

Neonatal Intubation and Enamel Hypoplasia in Primary Dentition: A Retrospective Cohort Study

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Abstract

Introduction: One of the known causes of hypoplasia in primary teeth is maternal complications during pregnancy, as well as factors such as premature birth, low birth weight of the infant, and the subsequent need for intubation. The present study aimed to investigate the effect of intubation during infancy on the occurrence of hypoplasia in primary teeth among children aged 3 to 5 years, with normal birth weight, in Bent El Hoda Hospital, Bojnurd.

Materials and Methods: This retrospective cohort study was carried out in Bojnurd city between 2020 and 2022. The medical records of infants born from 2015 to 2017 with a birth weight greater than 2500 grams were reviewed. Based on the documentation of intubation status, a total of 60 infants with normal birth weight were included, of whom 25 had undergone intubation and 35 had not. The families of the selected infants were subsequently contacted, and the children were invited for clinical examination. Clinical assessments were performed under lamp illumination using a tongue depressor, a disposable dental mirror, and a catheter, and the presence of enamel hypoplasia was evaluated. The collected data were analyzed using SPSS software version 22, and statistical analyses were conducted employing the chi-square test, Fisher's exact test, and t-test.

Result: The average age of all children was 4.6 ± 0.49 years and the average weight was 283.6 ± 423.8 grams. Among all children, only 3 children had a history of hypoplasia (2.9% in the control group and 8% in the group with intubation). In both studied groups, there was no significant relationship between children's gender and the prevalence of enamel hypoplasia. There was no significant relationship between the duration of intubation and the frequency of enamel hypoplasia.

Conclusion: In children with normal birth weight, there is no significant relationship between neonatal intubation and the prevalence of enamel hypoplasia.

Keywords: Intubation; Premature Babies; Enamel Hypoplasia; Birth Weight; Sex

Introduction

Enamel hypoplasia (EH)

Enamel hypoplasia (EH) is a developmental defect of enamel that occurs exclusively during tooth formation and may affect both primary and permanent dentitions [1]. It is characterized by a reduction in enamel thickness, which compromises the protective role of dental tissues against external challenges [2]. As a result, bacterial penetration into dentin is facilitated, increasing the risk of deep caries and subsequent lesions in dentin, cementum, and pulp [3]. Clinically, EH manifests as white opacities, pinpoint pits, or grooves on the external enamel surface [4]. Mild cases may be limited to isolated pitting or a horizontal line across the crown, whereas prolonged disruption of ameloblastic activity leads to more generalized enamel deficits [3].

Perinatal factors

Maternal complications during pregnancy, preterm birth, and low birth weight have been recognized as important contributors to EH in the primary dentition [4]. Approximately 6% of live births are preterm or of low birth weight (LBW) [1]. A high proportion of these infants demonstrate EH in the primary dentition, with prevalence reported as high as 78%. The underlying mechanisms may involve osteopenia and reduced bone mineral stores [5], as well as perinatal hypoxia [2]. In permanent teeth of children born preterm, EH and other developmental enamel defects (DED) have been observed at higher rates than in controls, particularly in the first permanent molars and maxillary lateral incisors [6]. The rougher surface of hypoplastic enamel may favor colonization by *Streptococcus mutans*, explaining higher salivary bacterial counts in affected children [3].

Other oral sequelae in preterm infants

Long orotracheal intubation has been associated with EH of the maxillary incisors, posterior crossbite, and grooved palate. Neonatal, or early postnatal, EH commonly involves the incisal two-thirds of anterior teeth, whereas prenatal EH is more often attributed to maternal metabolic disturbances [7].

Etiology of generalized enamel hypoplasia

Generalized hypoplasia may arise from systemic disturbances [8-11]. These include maternal-fetal Rh incompatibility, prematurity and very low birth weight, nutritional deficiencies involving calcium, phosphorus, and vitamins A, D, or C, as well as febrile or infectious exanthems during the first year of life, such as measles, scarlet fever, or varicella. Prolonged high fever, maternal poisoning during pregnancy (often producing a pitting pattern), congenital allergies, radiation therapy, maternal rubella affecting primary teeth, chronic fluoride overexposure, congenital syphilis, hypocalcemia, and traumatic delivery have also been implicated. Overall, the causes of EH are categorized as either local or systemic.

