Effects of Premature Delivery and Birth Weight on Eruption Pattern of Primary Dentition among Beijing Children

Xiao Zhe WANG[1#], Xiang Yu SUN[1#], Jun Kang QUAN[1], Chen Ying ZHANG[1], Min ZHAO[1], Xiang Ru SHI[1], Yan SI[1], Shu Guo ZHENG[1]

Objective: *To evaluate the effect of premature delivery and birth weight (BW) on primary tooth eruption.*

Methods: *A total of 2,230 children aged 3 to 36 months from urban and rural areas in Beijing, China, were classified for analysis by gestational age at delivery (89 preterm and 2,141 full term) and BW (low, normal and high). The tooth eruption status of these children was examined and recorded every 3 months.*

Results: *The timing of first primary tooth eruption was significantly delayed in preterm infants (8.4 months versus 7.3 months for full term; $P < 0.05$). Furthermore, the number of teeth was significantly less for the preterm and low-BW groups at 12 to 18 and 24 to 30 months, but the number of teeth caught up with normal-BW children by 30 to 36 months. In contrast, the time of first tooth eruption of high-BW children was earlier, while the erupted teeth at each month range was more than the normal-BW group. This research also demonstrated a negative correlation ($r = -0.202$; $P = 0.009$) between the time of first primary tooth eruption and BW as well as a positive correlation between the number of erupted teeth and BW.*

Conclusion: *Premature delivery and BW were the influencing factors for the timing of primary tooth eruption in children from Beijing, China. Recommendations for feeding habits and oral healthcare implementation may vary according to different primary tooth eruption status among individuals.*

Key words: *tooth eruption, primary teeth, premature delivery, birth weight (BW)*

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Primary teeth, as important masticatory organs in infants and children, affect children's growth and development as well as the formation of their successive permanent dentition. Normal status of tooth eruption leading to physiological stimulation of the masticatory system is the key factor in maxillofacial bone development in young children, which in turn plays a crucial role in the establishment of their functional and aesthetic occlusion.

Primary tooth eruption is a complex, time-dependent and localised event that could be impacted by gene regulation, disease and other environmental factors. Nutritional factors, endocrine diseases (eg, hypothyroidism and growth hormone deficiency) and congenital or hereditary disorders (eg, ectodermal dysplasia) were demonstrated to exert certain influences on dental development[1]. Furthermore, trauma, infection and other factors may also contribute to abnormal tooth eruption[2].

To a certain extent, the timing and sequence of primary tooth eruption not only reflects the overall physical health (especially the status of nutrition and the development of the endocrine and skeletal systems) of infants, but also indicates the maternal nutritional

1 Department of Preventive Dentistry, Peking University School and Hospital of Stomatology, National Engineering Laboratory for Digital and Material Technology of Stomatology, Beijing Key Laboratory of Digital Stomatology, Beijing, P.R. China.

# These authors contributed equally to this study and share first authorship.

Corresponding author: Dr Shu Guo ZHENG, Department of Preventive Dentistry, Peking University School and Hospital of Stomatology, 22# Zhongguancun South Avenue, HaiDian District, Beijing 100081, P.R. China; Tel: 86 10 82195510; Fax: 86 10 62173402; Email: zhengsg86@gmail.com

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Table 1 Comparison of eruption time of the first primary tooth between preterm and full-term infants.

Group	n	Eruption time (months)	*P* value
Preterm	6	8.4 ± 1.7	0.037*
Full term	217	7.3 ± 1.3	
Total	223		

* Comparison with full-term group ($P < 0.05$)
n: number of subjects

state. At the same time, it is closely related to the occurrence and progress of primary caries. Consequently, the eruption of primary teeth, particularly of the first primary tooth, is of interest to parents/guardians and paediatricians.

It was noticed in clinical practice that the timing of tooth eruption in premature (28 to 37 weeks/196 to 259 days)[3] children and those with a low birth weight (BW) (less than 2,500 g) is different from that in normal-BW children. Unfortunately, the few studies that have focused on primary dentition development are both decades old and incomprehensive, despite the fact that many researchers put significant effort into investigating the growth and development of these preterm infants. The present study therefore aimed to explore the relationship between premature birth, BW and the eruption of primary teeth. It also aimed to obtain a better understanding of the current situation and provide guidelines to paediatricians and parents/guardians on oral healthcare.

