Developmental Enamel Defects and Dental Caries in the Primary Dentition of Preterm Children

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ABSTRACT

Purpose: To assess developmental enamel defects (DED) and dental caries of preterm (PT) and/or low birth weight (LBW) children compared to full term (FT) and/or normal birth weight (NBW) infants, and to evaluate the association of DED with socioeconomic factors, gestational health, and postnatal factors.

Methods: This study included 84 two- to five-year-old children. The PT/LBW group included 42 children who received medical care at a university hospital, while FT/NBW group included 42 subjects. Children were matched by sex and age (1:1 ratio). Descriptive statistics, bivariate analysis, and Poisson regression were used to analyse the data.

Results: Children in the PT/LBW group had a significantly higher number of teeth with DED than subjects in the FT/NBW group. No difference was observed between the groups regarding dental caries ($P>0.05$). Admission to the neonatal intensive care was significantly associated with DED unit (prevalence ratio = 0.21 [95 percent confidence interval = 0.1 to 0.5]).

Conclusion: PT/LBW children presented more DED than FT/NBW children. No differences were observed between the groups for dental caries. Admission to the neonatal intensive care unit was associated with DED. **(J Dent Child 2021;88(1):40-5)**

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The World Health Organization (**WHO**) has estimated that nearly 15 million preterm **(PT)** infants are born each year. They may be categorized as: extremely preterm (younger than 28 weeks), very preterm (28 to 32 weeks), and moderate to late preterm (32 to 37 weeks).[1] Full-term (**FT**) infants are those born between 37 and 41 weeks and six days.[2] The WHO has

also defined low birth weight **(LBW)** as children born weighing less than 2,500 g. Children weighing less than 1,500 g at birth are defined as very low birth weight and extreme low weight is when newborns weigh less than 1,000 g.[2]

PT children are more vulnerable to developmental enamel defects (**DED**) than FT children. Enamel formation and mineralization begin during the third month of pregnancy and ends after the birth of the FT child. In prenatal infants, the mineralization period is thereby shortened by 10 weeks or more. Infants born before the 29th week, for instance, will miss an important period of tooth development during the third gestational trimester.[3] DED in the primary teeth may also take place as a result of hereditary and environmental factors,[4] which are more common in preterm infants, such as trauma, infections, nutritional disorders, and the use of medications.[5-8]

Changes in enamel development have been described as hypoplasia or opacity. Hypoplasia is defined as a quantitative loss of tooth enamel, while opacity and hypocalcification are a qualitative change (defective mineralization of enamel).[9] Enamel hypoplasia may favor the retention of dental plaque and bacteria, enabling the development of dental caries.[10] The results of the studies on the prevalence of dental caries among PT children are controversial. Studies have used different indices for caries assessment in which children in both primary and mixed dentitions have been evaluated. The studies have accounted for a prevalence of dental caries ranging between 12.9 percent[11] and 57.9 percent.[12]

Although the associations between (**PT**) and/or LBW children, DED, and dental caries have been evaluated in recent systematic reviews,[13,14] the published data on the association between prematurity, DED, and dental caries are inconsistent across varying populations. Some limitations of these studies are the lack of pairing cases and controls, absence of a comparison group, or lack of a standardized index to diagnose dental caries.[11,15,16] Still, some of these studies were carried out in populations with a high educational level or exclusion of children with uncooperative behavior from the sample.[15,16] These factors can influence the prevalence of dental caries and DED. Thus, it is important to analyze the factors associated with DED and dental caries, especially those related to premature birth and birthweight.

The purposes of this study were to: (1) compare dental caries and DED between a group of PT/LBW children with a group of FT/NBW children and (2) evaluate the factors associated with DED.