Localized enamel hypoplasia

Localized EH results from disturbances to enamel formation that affect only specific teeth. Clinically, it appears as demarcated discolorations or scattered pits on the crown surface, most frequently involving the premolars [12]. The main causes include periapical infection of the predecessor primary tooth and trauma to primary teeth, which may result in “Turner’s tooth” in the permanent successor. Such defects are frequent in maxillary anterior teeth, but also occur in premolars due to their proximity to the roots of primary molars. Similar defects may follow laryngoscopy or intubation trauma during infancy, often involving the left maxillary anterior region. Other iatrogenic causes, such as surgery for cleft palate, and prolonged retention of primary teeth have also been reported [5,7,8,11].

Systemic enamel hypoplasia

Systemic etiologies affect all teeth developing at the time of the insult [13]. Knowledge of tooth mineralization timelines assists in approximating the timing of the causal event. Clinical presentations include well-demarcated defects in several teeth formed during the

same period, typically manifesting as white or yellow opacities with symmetric distribution, often asymptomatic. Moderate defects may appear as punctate pits, grooves, or wavy enamel surfaces that darken over time, while the enamel remains dense and smooth; striated patterns usually do not breach enamel integrity. The most severe form, aplasia, involves partial absence of enamel on the crown and is associated with pain in response to stimuli [13-15].

Neonatal endotracheal intubation (NEI)

Early recognition of congenital anomalies such as choanal atresia, esophageal atresia, and upper gastrointestinal obstructions is essential, as delayed diagnosis may lead to respiratory distress or fatal aspiration [16-18]. Standard neonatal assessment often includes passage of a tube through the nose into the esophagus and stomach to exclude obstructions and to suction gastric contents [19]. Neonatal endotracheal intubation (NEI) is a common, potentially life-saving procedure in delivery rooms and neonatal intensive care units [19,20]. However, the procedure carries risks such as apnea lasting more than 10 - 15 seconds, bradycardia with heart rates below 100 beats per minute, or cyanosis. A heart rate drop of more than 20 beats per minute is considered an adverse event related to intubation [19,21].

Recent literature highlights its potential oral and dental consequences. Bag., *et al.* (2021) reported that preterm births, representing approximately 6% of live births in developed countries, showed generalized EH in 40 - 70% of cases in the primary dentition, possibly linked to reduced bone mineral stores. Orofacial anomalies, such as crown dilacerations and palatal grooves, were also frequently reported and were often associated with traumatic laryngoscopy or prolonged intubation. Increased prevalence of early childhood caries (ECC) and ICDAS scores ≥ 2 have been documented in LBW infants, with maternal factors suggested as contributing influences [22].

Pamukcu., *et al.* (2020) conducted a survey of 94 neonatologists and 137 anesthesiologists regarding oral complications of orotracheal intubation and protective practices. Awareness of oral complications was high among both groups (95.7% for neonatologists and 83.2% for anesthesiologists). The most commonly reported injuries were oral and pharyngeal trauma (60.7%) and palatal grooving (52.2%). The preferred method of tube fixation was taping around the mouth (98.3%). Although more than half of respondents believed palatal stabilization devices could prevent complications, only 23.8% were aware of them and just 1.3% reported their use [23].

Noren., *et al.* (2015) examined 35 children in Sweden who had been intubated within the first three months of life, with a mean birth weight of 2950g. Enamel defects were identified in 74% of the children, including EH in 15 cases and EH with hypomineralization in 8 cases. Defects were predominantly observed in the right maxilla, suggesting that initial laryngoscope trauma was a likely etiologic factor [25].

Earlier studies estimated that 19% of premature infants weighed between 2000 and 2500g [30]. Historically, research focused mainly on heavier infants due to the high mortality of very low birth weight (VLBW) neonates, but advances in neonatal care now allow evaluation of smaller infants as well [1]. Since Stein's first description of preterm dentition in 1936 [1], reported EH prevalence has ranged from 20% to 32%. More recent studies in VLBW populations have found rates of developmental enamel defects-including EH, diffuse opacities, and mottling-between 52% and 96% [1,28].

EH is typically characterized by a loss of enamel continuity, reduced thickness, and the presence of multiple pits or grooves [27]. Proposed mechanisms include systemic disturbances of calcium homeostasis before and after birth, as well as local trauma from endotracheal intubation and mechanical ventilation during the neonatal period [27]. However, the relative contribution of prematurity versus intubation remains unclear [29]. Some recent evidence suggests that orotracheal tubes may directly induce dental malformations, enamel defects, tooth displacement, and delayed eruption or maturation in both primary and permanent dentitions, with longer intubation duration increasing the risk [24,26].

