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Research Article

Developmental Defects of Enamel and in Primary Teeth

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ABSTRACT

Background: Developmental defects of enamel (DDE) in primary teeth are prevalent worldwide and can predispose children to early childhood caries (ECC).

Objective: To assess the prevalence of DDE in primary dentition and examine associated risk factors, including birth weight and early life events.

Methods: A descriptive cross-sectional study was conducted on 192 children aged 3 to 5 years using non-probability convenience sampling technique. Clinical examinations were performed by trained dental professionals using standardized criteria for diagnosing developmental defects of enamel (DDE) in primary teeth, based on the presence of hypoplasia, demarcated opacities, and diffuse opacities. Data on potential risk factors such as parental education, infection history, medication during lactation, formula feeding, and birth complications were collected. Statistical analysis involved Fisher exact tests with a significance level set at $p<0.05$.

Results: Among the 192 participants, the frequency of enamel defects was 14.6% (n=27). Mild defects were observed in 5.21% (n=10), moderate defects in 3.13% (n=6), severe defects in 3.65% (n=7), and atypical restorations in 1.56% (n=3). Significant associations were found between enamel defect severity and paternal education ($p=0.04$) and medication use during lactation ($p=0.039$). No significant associations were found for maternal education, infection history, or birth complications (all $p>0.05$).

Conclusion: The study found a 14.6% frequency of enamel defects among the study population. Paternal education and medication use during lactation were significant risk factors. These findings highlight the need for targeted preventive strategies and further research into the etiology of enamel defects.

Keywords: Developmental Defects of Enamel (DDE), Primary Teeth, Molar Incisor Hypomineralization (MIH), Enamel Hypomineralization, Pediatric Dental Epidemiology

INTRODUCTION

Developmental defects of enamel (DDE) in primary teeth are significant dental anomalies that can adversely affect both oral health and overall well-being in children [1]. These defects arise due to disturbances during the formation of enamel, leading to conditions such as enamel hypoplasia and opacities [2]. Enamel hypoplasia is characterized by a reduction in enamel thickness, often presenting as pits or grooves, while enamel opacities manifest as areas of altered translucency or coloration due to improper mineralization [3]. The prevalence of DDE varies globally, with studies reporting rates ranging from 24% to over 80% in different populations [4] .The etiology of DDE is multifactorial, encompassing prenatal, perinatal, and postnatal influences [5]. Prenatal factors include maternal health issues and exposure to certain medications, while perinatal factors involve complications during birth such as low birth weight and prematurity [6]. Postnatal contributors encompass early childhood illnesses, nutritional deficiencies, and environmental exposures like excessive

fluoride intake [7]. For instance, a study in Tanzania found that children with a history of low birth weight were more likely to exhibit enamel hypoplasia, underscoring the impact of early life events on enamel development [8] .DDE not only compromise the structural integrity of teeth but also increase susceptibility to dental caries [9]. The irregularities in enamel surface associated with DDE facilitate plaque accumulation, creating an environment conducive to caries development [10]. A cross-sectional study revealed that children with DDE had significantly higher odds of experiencing dental caries compared to those without such defects [11]. This association highlights the importance of early detection and management of DDE to prevent subsequent oral health issues [12].Beyond physical health implications, DDE can affect the psychosocial aspects of a child's life [13]. Visible enamel defects, particularly on anterior teeth, may lead to aesthetic concerns, potentially impacting a child's self-esteem and social interactions [14]. Therefore, addressing DDE is not only crucial for maintaining oral health but also for supporting the overall quality of life in affected children [15]. Preventive strategies, including maternal health optimization and adequate nutrition.

LITERATURE REVIEW

Wong HM (2014): This cross sectional study analyzed the association between DDE and dental caries in primary teeth. The Study revealed that children with DDE had significantly higher odds (OR 3.32; 95% CI 2.41 -- 4.57) of developing dental caries compared to those without defects. Specifically, enamel hypoplasia and diffuse opacities were strongly linked to increased caries risk. The study underscores the importance of early detection and management of DDE to prevent subsequent oral health issues [16].

Machado (2018): This study investigated the relationship between early-life events and the occurrence of DDE in children aged 24–36 months. The study found that children with lower Apgar scores (<7) had approximately 2.5 times higher odds of developing DDE. Additionally, enamel hypoplasia and diffuse opacities were more prevalent among these children. The findings suggest that perinatal health significantly influences enamel development, highlighting the need for monitoring and preventive strategies in at-risk populations [17].