METHODS

This paired cross-sectional study was approved by the Human Research Ethics Committee of the Federal University of Minas Gerais (UFMG), Belo Horizonte, Minas Gerais, Brazil. The study was conducted with two- to five-year-old children of both sexes, in primary dentition only, between June and December 2017. Those with permanent teeth, children whose parents did not allow them to participate, whose parents were illiterate, and who were uncooperative during the clinical examination were excluded. The sample was divided into two groups: Group 1 included PT/LBW subjects who received medical care at the UFMG Hospital and Group 2 included the FT/NBW from public preschools of the same city. Children were selected in a non-random manner, i.e., those who were present at the study sites during data collection were invited to participate. Parents of school children were contacted through an invitation letter sent home together with the child's homework. Parents signed an informed consent form for their children's participation. The groups were matched by sex and age, at a 1:1 ratio.

A questionnaire about the child's health, the mother's health during pregnancy, delivery complications, and sociodemographic information was developed. Data collected included baby's fever reported by mothers during the first year, mother's number of pregnancies, mother's self-reported use of illicit drugs/alcohol/tobacco during pregnancy, child's birth term status (PT/FT), mothers' schooling level (at least eight years/eight to 11 years/more than 11 years) and family's monthly income. The latter was defined as the sum of the Brazilian monthly minimum wages (BMMW) earned by all household members (father, mother, grandparent, etc.) The BMMW was R$937 at the time of data collection, corresponding to nearly US$250. This variable was dichotomized according to the median in two or fewer BMMWs and more than two BMMWs.

The examiner, a graduate student in pediatric dentistry, was trained and calibrated by one of her faculty in three phases. First, the criteria used for diagnosis was established. For dental caries, the decayed, missing, and filled primary teeth (dmft) index was used.[17] For DED, codes were used according to the criteria of the Developmental Defects of Enamel Index (DED Index).[9] When the enamel was defective but presented normal thickness and a smooth surface, it was classified as demarcated opacity. In this case, the enamel has a distinct and clear boundary from the adjacent normal enamel and changes in color that can be white, cream, yellow, or brown. Diffuse opacity was defined as an alteration in the translucency of the enamel, variable in degree. Enamel hypoplasia was defined as reduced thickness of enamel. In the second calibration phase, photographs of dental carious lesions and DED were used to standardize the diagnosis. The third calibration phase consisted of examining 16 two- to five-year-old children who received dental care at the university dental clinic. The examiner used a headlamp to mimic the light source that would be used during data collection. Children were examined twice within a seven-day interval and were not included in the study. Cohen's Kappa values for intra-examiner agreement were 0.88 for dental caries and 1.00 for DED.

Kappa values for inter-examiner agreement were 0.85 for dental caries and 1.00 for DED. The examiner was deemed able to perform data collection. The questionnaire was pre-tested with 10 parents of children who received dental care at the UFMG dental school clinic, and no changes were necessary.

For the main study, all mothers in both groups answered the questionnaire. For the children in the PT/LBW group, we cross-checked information reported in the questionnaire with the medical records, such as medical care received by the newborn in the neonatal intensive care unit (NICU), whether they were placed in an incubator or were intubated, or diagnoses of infections (e.g., syphilis, human immunodeficiency virus, etc.) For the PT/NBW group, these questions were obtained only from the questionnaire. The children in the PT/LBW group were evaluated during their medical follow-up appointments at the university hospital while those in the FT/NBW group were evaluated at the preschool.

The oral clinical examination was performed in both sites with using a head lamp, mirror, explorer, gauze and personal protective equipment. The participants lay down either on a hospital stretcher or on a table at school, with the examiner standing behind the child. A dental student assisted with data collection. Subjects who needed dental treatment were referred to the university dental school.