Aim of the Present Study

The aim of the present study was to isolate the effect of neonatal endotracheal intubation on enamel hypoplasia (EH) of primary teeth. To achieve this, children aged 3 to 5 years with and without a history of neonatal intubation, all with normal birth weight greater than 2500 g, were recruited from Bent-ol-Hoda Hospital in Bojnurd. By restricting the sample to normal birth weight infants, the confounding influence of low birth weight was minimized, thereby allowing a more focused examination of the association between neonatal intubation and the prevalence of EH.

Materials and Methods

This retrospective cohort study included children aged 3 to 5 years with normal birth weight greater than 2500g, born at Bent-ol-Hoda Hospital in Bojnurd, Iran. The study population was divided into two cohorts: Group 1 comprised children with a documented history of neonatal endotracheal intubation, while Group 2 included children with no history of intubation. All participants were subsequently recruited and clinically examined at the Faculty of Dentistry, Bojnurd.

Sample size

Based on prior work (e.g. Noren; expected prevalence of enamel hypoplasia 74% vs 40% in normal-weight children) and using $\alpha = 0.05$ and power $(1-\beta) = 0.90$, the minimum sample per group was calculated as:

$$\begin{aligned} \alpha &= 0.05 \\ 1 - \beta &= 0.90 \\ P_A &= 0.74 \\ P_B &= 0.40 \\ n &= \frac{P_A(1 - P_A) + P_B(1 - P_B)}{(Z_{1-\frac{\alpha}{2}} + Z_{1-\beta})^2 (P_A - P_B)^2} \sim 40 \text{ per group} \end{aligned}$$

Allowing for attrition, 45 children per group were targeted (total n = 90) [6].

Eligibility criteria

Inclusion

- Age 3-5 years at examination.
- Birth weight > 2500 g (normal)
- Born at Bent-ol-Hoda Hospital with accessible medical records.

Exclusion

- Birth weight < 2500g;
- Major conditions affecting dental development (e.g. severe neurologic disorders, significant congenital malformations);
- Maternal severe medical/psychiatric illness, HIV, alcohol/drug abuse; maternal age < 18 years [4];
- Chronic systemic disease in the child, severe neonatal jaundice requiring exchange transfusion;
- Inability to obtain complete hospital chart data; withdrawal of consent.

Timeframe and procedures

The study was conducted in Bojnurd (2020-2022; 1399-1401). After Ethics approval from North Khorasan University of Medical Sciences, hospital birth records for 2016-2018 (1395-1397) were screened to identify normal-weight neonates with/without intubation. Eligible families were contacted by phone. Following written informed consent (Appendix 2), parents were invited for an interview, questionnaire completion (Appendix 1), and clinical dental examination.

Clinical examination and outcome definition

Children were examined under clinical light using mouth mirror, disposable tongue depressor, and explorer, by a dentist under supervision of a pediatric dentistry specialist. The examiner assessed enamel hypoplasia (EH) in the primary dentition, recording the following signs [6]:

- Cavitations, small pits, depressions, grooves/fissures;
- White/chalky opacities;
- Yellow-brown opacities;
- Tooth arch/eruption disharmony compatible with EH.

The primary outcome was presence/absence of EH in primary teeth (binary). Where possible, lesion distribution was also noted.

Variables and operational definitions

The variable used in the study are listed in table 1.

Variable	Role	Scale	Operational definition/unit
Neonatal intubation	Exposure (independent)	Categorical (nominal)	Endotracheal intubation during the first postnatal month (Yes/No)
Duration of intubation	Exposure (dose)	Quantitative (continuous)	Total hours of orotracheal intubation
Enamel hypoplasia	Outcome (dependent)	Categorical (nominal)	Developmental enamel defects in primary teeth (present/absent)
Sex	Covariate	Categorical (nominal)	Male/Female

Table 1: Demographic and dental variables.

Data collection

A researcher-designed checklist (two sections) was used:

1. Demographics and perinatal data (mother and child): gestational age, sex, birth weight, etc.
2. Dental parameters: EH indicators.

Content validity was confirmed by two faculty experts in pediatric dentistry. Data collection commenced after formal letters of introduction to the hospital administration. Convenience sampling continued until the target size was reached. Presence/absence of EH was determined by clinical exam performed by the dentist and verified by the pediatric dentistry specialist. (If you'd like, we can add an inter-examiner reliability paragraph with kappa once you have duplicate scoring for a subset).