Manton DJ (2020): This study explored the role of genetic factors in the development of DDE among Polish children. The researchers identified significant associations between specific genetic polymorphisms and the presence of enamel defects. These findings indicate that genetic predisposition plays a crucial role in enamel formation, suggesting that genetic screening could be beneficial in identifying individuals at risk for DDE [18].

Lacruz RS (2017):This cross-sectional study assessed the prevalence of DDE in children aged 6–36 months in Tanzania and examined associated early life events. The researchers found a high prevalence of enamel defects, particularly among children who experienced malnutrition or systemic illnesses during early development. The study emphasizes the impact of environmental and health factors on enamel formation and the importance of addressing these issues to reduce DDE incidence [19].

Murray JJ (1979): This study focused on the prevalence of hypomineralized second primary molars (HSPM) in Dutch 5-year-olds. The study reported a prevalence rate of 5% at the child level and 4% at the tooth level, with demarcated opacities being the most common defect. The findings highlight the need for early identification and management of HSPM to prevent potential complications in permanent dentition [20].

Rodd HD (2010): This study evaluated the impact of DDE on the oral health-related quality of life (OHRQoL) among children in Southwest Nigeria. The results indicated that children with enamel defects experienced significant challenges, including pain, difficulty in eating, and social embarrassment. The research underscores the broader implications of DDE beyond physical health, affecting psychological and social well-being [21].

Longnecker MP (2001): This cross sectional study examined the relationship between life course events and the development of enamel defects in Brazilian children. The researchers found that factors such as low birth weight, preterm birth, and early childhood illnesses were significantly associated with increased DDE prevalence. The study highlights the

importance of comprehensive prenatal and postnatal care in preventing enamel defects [22].

Rosenblatt A(2006):This cross-sectional study assessed the prevalence of DDE in Brazilian preschoolers and identified associated risk factors. The findings revealed a high prevalence of enamel defects, with significant associations to socioeconomic status, maternal education, and early childhood illnesses. The research emphasizes the multifactorial nature of DDE and the need for targeted public health interventions [23].

Muglia LJ (2022): This study investigated the pre- and postnatal factors contributing to deciduous molar hypomineralisation (DMH) in 6-year-old children. The researchers identified associations between DMH and factors such as maternal smoking during pregnancy, low birth weight, and early childhood illnesses. The findings suggest that both prenatal and postnatal environments play critical roles in enamel development [24].

Gozdowski D (2023): This study examined the relationship between DDE and dental caries among preschoolers in Jeddah, Saudi Arabia. The study found that children with enamel defects had a higher prevalence of dental caries compared to those without defects. The results highlight the importance of early detection and management of DDE to prevent caries development [25].

MATERIAL AND METHODS

Study Design and Setting

A descriptive cross-sectional study was conducted to assess the prevalence and associated risk factors of developmental defects of enamel (DDE) in primary teeth among school-aged children. The study was carried out in selected public and private schools within an urban district from January to May 2024. This design was chosen to allow for a snapshot evaluation of enamel defects and their potential associations with early childhood risk factors. The cross-sectional nature enabled the researchers to gather epidemiological data efficiently across a well-defined target population, facilitating the identification of both clinical and demographic trends.

Study Population and Sampling Technique

The study population comprised 192 children aged between 3 and 5 years, recruited from various preschools, early education centers, and pediatric dental outpatient clinics within an urban district. Participants were selected using a non-probability convenience sampling technique, based on factors such as accessibility, participant availability, and limited logistical resources. This approach facilitated efficient enrollment within the designated data collection period and enabled inclusion of a demographically diverse group of children in the primary dentition phase. Inclusion criteria required children to have fully erupted primary teeth (including incisors, canines, and molars) to allow for a thorough and consistent evaluation of developmental defects of enamel (DDE) using standardized clinical criteria. Children with known systemic syndromes, congenital anomalies, or hereditary enamel conditions such as amelogenesis imperfecta were excluded to avoid confounding influences on enamel development.