Materials and methods

Investigation objective

Healthy children aged from 3 to 36 months having routine checkups at health departments in the Haidian and Miyun districts of Beijing, China, were recruited for this research study. The participants' mothers were required to meet the inclusion criterion that they did not suffer from any illness/disease during their pregnancy that may have affected their infants' tooth eruption. All the parents/guardians of the children recruited for this study gave their signed informed consent. This research was reviewed and approved by the Ethical Committee of the Peking University School of Stomatology (Approval No. PKUSSIRB-2013047).

The information regarding the children's essential characteristics, including gender, date of birth and BW, was collected from their birth records and from questionnaires. Clinical examinations were conducted by trained examiners using artificial light, plane mouth mirrors and standard WHO community periodontal index (CPI) probes, with participants lying in their mothers' arms. Regular follow-ups were performed every 3 months until all teeth had erupted. The eruption status of every single tooth was then scored using a predesigned table according to the following criteria: 1) A score of 1 referred to one-third eruption – a portion of the tooth crown had broken through the gum, while its occlusal surface or incisal edge was not fully exposed. 2) A score of 2 referred to two-thirds eruption – a tooth whose whole occlusal surface or incisal edge was completely exposed in the oral cavity but had not yet reached the occlusal plane. (3) A score of 3 referred to complete eruption – the erupted tooth had reached the occlusal plane.

Statistical analyses

A uniqueness check, logic check and double check were conducted to ensure the correctness and effectiveness of the data. Statistical analyses were carried out using SPSS 18.0 software. Comparisons between groups were performed with independent Student's *t*-test, while the associations between eruption time and other variables were evaluated using Spearman's rank correlation analysis. Data are presented as mean ± standard deviation (SD). $P < 0.05$ was considered to be statistically significant.

Results

A total of 2,230 children participated in this study: 1,196 males and 1,034 females (sex ratio: 1.15:1). There were 89 premature infants among them, of which only six had first primary teeth in the process of eruption. The age of the enrolled children was calculated from their birth (chronological age). The average initial eruption time of primary teeth was 8.4 months in the preterm group, which was significantly delayed compared with 7.3 months in the full-term group ($P < 0.05$) (Table 1).

Simultaneously, the number of erupted primary teeth at the different age ranges between preterm and full-term were also analysed (Table 2). At the various age ranges after birth (except for 30 to 36 months), the number of erupted teeth in the preterm group was smaller than that of the full-term group. Ultimately, it caught up with the number in the full-term group by 30 to 36 months (average 17 teeth) (Fig 1).

A low-BW infant was defined as one with a BW of less than 2,500 g, while the BW of a high-BW infant was greater than 4,000 g. This study also evaluated

Table 2 Comparison of average number of erupted teeth at different age ranges between preterm and full-term infants.

Age range (months)	Preterm		Full-term		*P* value
	n	mean ± SD	n	mean ± SD	
6–9 months	22	2.55 ± 2.13	799	2.98 ± 1.85	0.281
9–12 months	16	4.75 ± 2.70	228	5.21 ± 2.39	0.465
12–18 months	35	7.06 ± 3.57	678	8.49 ± 3.47	0.017*
18–24 months	16	13.75 ± 3.15	592	14.65 ± 2.41	0.277
24–30 months	16	16.25 ± 0.68	437	16.84 ± 1.36	0.005*
30–36 months	7	18.8 ± 1.68	76	17.9 ± 1.49	0.147
Total	112		2810		

* Statistical significance in comparison with the full-term group ($P < 0.05$)
n: number of subjects; mean ± SD: mean number of erupted teeth ± standard deviation

the association between BW and primary tooth eruption. Although the differences were not significant, the eruption time of the first primary tooth was later in the low-BW group, while it was earlier in high-BW group compared with the normal-BW group ($P > 0.05$ for both) (Table 3).

Furthermore, the number of erupted primary teeth at different age ranges was also calculated (Table 4). The number of teeth in the low-BW group was smaller than that in the normal-BW group at every age range; the difference at 12 to 18 and 24 to 30 months was statistically significant. On the contrary, the number of teeth in the high-BW group was notably more compared with that in the normal-BW group at 18 to

Table 3 Comparison of eruption time of the first primary tooth in low-, high- and normal-BW infants.