The sample power was calculated using SPSS software (Version 25.0IBM Corp., Armonk, N.Y., USA). Type I error was considered at 0.05 significance level. A descriptive analysis of the means of DED and dental caries was run between groups, and differences were tested using the Wilcoxon test. The variable DED was dichotomized in children without it (DED = zero) and with DED (DED greater than one). Pearson's chi-square, linear-by-linear, and Fisher's exact tests were used for bivariate analysis between DED (DED = zero or DED greater than one) and independent variables. Pearson chi-square was used for nominal variables when the values were higher than five in each cell of the two-by-two contingency tables. Fisher's exact test was used for nominal variables when the values in any of the cells of a contingency two-by-two table were below five. The

Table 2. Association Between Developmental Enamel Defects (DED) and Independent Variables*

	DED=0 n (%)	DED ≥1 n (%)	*P*-value
*Group***			
1	23 (54.8)	19 (45.2)	**0.019†**
2	34 (81.0)	8 (19.0)	
Family income (minimum wage [MW])			
≤2 MWs	30 (63.8)	17 (36.2)	0.481†
>2 MWs	27 (73.0)	10 (27.0)	
Mothers' schooling (years of study)			
≤8	11 (55.0)	9 (45.0)	**0.168‡**
>8 - ≤11	28 (70.0)	12 (30.0)	
>11	18 (75.0)	6 (25.0)	
Neonatal intensive care unit admission			
No	35 (83.3)	7 (16.6)	**0.005†**
Yes	22 (52.3)	20 (47.6)	
Incubator use			
No	33 (80.5)	8 (19.5)	**0.020†**
Yes	24 (55.8)	19 (44.2)	
Intubation			
No	46 (75.4)	15 (24.6)	**0.020†**
Yes	11 (47.8)	12 (52.2)	
Infections			
No	43 (72.9)	16 (27.1)	0.201†
Yes	14 (56.0)	11 (44.0)	
High fever			
No	30 (66.7)	15 (33.3)	0.820†
Yes	27 (69.2)	12 (30.8)	
Multiple pregnancies			
No	48 (68.6)	22 (31.4)	0.761§
Yes	9 (64.3)	5 (35.7)	
Drug use during pregnancy			
No	51 (67.1)	25 (32.9)	0.999§
Yes	6 (75.0)	2 (25.0)	
Complications at birth			
No	47 (75.8)	15 (24.2)	**0.016†**
Yes	10 (45.5)	12 (54.5)	

** Group 1: preterm and/or with low birthweight children; Group 2: children born at term and/or with normal weight.*
† Pearson's chi-square test. ‡ Linear-by-linear test.
§ Fisher's exact test; significance level=5%.

Table 1. Distribution of Developmental Enamel Defects (DED) Between Groups*

	Group 1*						Group 2*					
	Maxilla n (%)			Mandible n (%)			Maxilla n (%)			Mandible n (%)		
	Incisors	Canine	Molar	Incisors	Canine	Molar	Incisors	Canine	Molar	Incisors	Canine	Molar
Hypoplasia	17 (10)	05 (6)	06 (3.6)	04 (2.4)	06 (7.1)	05 (3)	00 (0)	00 (0)	00 (0)	00 (0)	00 (0)	00 (0)
Demarcated opacities	01 (0.6)	01 (1.2)	06 (3.6)	04 (2.3)	06 (7.1)	07 (4.1)	01 (0.6)	03 (3.6)	00 (0)	01 (0.6)	05 (6)	00 (0)
Diffuse opacities	03 (1.8)	00 (0)	04 (2.4)	02 (2)	00 (0)	04 (2.4)	02 (1.2)	00 (0)	00 (0)	01 (0.6)	01 (1.2)	02 (2)
Total	**168 (100)**	**84 (100)**	**168 (100)**	**168 (100)**	**84 (100)**	**168 (100)**	**168 (100)**	**84 (100)**	**168 (100)**	**168 (100)**	**84 (100)**	**168 (100)**
Teeth with DED	21 (12.5)	6 (7.1)	16 (9.5)	10 (5.9)	12 (14.2)	16 (9.5)	3 (1.78)	3 (3.5)	0 (0)	2 (1.1)	6 (7.1)	2 (1.1)