Statistical analysis

Descriptive statistics were reported as frequency (%) for categorical variables and mean (SD) for continuous variables. Between-group comparisons employed:

- Chi-square or Fisher’s exact test for categorical outcomes (e.g. EH prevalence);
- Independent t-test for continuous variables (e.g. intubation hours).

Two-sided $\alpha = 0.05$ defined statistical significance. Analyses were performed with SPSS v22.

Ethics

The protocol was approved by the Institutional Ethics Committee prior to data collection. (IR.NKUMS.REC1400.107). Study procedures were explained verbally in lay language to the parent/guardian; time was provided for questions. Written informed consent was obtained; a copy of the signed form (Appendix 2) was given to the guardian. Confidentiality was ensured; data were de-identified and not shared outside the research team. When a guardian could not read the form, a neutral third party read and explained it; in such cases the form bore the signatures/marks of the guardian, investigator, and third party. Participation was voluntary; families could withdraw at any time without consequence.

Results

A total of 60 children were enrolled, including 25 with a history of neonatal intubation and 35 without intubation. The overall mean age was 4.6 ± 0.49 years, and the sample consisted of 35 boys (58.3%) and 25 girls (41.7%). The mean birth weight was 2838.6 ± 423.8 g. Only 3 children (5.0%) presented with enamel hypoplasia (EH).

Demographic and clinical characteristics

There were no statistically significant differences between the two groups for sex ($p = 0.825$) or age distribution ($p = 0.593$). The prevalence of EH was similar: 8.0% in the intubated group vs 2.9% in the non-intubated group ($p = 0.565$). Table 2 summarizes the distribution of sex, age, and enamel hypoplasia according to intubation status.

Variable	With intubation (n = 25)	Without intubation (n = 35)	p-value
Sex			0.825
Girls	10 (40.0%)	15 (42.9%)	
Boys	15 (60.0%)	20 (57.1%)	
Enamel hypoplasia			0.565
No	23 (92.0%)	34 (97.1%)	
Yes	2 (8.0%)	1 (2.9%)	
Age			0.593
4 years	14 (56.0%)	22 (62.9%)	
5 years	11 (44.0%)	13 (37.1%)	

Table 2: Frequency of sex, presence of enamel hypoplasia, and age by intubation status (Chi-square test).

Birth weight and age comparison

Table 3 shows mean age and birth weight by group. The mean birth weight was $2932.2 \pm 476.6\text{g}$ in the intubated group and $2771.7 \pm 374.6\text{g}$ in the non-intubated group, with no statistically significant difference ($p = 0.150$). Age distribution also did not differ significantly ($p = 0.600$). Figure 1 illustrates the distribution of birth weight across the two groups, stratified by presence of enamel hypoplasia.

Variable	Group	N	Mean $\pm$ SD	Min	Max	p-value
Age (years)	Intubated	25	4.56 ± 0.51	4	5	0.600
	Non-intubated	35	4.63 ± 0.49	4	5	
	Total	60	4.60 ± 0.49	4	5	
Weight (g)	Intubated	25	2932.2 ± 476.6	2300	3940	0.150
	Non-intubated	35	2771.7 ± 374.6	2400	3600	
	Total	60	2838.6 ± 423.8	2300	3940	

Table 3: Comparison of mean age and birth weight between intubated and non-intubated children (Independent t-test).

