (Table 2). Northeast area had the highest prevalence of low BW (19.79%), while the capital Bangkok had the lowest prevalence of low BW.

Table 2. Percentage of low BW among five study sites

Site	Number of Low BW	Percentage of low BW
North	62	8.17
Northeast	210	19.79
Central	104	12.19
South	110	14.25
Bangkok	29	4.32
Total	515	12.51

Time to erupt the first tooth

Thai infants had the median time of first tooth eruption of 8 months, as shown in figure 2.

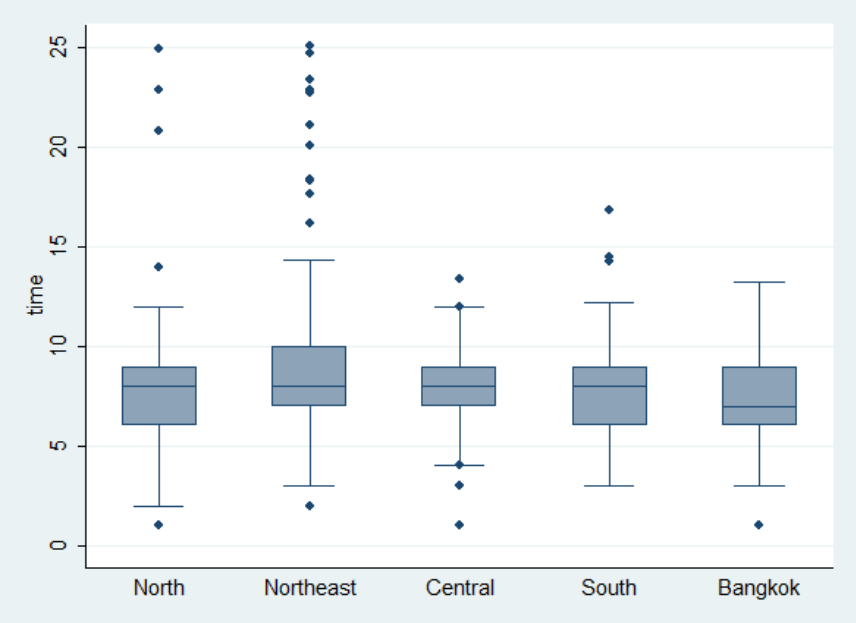

Figure 2. Median time of first tooth eruption among five study sites

Factors associated with time to eruption

Cox proportional regression analysis provided the effect of each characteristic on the outcome. Table 3 shows the crude hazard ratios of having the first tooth eruption in infants.

Table 3. Crude HR of having the first tooth eruption for each explanatory factor, stratifying by study site

Factors	n	Person-months	Incident rate/100	Crude HR	95%CI	P-value
Birth weight						<0.001
Normal BW	3,598	28,829	11.9	1.00	Reference	
Low BW	515	4,492	10.4	0.79	0.72 to 0.87	
Maternal age (1-year increase)	N/A	N/A	N/A	1.00	0.99 to 1.00	0.830
Highest education of mothers						0.949
Illiterate	211	1,683	11.5	1.00	Reference	
Primary	1,925	15,837	11.6	0.97	0.74 to 1.00	
High	1,151	9,355	11.7	0.97	0.75 to 1.02	
College	339	2,679	12.1	0.98	0.77 to 1.11	
University and higher	399	3,095	12.3	1.01	0.78 to 1.12	
Others	10	76	13.2	1.28	0.55 to 1.97	
Alcohol drinking during pregnancy						0.452
No	3,670	29,733	11.8	1.00	Reference	
Yes	152	1,156	12.9	1.07	0.90 to 1.26	
Passive smoking						0.053
No	818	6,398	12.3	1.00	Reference	
Yes	2,433	19,880	11.6	0.92	0.85 to 1.00	
Child's gender						<0.001
Female	2,040	16,889	11.4	1.00	Reference	
Male	2,025	16,074	12.1	1.18	1.10 to 1.25	
Gestational age						<0.001
Term birth	3,555	28,541	11.9	1.00	Reference	
Preterm birth	558	4,779	10.7	0.83	0.76 to 0.91	
Breast feeding						0.819
No	385	3,067	12.1	1.00	Reference	
Yes	3,466	28,187	11.7	1.01	0.91 to 1.13	

After adjusting for child's gender, GA, maternal age, and alcohol drinking, and passive smoking during pregnancy, low BW infants faced a significant hazard of not erupted tooth 17% greater than normal BW infants (adjusted HR = 0.83, 95% confidence interval 0.75 to 0.93) (Table 4). Girls have earlier time of tooth eruption than boys.

Table 4. Adjusted HR of having first tooth eruption for each explanatory factor

Factors	Erupted (n)	Erupted (%)	Crude HR	Adjusted HR (95% CI)	P-value
Birth weight					0.001
Normal BW	3,445	95.67	1.00	1.00	
Low BW	469	91.07	0.79	0.83 (0.75 to 0.93)	
Child's gender					<0.001
Female	1,917	93.97	1.00	1.00	
Male	1,949	96.25	1.18	1.17 (1.10 to 1.25)	
Gestational age					0.038
Term birth	3,405	95.70	1.00	1.00	
Preterm birth	509	91.22	0.83	0.90 (0.81 to 0.99)	

The hazard rate curve showed the difference in the probability of having erupted tooth between low BW and normal BW groups (Figure 3).