** Group 1: preterm and/or with low birthweight children; Group 2: children born at term and/or with normal weight.*

linear-by-linear test was used for ordinal variables for a larger-than-two-by-two table.[18] Bivariate and multivariate Poisson regression models were used to compare DED and the independent variables. Variables with a *P*-value of less than 0.2 in the bivariate analysis were incorporated into the multiple regression model. For this model, values of $P<0.05$ were considered statistically significant. Multicollinearity diagnostics for independent variables were calculated using the variance inflation factor (VIF). The VIF was less than 10 for all associations, indicating the absence of multicollinearity.[18]

RESULTS

The sample consisted of 50 girls and 34 boys, equally distributed between the two groups. The mean age of participants was 3.4 years (±1.0). In Group 1, 29 children (69 percent) were born via Cesarean section, while in Group 2 the number was 19 (46 percent).

The mean dmft was similar between Group 1 (0.38±1.8) and Group 2 (0.55±1.2; $P=0.894$). The components of dmft were similar between Groups 1 and 2: decayed teeth (0.31±1.1 versus 0.40±1.6, respectively; $P=0.803$) and filled teeth (0.07±0.3 versus 0.14±0.6, respectively; $P=0.999$). The mean missing component was zero in both groups.

Group 1 had a significantly higher mean of primary teeth with DED (1.93±3.8) compared to Group 2 (0.38±0.9; $P=0.007$). In Group 1, the maxillary incisors were the most affected teeth by DED (N=21) while in Group 2 the mandibular canines were most affected (N=5). In Group 1, teeth with hypoplasia were more common (43 children), followed by demarcated opacity (25 children) and diffuse opacity (13 children). In Group 2, there was more demarcated opacity (10 children), followed by diffuse opacity (six children) and hypoplasia (none). Although both groups presented DED, children in Group 1 presented a higher prevalence for all types of DED (Table 1).

The independent variables prematurity, mothers' schooling, admission to NICU, incubator use, intubation, and complications during child's birth had a *P*-value less than 0.20 in the association with the dependent variable DED (Table 2) and were, therefore, incorporated into the multiple Poisson regression model. In the final multiple model, children not admitted to the NICU were 0.215 times less likely to have primary teeth with DED when compared to children admitted to the NICU (prevalence ratio: 0.215; 95 percent confidence interval:0.1 to 0.5; Table 3).

Table 3. Bivariate and Multivariate Poisson Regression Models Evaluating the Association Between Developmental Enamel Defects (DED) and Independent Variables

	PR (95% CI)*	*P*-value	PR (95% CI)*	*P*-value
Group **				
1	1	0.016	1	
2	0.42 (0.2-0.8)		1.39 (0.4-5.1)	0.617
Mothers' schooling (years of study)				
≤8	1.80 (0.8-4.2)	0.173	2.05 (0.9-4.8)	0.094
>8 - ≤11	1.20 (0.6-2.8)	0.670	1.16 (0.5-2.5)	0.702
>11	1		1	
Neonatal intensive care unit admission				
No	0.35 (0.2-0.8)	0.006	0.215 (0.1-0.5)	0.000
Yes	1		1	
Incubator use				
No	0.44 (0.2-0.9)	0.023	2.18 (0.6-7.6)	
Yes	1		1	0.220
Intubated				
No	0.47 (0.3-0.8)	0.012	0.55 (0.2-1.2)	
Yes	1		1	0.123
Complications at birth				
No	0.44 (0.2-0.8)	0.006	0.59 (0.3-1.1)	
Yes	1		1	0.099

* *PR=prevalence ratio; CI=confidence interval; significance level=5%.*

** *Group 1: preterm and/or with low birthweight children; Group 2: children born at term.*

DISCUSSION

The PT/LBW children had a higher prevalence of DED than FT/NBW children, but all were similar regarding dental caries. Moreover, admission to the NICU was associated with a greater occurrence of DED.