Group	n	Eruption time (months)	*P* value
Low BW	7	8.4 ± 1.9	0.053
High BW	18	6.9 ± 1.3	0.171
Normal BW	197	7.3 ± 1.4	
Total	222		

n: number of subjects

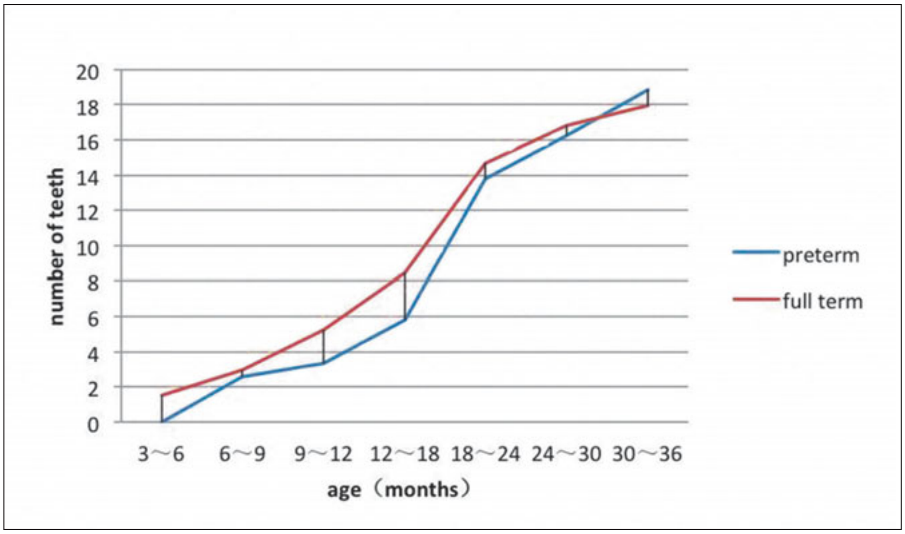

Fig 1 Number of erupted teeth in full-term and preterm groups for different age ranges.

Table 4 Comparison of the average number of erupted teeth at different age ranges between low-, high- and normal-BW infants.

Age range (months)	Normal BW		Low BW			High BW		
	n	mean ± SD	n	mean ± SD	*P* value	n	mean ± SD	*P* value
6–9	731	2.95 ± 1.85	22	2.50 ± 1.50	0.258	67	3.30 ± 2.02	0.147
9–12	220	5.17 ± 2.42	6	4.50 ± 2.81	0.504	17	5.47 ± 2.27	0.624
12–18	639	8.4 ± 3.43	26	6.77 ± 3.45	0.018*	41	9.44 ± 3.87	0.100
18–24	542	14.56 ± 2.47	21	14.19 ± 2.87	0.503	46	15.30 ± 1.78	0.011*
24–30	400	16.85 ± 1.38	26	16.19 ± 0.69	0.000*	26	16.92 ± 1.29	0.792
30–36	74	18.07 ± 1.49	6	17.67 ± 2.07	0.540	2	19.0 ± 1.41	0.386
Total	2606		107			199		

* Statistical significance in comparison with the normal-BW group ($P < 0.05$)
n: number of subjects; mean ± SD: mean number of erupted teeth ± standard deviation

24 months. Interestingly, tooth numbers in the different BW groups eventually reached a level equivalent to that of the normal-BW group at 30 to 36 months. A catch-up tendency can clearly be observed in the low-BW group (Fig 2).

Correlation analysis was performed to clarify the relationship between BW and time of first primary tooth eruption or number of erupted teeth in children of different ages. A negative correlation between time of first primary tooth eruption and BW was found ($r = -0.202$; $P = 0.009$), while the number of erupted teeth and BW was positively correlated at 9 to 12, 12 to 18, 18 to 24 and 24 to 30 months (Table 5).

Discussion

Parents/guardians are often interested in the time of their child's first primary tooth eruption since it could reflect the growth and development of the child to some extent. In this study, several factors were demonstrated to influence the development and eruption of primary teeth. Two potential factors impacting primary tooth eruption – premature delivery and BW – were analysed in this study.

Numerous previous studies have explored the relationship between premature delivery and the eruption of primary teeth. Viscardi et al[3] previously reported