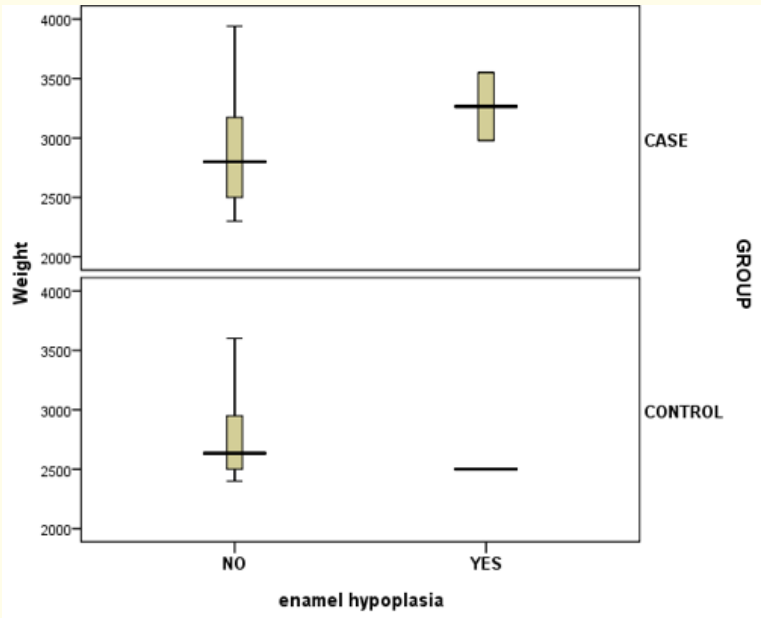


Figure 1: Illustrates the distribution of birth weight across the two groups.

Enamel hypoplasia by sex

As shown in table 4, the prevalence of EH did not differ significantly between boys and girls in either group. In the intubated cohort, two children (one boy, one girl) had EH, while in the control cohort, one girl had EH. No significant sex-related differences were observed ($p > 0.05$).

Sex	With intubation	Without intubation	p-value
Boys	1/10 (9.1%)	0/15 (0.0%)	0.850
Girls	1/14 (7.1%)	1/19 (5.3%)	0.571

Table 4: Prevalence of enamel hypoplasia by sex and intubation status.

Duration of intubation and EH prevalence

Table 5 presents the relationship between duration of intubation and enamel hypoplasia. Among the intubated children, 21 had a single-day intubation (2 developed EH), while 2 children were intubated for 4-5 days (none developed EH). The association between intubation duration and EH was not statistically significant (p = 0.184, Fisher’s exact test).

Duration of intubation	Without EH	With EH	p-value
1 day	21 (84.0%)	2 (8.0%)	0.184
4-5 days	2 (8.0%)	0 (0.0%)	

Table 5: Prevalence of enamel hypoplasia by intubation duration.

Discussion

Odontogenesis begins in the 6th-7th week of embryonic life and continues through adolescence. Throughout this period, systemic and local metabolic, physiological, and pathological events in both mother and child can influence tooth formation [1]. Neonatal endotracheal intubation, though often life-saving in infants with postnatal complications, has been implicated in disrupting odontogenesis and contributing to enamel hypoplasia (EH) [20]. EH results from incomplete enamel formation, leaving teeth structurally weak and susceptible to external insults. This defect facilitates bacterial penetration into dentin, promoting extensive caries and secondary involvement of dentin, cementum, and pulp [24,25]. Accordingly, this study was designed to assess the role of neonatal intubation in the development of enamel hypoplasia in the primary teeth of 3-5-year-old children with normal birth weight.

In this study, 60 children were evaluated, including 25 with a history of intubation and 35 without, with no significant differences in age, sex distribution, or mean birth weight, thereby ensuring comparability of the cohorts. The overall prevalence of enamel hypoplasia (EH) was low (5%), with 8% of children in the intubated group and 2.9% in the control group exhibiting EH, a difference that was not statistically significant and showed no association with sex. Duration of intubation also did not correlate with EH, although the very small number of EH-positive cases limited the possibility of meaningful subgroup analysis. To minimize confounding, the study was restricted to children with normal birth weight, excluding the effects of prematurity and low birth weight, both recognized risk factors for EH. The prevalence of EH observed in our study was markedly lower than that reported in studies involving preterm or low-birth-weight infants, where rates range from 18% to as high as 80% [32,33]. This supports the interpretation that prematurity and systemic disturbances around birth are major contributors to enamel defects.

By contrast, Noren., *et al.* (2015), in a study of children with a mean birth weight of 2950 g and a history of neonatal intubation, reported enamel defects in 74% of cases, including EH in 42.8% and hypomineralization in 22.8% [25]. The discrepancy with our findings may be explained by differences in sample size, intubation duration and technique, and diagnostic criteria for EH, while Noren’s observation of a higher prevalence of defects in the right maxilla supports the hypothesis of iatrogenic trauma from laryngoscopy as a potential mechanism.