LBW children may present an increased risk of enamel hypoplasia compared to NBW children.[19] In a previous study, preterm children were 7.5 times more likely to have DED in the primary dentition.[20] In this study, the primary maxillary incisors were the teeth most affected by DED, which is in accordance with the findings of another study.[15]

Due to the age range of the sample, not all children had complete primary dentition. In PT children who presented with DED, tooth mineralization may also have been temporarily impaired. A systematic review confirmed that PT children are more vulnerable to the risk of developing hypoplasia in primary teeth,[21] which is in agreement with the results found in the present study. The most common type of DED among PT/LBW children was hypoplasia. Other authors, however, claim that the most prevalent type of DED in PT children is diffuse and demarcated opacity.[15] This difference may be explained by the difficulty in diagnosing diffuse opacity. Moreover, there are differences between studies regarding the teeth examined and the type of light used during diagnosis.

No differences were observed for dmft between both groups. The dmft index uses the carious lesions as a criterion to measure dental caries experience. This criterion may have underestimated the real prevalence of dental caries, since early white spot lesions were not taken into account during the evaluation. One confounder might be the chronological age of PT children who may

have delayed tooth eruption,[14] which can decrease the exposure of tooth surfaces to the oral environment. However, this problem was not detected in the present study as both groups had comparable tooth eruption at the time of the examination.

Another factor that might have influenced the findings in this study was the enrolment of mothers of PT/LBW children in a health promotion program conducted at the hospital. During this program, mothers receive both oral health instructions and dietary information that may have positively affected their children's oral health. By contrast, the FT/NBW children were enrolled in public preschools, where a balanced diet is provided to the children, minimizing sugar intake and industrialized foods. Some studies conducted with children who took part in health promotion programs showed different results of prevalence of dental caries, where PT children tended to have a lower caries experience.[22,23] However, one study demonstrated that PT children were 6.2 times more likely to develop noncavitated carious lesions.[20] The heightened likelihood of dental caries among PT children could be justified by the impairment of the immune response of these children, which could lead to the early colonization of cariogenic bacteria. However, this hypothesis remains untested.[14]

Admission to the NICU remained significantly associated with DED. Only one child in the PT/LBW group did not require medical assistance in the NICU. Other studies confirmed the association between children hospitalized in the NICU and changes in dental enamel formation and mineralization.[24,25] Unintentional trauma during medical management at the NICU may also occur during intubation, permanently affecting the development of dental enamel.[25]

Tooth development is genetically controlled and sensitive to environmental disturbances. Once teeth formation is complete, it does not undergo remodeling. In general, systemic factors that disturb the ameloblasts during the secretory stage cause restriction of crystal elongation and result in pathologically thin or hypoplasic enamel.[25] Among PT/LBW children, the higher prevalence of hypoplasia in primary incisors may be explained by the greater susceptibility to the trauma of the anterior teeth during medical procedures, as this children might be more vulnerable to oral manipulation during hospitalization (e.g., oral intubation).[26] However, DED can also be a consequence of hereditary and/or acquired etiological factors, such as trauma, infection, nutritional changes, and use of medications, resulting in an increased risk of dental caries and dental wear.[4] Children born with complications at birth have an increased chance of being intubated, placed inside an incubator, and being admitted to the NICU. With more fragile health conditions, these children are more susceptible to the use of medications and more manipulation during hospitalization. They may also have lower immunity, thus becoming more susceptible to infections.[24,25,27,28]

This study has some inherent limitations, such as mothers' memory bias[29,30] when answering the questionnaires. In addition to that, the present study did not evaluate the association of DED with vitamin D deficiency during pregnancy. Studies show that supplementation with a high-dose of vitamin D during pregnancy is associated with a reduced probability of DED in preschool children.[31] The control group was not recruited from the same hospital environment as the PT/LBW group. The findings presented herein should not be extrapolated to the general population.[32]

CONCLUSIONS

Based on the results of this study, the following conclusions can be made:

1. PT children with LBW had a higher prevalence of primary teeth with DED;
2. Being admitted to the NICU was associated with a higher prevalence of DED; and
3. PT children with LBW had similar caries experience as FT/NBW children.

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