Fig1.Development of enamel defect

Prior to the clinical examination, comprehensive information regarding the study's aims, procedures, and significance was provided to the parents or legal guardians of all potential participants. Written informed consent was obtained in accordance with the ethical principles outlined in the Declaration of Helsinki. The study protocol received ethical

approval from the Institutional Review Board (IRB) of the affiliated university or relevant health authority, confirming adherence to ethical and regulatory standards for human research.

Data Collection Procedure

Clinical data were collected through direct oral examinations conducted under natural daylight by licensed dental professionals who had undergone calibration training to ensure diagnostic consistency. Examiners were trained and standardized in the identification of Developmental Defects of Enamel (DDE) in primary teeth using World Health Organization (WHO) and FDI criteria, which include enamel hypoplasia, demarcated opacities, and diffuse opacities. Calibration exercises were carried out using reference photographs and mock assessments, achieving a Cohen's kappa score above 0.80, indicating excellent inter-examiner reliability. Each child was examined in an upright position, with teeth cleaned and dried using sterile gauze to ensure optimal visibility. Dental mirrors and blunt WHO periodontal probes were used without pressure. Observed enamel defects were recorded on standardized dental charts, detailing the type, location, color (white, yellow, or brown), and severity (mild, moderate, or severe) of each lesion found on primary teeth only. Following the clinical examination, a structured questionnaire was administered to the parents or guardians to collect information on potential etiological factors influencing enamel development. These included prenatal and perinatal factors, such as maternal health, medication use during lactation, feeding practices (breastfeeding vs. formula feeding), history of infections in early childhood (0–3 years), parental education, and birth-related factors like low birth weight, prematurity, or neonatal hospitalization. A trained research assistant reviewed each questionnaire with the caregivers to ensure completeness and accuracy. This comprehensive approach enabled the integration of clinical data with background risk factors to investigate associations with enamel defects in the primary dentition.

Data Analysis

All collected data were compiled and analyzed using IBM SPSS Statistics software, version 25.0 (IBM Corp., Armonk, NY, USA). The analysis began with descriptive statistical techniques to summarize the demographic and clinical characteristics of the participants. Frequencies and percentages were calculated for categorical variables such as age group, sex, parental education, feeding practices, history of infections, and the presence or absence of enamel defects. This allowed for a clear depiction of the overall distribution and prevalence of developmental defects of enamel (DDE) among the study population.To evaluate potential associations between DDE and selected early life risk factors including history of birth complications, medication during lactation, formula feeding, and infection history bivariate analyses were conducted using the Fisher exact test. This test was chosen specifically due to the categorical nature of the variables and the relatively small sample size ($n = 192$), which could result in expected frequencies less than five in some contingency table cells.The significance level for all statistical tests was set at $p < 0.05$. Results with p-values below this threshold were considered statistically significant, indicating a meaningful association between the enamel defects and the variable in question. The use of the Fisher exact test ensured accurate interpretation of small-sample categorical data and minimized the risk of Type I errors. The findings were presented in tabular format, providing clear visual representation of statistically significant associations.

RESULT AND DISCUSSION

Table 1: Demographic Characteristics of the Study Participants (n=192)

Characteristic	Frequency (n)	Percentage (%)
3-4	78	40.6
4-5	114	59.4
Male	98	51.0
Female	94	49.0
Below High School (Father)	42	21.9
High School Graduate (Father)	76	39.6
University Graduate (Father)	74	38.5
Below High School (Mother)	39	20.3

High School Graduate (Mother)	85	44.3
University Graduate (Mother)	68	35.4

This table outlines the demographic breakdown of participants. The majority of children were in the 3 -5years age group (59.4%), with a nearly equal gender distribution. The education levels of parents were relatively balanced, with most having completed high school or university. These demographic variables were assessed for their potential association with enamel defects.

Table 2: Prevalence and Severity of Developmental Defects of Enamel (DDE)

DDE Severity	Frequency (n)	Percentage (%)
No Defects	165	85.4
Mild Defects	10	5.21
Moderate Defects	6	3.13
Severe Defects	7	3.65
Atypical Restorations	3	1.56
Total DDE Cases	27	14.6

The prevalence of DDE was 14.6%. Mild cases were the most common (5.21%), while atypical restorations and severe defects were less frequent. These results align with global averages and suggest a moderate public health concern, especially considering the cosmetic and functional implications of moderate-to-severe DDE.