Similarly, Melo (2014) reported enamel defects in 86.3% of intubated children (mean birth weight 1656g) compared with 13.7% of non-intubated children, with risk increasing in proportion to intubation duration [26]. Additional studies by Seow (1984) and Vello (2010) also demonstrated an association between orotracheal intubation duration and developmental defects of enamel [11,34]. In contrast, our study did not reveal a significant relationship between intubation duration and EH, a finding that likely reflects the low prevalence of EH in our cohort and the resulting limited statistical power, but may also suggest that advances in intubation techniques and neonatal care have reduced the risk of dental trauma compared with older reports. Operator technique, particularly the degree of rotational force applied during laryngoscopy, has also been identified as a factor influencing oral tissue injury [19].

From a clinical and biological perspective, intubation may cause trauma-induced EH, but systemic conditions remain highly relevant. Although modern neonatal care has improved survival among preterm infants, these children remain at risk for enamel defects due to systemic complications such as hypocalcemia, hypoxia, metabolic disturbances, vitamin deficiencies, and neonatal jaundice [35]. Bag., *et al.* (2021) emphasized that traumatic laryngoscopy and prolonged intubation can produce enamel hypoplasia and palatal malformations in preterm infants [22], while Kim., *et al.* (2019) reported EH to be six times more common in intubated neonates, affecting both primary and permanent dentition [24]. Other studies have further described enamel hypoplasia, delayed eruption, abnormal crown morphology, and pulp anomalies in children with repeated intubation [24,37]. In the present study, which included only normal-birth-weight children, no significant association between intubation and EH was found, suggesting that prematurity itself rather than intubation alone may represent the predominant etiologic factor. Supporting this, Nelson., *et al.* (2013) and Franco., *et al.* (2007) demonstrated strong associations between low birth weight (< 2500g, particularly < 1500g) and EH [4,27], while Gravina., *et al.* (2013) and Sayagh., *et al.* (2008) confirmed that very low birth weight was linked not only to EH but also to delayed eruption of primary teeth [13,14].

The strengths of this study include the careful selection of normal-birth-weight children to isolate the effect of intubation and the clinical evaluation by pediatric dental specialists using standardized criteria. However, limitations include the small sample size and the very low prevalence of EH, which reduced statistical power; reliance on retrospective chart data for intubation history; lack of microscopic or radiographic assessments to detect subclinical enamel changes; and unmeasured variability in intubation techniques across operators

Although our findings did not demonstrate a significant effect of neonatal intubation on EH in normal-birth-weight children, they do not exclude the possibility of subtle or long-term effects. Given that enamel defects can compromise esthetics, predispose to caries, and complicate restorative treatment, early dental monitoring of intubated children remains advisable. Pediatric dentists should collaborate with neonatologists to establish preventive protocols and provide parents with guidance on oral health care.

Limitations and Recommendations

This study had several limitations. The small sample size and, more importantly, the very low number of children affected by enamel hypoplasia, limited the statistical power and reduced the certainty of the findings. In addition, the study did not assess other developmental dental defects beyond enamel hypoplasia, nor did it incorporate advanced diagnostic tools such as SEM or radiographic imaging.

Based on these limitations, the following recommendations are proposed:

- Future research should involve larger multicenter cohorts to improve statistical power and allow for stratified analyses by factors such as intubation duration, technique, and neonatal complications.
- Studies should consider evaluating other developmental dental defects (DDEs), including hypomineralization, delayed eruption, and crown morphology abnormalities.
- Prospective *in vivo* studies with long-term follow-up are recommended to better assess the cumulative effects of neonatal intubation on both primary and permanent dentitions.

- Incorporating microscopic and imaging-based assessments (e.g. SEM, micro-CT) may provide deeper insights into subtle structural changes not detectable by visual inspection alone.
- Collaboration between pediatric dentists and neonatologists is encouraged to identify high-risk children early and establish preventive oral health strategies.

Conclusion

The present retrospective cohort study evaluated the relationship between neonatal endotracheal intubation and the prevalence of enamel hypoplasia (EH) in primary teeth of children aged 3-5 years with normal birth weight. The key findings can be summarized as follows:

1. No significant association was found between neonatal intubation and the occurrence of enamel hypoplasia. The prevalence of EH was 8% in the intubated group compared to 2.9% in the non-intubated group.
2. Duration of intubation showed no statistically significant correlation with the prevalence of enamel hypoplasia.
3. Child's sex was not associated with the presence of enamel hypoplasia.

These findings suggest that, in children with normal birth weight, neonatal intubation alone may not be a strong independent risk factor for enamel hypoplasia. Other etiological factors, particularly those related to prematurity and systemic neonatal complications, may play a more decisive role.

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