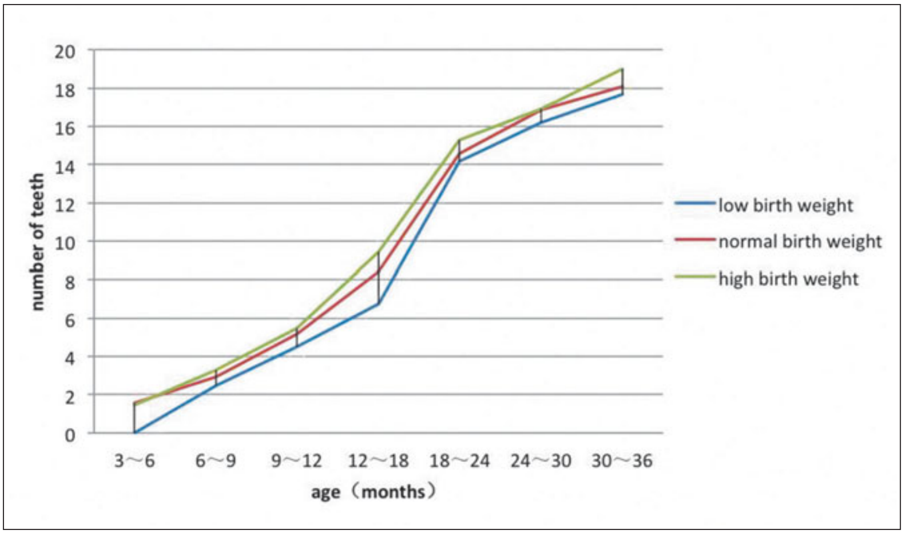

Fig 2 Number of erupted teeth in low-, normal- and high-BW groups at different age ranges.

Table 5 Correlation analysis between BW and tooth eruption variables.

	Correlation factor	n	Correlation coefficient	*P*
BW	Time of first primary tooth eruption (months)	222	-0.202	< 0.01
	Number of erupted teeth			
	3–6 months	80	0.241	0.032
	6–9 months	821	0.062	0.074
	9–12 months	244	0.167	< 0.01
	12–18 months	713	0.131	< 0.01
	18–24 months	612	0.116	< 0.01
	24–30 months	455	0.153	< 0.01

n: number of subjects

that 60% of preterm infants experienced delayed tooth eruption, even when gestational ages were used for the analysis, which might be attributed to a shorter gestational period and maternal malnutrition in premature infants. These factors were proven to affect the growth and development of craniofacial tissue. Delayed tooth eruption was considered to be associated with a series of conditions such as rickets, nutritional deficiencies and hypothyroidism[4]. A longitudinal study by Holman and Yamaguchi[5] revealed that nutritional status was closely correlated with the eruption of primary teeth: eruption time was significantly delayed in cases of nutritional deficiency, while the tooth eruption process was also much slower in these individuals.

Furthermore, Infante and Owen[6] demonstrated that the nutritional status of children had an appreciable effect on the eruption of their primary teeth. Based on the above studies, we propose that delayed timing of primary tooth eruption in preterm infants may be related to maternal nutritional status.

In this study, the incidence rate of preterm birth was 4% (89 out of 2,230 infants), while according to other studies[7], this figure is 5% to 7% in mainland China. This difference may be attributed to the limited sample size in our study. However, our results still revealed that tooth eruption was significantly delayed and there were fewer erupted teeth in preterm compared with full-term infants in the early age ranges. Interestingly, these numbers in both groups (preterm and full-term) tended to be consistent at around 30 months. Researchers found that healthy premature infants exhibited progressive growth rates that were greater than those of full-term infants as they grew up, although some delayed development in premature infants may continue to exist for a certain period of time[8,9]. Up to the present, quite a few studies have investigated the types of progressive (or catch-up) growth and development of premature babies; nevertheless, very few of them have focused on premature tooth development. The present study looks at the developmental potential and catch-up trend of preterm infants from the perspective of tooth eruption.

Both premature delivery and BW of infants are closely associated with dental development. The present study revealed a negative linear correlation between BW and time of initial tooth eruption ($r = -0.202$; $P = 0.009$). In addition, the number of erupted teeth in infants of 9 to 12, 12 to 18, 18 to 24 and 24 to 30 months was positively correlated with BW. The time of first tooth eruption of low-BW infants was later than normal-BW infants. Consequently, the number of erupted teeth in the low-BW group at each age range was also smaller than that in the normal-BW group. By contrast, the time of first tooth eruption of high-BW infants was earlier than that of normal-BW infants, while the number of erupted teeth at each age range was greater than that of the normal-BW group. Results of previous studies support an inverse relationship between BW and age of tooth eruption[8,10,11]. Another study presented similar findings, showing that the number of erupted teeth was remarkably related to BW at 6 to 11 and 12 to 17 months, with very-low-BW infants (< 1,500 g) having the least number of erupted teeth compared with low-BW and normal-BW (> 2,500 g) infants. These findings also indicated that not only the initial eruption

Table 6 Recommendations for textures of supplementary food according to primary tooth eruption status.