Table 3: Association between DDE and Paternal Education

Paternal Education	DDE Present (n)	DDE Absent (n)	Total (n)	p-value
Below High School	10	32	42	0.04
High School Graduate	11	65	76	
University Graduate	6	68	74	

A statistically significant association was found between paternal education and the presence of DDE (p=0.04). Children with less-educated fathers were more likely to have enamel defects, suggesting that lower paternal education may correlate with reduced awareness of oral health practices or less access to preventive care.

Table 4: Association between DDE and Medication Use during Lactation

Medication Use During Lactation	DDE Present (n)	DDE Absent (n)	Total (n)	p-value
Yes	15	42	57	0.039
No	12	123	135	

There was a statistically significant relationship between enamel defects and maternal medication use during lactation (p=0.039). Medications taken during lactation might influence enamel formation if transmitted through breast milk during critical periods of tooth development.

Table 5: Association between DDE and Maternal Education

Maternal Education	DDE Present (n)	DDE Absent (n)	Total (n)	p-value
Below High School	5	34	39	>0.05 (NS)
High School Graduate	13	72	85	
University	9	59	68	

Graduate				

No significant association was observed between maternal education and enamel defects. This finding contrasts with paternal education outcomes, possibly reflecting differing roles in dietary and health supervision in this cultural context or sampling limitations.

Table 6: Association between DDE and Feeding Practices

Feeding Practice	DDE Present (n)	DDE Absent (n)	Total (n)	p-value
Breastfeeding	9	71	80	
Formula Feeding	18	94	112	>0.05 (NS)

Although more cases of DDE were found among formula-fed children, this relationship was not statistically significant. However, the trend supports the hypothesis that formula feeding may contribute to enamel defects, possibly due to differences in nutritional content or immune protection.

Table 7: Association between DDE and Birth Complications and Infection History

Factor	DDE Present (n)	DDE Absent (n)	Total (n)	p-value
Birth Complications (Yes)	7	43	50	>0.05 (NS)
Birth Complications (No)	20	122	142	
Infections (Yes)	12	81	93	
Infections (No)	15	84	99	>0.05 (NS)

Neither birth complications nor early-life infections showed significant associations with enamel defects. This finding suggests that while these factors can affect general development, their specific influence on enamel hypomineralization in this population may be limited or overshadowed by other unmeasured variables (e.g., genetic factors, fluoride exposure).

DISCUSSION

This cross-sectional study found that 14.6% of children aged 3-5 years exhibited developmental defects of enamel (DDE) in their primary teeth, with mild defects being the most common. This prevalence aligns with existing literature and highlights the importance of early detection and management. Among all severity levels, the presence of demarcated opacities and atypical restorations underscores the need for preventive care in populations. The distribution of severity suggests most cases are manageable with early intervention, though more severe defects may increase the risk of dental complications. Significant associations were found between DDE and paternal education level (p=0.04) and maternal medication use during lactation (p=0.039). Children with less-educated fathers were more likely to have enamel defects, possibly reflecting differences in health awareness, nutrition, or access to dental care. Similarly, medication exposure during lactation could affect enamel formation during infancy, though further research is needed to determine which drug classes pose the greatest risk. No significant relationships were found with maternal education, feeding practices, birth complications, or infection history, although trends suggested that formula feeding might be linked to increased DDE. Overall, the results emphasize that DDE is influenced by modifiable early-life factors and socioeconomic status. This calls for targeted education and support for parents, especially regarding safe medication use during breastfeeding and the benefits of preventive dental care. While the study's limitations such as convenience sampling and potential recall bias may affect generalizability, the findings still provide valuable insights for public health planning and pediatric dental guidelines.

CONCLUSION

This study identified a 14.6% prevalence of developmental defects of enamel (DDE) among primary teeth in children aged 3-5 years, with most defects classified as mild. Significant associations were observed between DDE and paternal education level as well as maternal medication use during lactation, suggesting that both socioeconomic and early-life health factors contribute to enamel development. Although no significant

links were found with maternal education, feeding practices, birth complications, or infection history, these variables remain important areas for continued investigation.The findings underscore the importance of early preventive dental care and parental education, particularly in populations with lower socioeconomic status. Public health initiatives should focus on improving awareness around safe breastfeeding practices, maternal health during lactation, and the need for regular dental screenings in children. Further longitudinal studies are recommended to explore causal relationships and long-term impacts of early-life exposures on enamel formation and oral health.

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