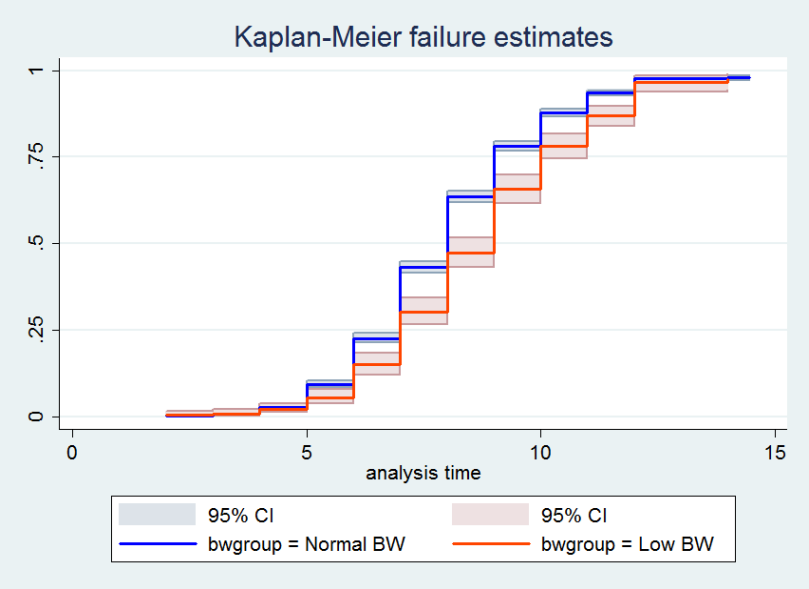

Figure 3. Difference in the probability of having erupted tooth between low BW and normal BW groups

DISCUSSIONS

This study evaluated the association between low BW and the time of first tooth eruption. We found that low BW lead to prolonged time of the first tooth eruption. At a given time, children born with low BW have 83% probability of having the first tooth erupted comparing to normal BW children. Mothers of low BW infants usually have malnutrition during their pregnancy (Noren, 1983). This may influence their infant's physical development including oral structures (Infante and Owen, 1973). Insufficient nutrition to provide to the infants may result in calcium deficiency, affecting to the formation of tooth enamel in both primary and permanent teeth (Aine et al., 2000; Robles et al., 2013). Besides, malnutrition may be related to some diseases in neonatal period that may have an impact on oral tissue formation (Infante and Owen, 1973; Seow, 1997). Our findings are consistent with other previous studies (Aktoren et al., 2010; Fadavi et al., 1992; Sajjadian et al., 2010; Seow et al., 1984). Seow et al. suggested a positive association between low BW and time of tooth eruption (Seow et al., 1984). In a study of Fadavi et al., the authors also found the same results with infants having low BW (Fadavi et al., 1992). On the other hand, Lawoyin et al. provided an inconsistent finding with other studies (Lawoyin et al., 1996). This may be due to different population and different sample sizes.

Passive smoking is one of the risk factors that should be concerned. We found an increased risk of having later time of tooth eruption among children whose mother exposed to cigarette smoking at home or at work. Smoke may increase the amount of calcium that goes out of the body by uterine, resulting hypocalcemia (Hypocalcemia). Once hypocalcemia occurs, it may have an effect on dental calcification. It occurs when the infant body cannot accumulate calcium and phosphate or does not absorb enough during the last three months of pregnancy (Jain et al., 2008; Jain et al., 2010; Seow, 1986).

We also found the non-significant association between social economic status of parents including income and education level and the development with tooth eruption. This finding is similar with the study of Adler *et al.* (Adler, 1963; Kutesa et al., 2013). Low income and not well-educated parents might have not provided sufficient nutrition to their infants. Maternal age is also related to the time of eruption of the first tooth, especially the young mothers. They may lack of physical maturity. Moreover, they themselves are developing, so the development of the infants may be competing with them (DeRoo et al., 2003).

Preterm birth were also related to the time of tooth eruption, as mentioned in many previous studies (Kutesa et al., 2013; Niswander and Sujaku, 1960; Peedikayil). Infants with preterm birth and low BW may lack of vitamin D absorption resulting in reduction of calcium and phosphate intake. This could lead to insufficient nutrients among those infants, thus they are lack of dental calcification necessary for the formation of their first dentition.

There was a difference between girls and boys regarding the time of first tooth eruption. A previous study in Uganda also showed a similar result that girls have shorter time of tooth eruption than boys about half year (Krumholt et al., 1971). While recent study of Kutesa (Kutesa et al., 2013) has found an earlier time (0.8 year) in girls comparing to boys. This gender-relationship has still not known much yet until now, however, some authors assumed that this differences was due to the differences in sexual maturity (Kutesa et al., 2013) or embryologic timing (DeRoo et al., 2003).

Strengths of the study

This study is a strongest observational design which can investigate multiple risk factors for delayed first tooth eruption. Besides, this study used data from PCTC project which is a very large birth cohort study in Thai population, therefore this sample can be a national representative. Another strength of this study is the minimal loss to follow-up.

Limitations of the study

Although having several strengths described above, this study also had some limitations that might distort the findings. Firstly, to overcome information bias in the main PCTC study, we trained and calibrated the interviewers. Another type of bias that may occur in this study is potential confounding factors. We have made our efforts to control for several possible confounders which were listed in table 1 by adjusting in data analysis process.

Causal inferences are still suspect in this recent study as this is a part of PCTC, a cohort study design. Also, this study does not allow us to see the change of association over time.

Missing values are also concerned as one of the limitations of this study. By comparing the missing group to the completed group, we found that they are similar with regard to all significant predictors (data not shown). Therefore, the assumption of "missing at random" can be made reasonably.

CONCLUSIONS

In summary, our findings suggested that at a given time, children born with low BW had 83% probability of having the first tooth erupted comparing to normal BW. This may lead to many problems in the dental and nutritional development of infants. Further studies on this topic in other population should be conducted in the future to achieve much more evidences in order to help the policy-makers eliminate this burden.

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