Age range (months)	Erupted teeth	Food textures	
		PAHO/WHO	CMA
4–6	–	Mashed	Mashed
7–9	A	foods	foods
10–12	A+B	Finger foods	Minced
13–18	A+B+D/C		foods
18–24	A+B+D+C	Lumpy	Finger foods
> 24	A+B+D+C+E	foods	Lumpy foods

A: primary central incisor; B: primary lateral incisor; C: primary canine; D: primary fist molar; E: primary second molar

of primary teeth but also the eruption of primary canines and primary molars was affected by infant BW[12]. As we know, BW may reflect the development of the foetus in the mother's uterus. Lower BW individuals manifested slower body development generally, which might have led to the delayed development of their primary teeth.

Streptococcus mutans (*S. mutans [MS]*) is a cariogenic bacterium whose colonisation commences as soon as a tooth erupts. Consequently, the tooth-eruption process of the primary dentition becomes the critical period for *MS* infection[13]. The detection rate of *MS* increases with age and the number of erupted teeth, then reaches its first peak when the primary first molar erupts[14]. A previous study revealed tooth eruption in obese children to be earlier than in children of normal weight, which is similar with high-BW children[15]. This suggests that the early eruption of primary teeth may increase the incidence of dental caries and malocclusion. In addition, another longitudinal study showed that preterm infants had 4.4 times higher odds of being colonised by *MS* than full-term infants as well as a higher risk of dental caries[16]. Therefore, it is advisable to guide parents/guardians on feeding habits and oral healthcare to avoid dental caries, not only in high-BW but also in premature infants.

Complementary feeding is undertaken to meet the nutritional demands of children in different stages of growth and development. Guides for complementary feeding of children were released by the Pan American Health Organization/World Health Organization (PAHO/WHO) and Pediatric Society of the Chinese Medical Association (CMA) in 2009. Although the detailed suggestions are slightly different for the various countries, the consensus is to increase food consistency and variety gradually as the infant ages, adapting to his or her requirements and abilities[17,18].

Appropriately changing the texture of food is one way to adapt and stimulate craniomaxillofacial development and masticatory function; for instance, it was proposed that by 12 months most children should consume lumpy food. The results of this research showed the average number of erupted primary teeth in low-BW and preterm infants to be 6.77 and 7.06 at 12 to 18 months, respectively. The study also showed that only incisors had appeared in the children's mouths; these teeth may not be capable of coping with lumpy food (Table 6). To be more intuitive and accurate, therefore, the authors suggest that parents/guardians of preterm and low-BW infants should refer to the complementary feeding recommendations regarding food texture and replace lumpy food with something appropriate, depending on the child's chronological and gestational age as well as the eruption status of the primary dentition.

The timepoint of primary tooth eruption is relatively transient. It is therefore challenging to seize the moment in clinical practice, especially in 'abnormal' children. This resulted in the initial tooth eruption only being recorded in a few children, and is one of the limitations of our study. Nevertheless, the preliminary results of our study can provide some guidance for oral healthcare implementation, complementary feeding and oral disease prevention. In preterm infants with delayed primary tooth eruption, although their great potential for growth narrows the disparity with 'normal' infants, regular assessment and consultation with their parents/guardians is necessary. On the other hand, early erupted primary teeth are more susceptible to dental caries due to incomplete calcification. Therefore, it is essential to introduce proper feeding habits and oral healthcare intervention in children with a high BW. We hope to explore the associated factors of primary tooth eruption in a follow-up study in order to gain a thorough understanding of the entire process of primary dentition formation.

Conclusion

The results of this study indicate that premature delivery and BW could affect the formation of primary dentition. The time of primary tooth eruption in preterm or low-BW infants was relatively delayed, while it could be earlier in high-BW compared with normal-BW infants in Beijing, China. It is recommended that dietary habits, complementary feeding and oral healthcare implementation should be properly adjusted according to the eruption status of the primary dentition in individual children.

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Conflicts of interest

The authors reported no conflicts of interest related to this study.

Author contribution

Dr Xiao Zhe WANG contributed to the data acquisition, data analyses and interpretation and drafted the manuscript; Dr Xiang Yu SUN contributed to the data analyses and fieldwork and revised the manuscript; Dr Jun Kang QUAN contributed to the data acquisition and fieldwork and drafted the manuscript; Drs Min ZHAO, Chen Ying ZHANG and Xiang Ru SHI conducted the fieldwork; Drs Yan SI and Shu Gguo ZHENG contributed to the design of the study and revised the manuscript. All the authors read and approved the final manuscript.

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