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**Orginal Article**

# FREQUENCY AND RISK FACTORS OF DEVELOPMENTAL DEFECTS OF ENAMEL - A CROSS SECTIONAL STUDY

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## ABSTRACT

***Objectives:*** *To determine the frequency and risk factors for enamel defects in patients reporting to Saidu College of Dentistry, Swat.*

***Materials and Methods:*** *This descriptive cross-sectional study was conducted on 192 children aged 8 to 12 years was determined using non-probability consecutive sampling. Clinical examinations were performed by trained dental professionals using diagnostic criteria of Molar Incisor Hypomineralization (MIH) based on the presence or absence of demarcated opacities for diagnosing enamel defects. 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=0.4) and medication use during lactation (p=0.039). No significant associations were found for maternal education, infection history, or birth complications with 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.*

***Key words:*** *Enamel defects, Risk factors, Pediatric dentistry*

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## INTRODUCTION

Enamel, the hardest and most mineralized tissue in the human body, is crucial for the protection and functionality of teeth. It covers the crown of each tooth, providing a durable shield against mechanical forces from chewing and chemical attacks from acidic foods and bacteria[1]. Composed predominantly of hydroxyapatite crystals, enamel's unique structure is vital for its strength and resilience[2]. The development of enamel, or amelogenesis, begins in utero and continues postnatally, involving a complex process of matrix secretion and mineralization orchestrated by ameloblasts[3]. Any disruption in this finely tuned process can result in developmental defects[4]. Proper enamel formation ensures not only the aesthetic appearance of teeth but also their long-term health and function[5].

Developmental defects of enamel (DDE) represent a significant concern in pediatric dentistry, impacting both dental aesthetics and functionality[6]. Enamel, the outermost layer of the tooth, is crucial

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for protecting the underlying dentin and pulp from mechanical and chemical damage[7]. DDE can manifest as hypoplasia, hypocalcification, or hypomaturation, leading to compromised structural integrity and increased susceptibility to caries and wear[8].

Studies have identified various potential risk factors for developmental defects of enamel (DDE), such as low socio-economic status, respiratory infections, cigarette smoke exposure, asthma, otitis media, urinary tract infections, chickenpox, and early life health problems. However, these associations are frequently disputed[9]. For instance, while some research links the use of amoxicillin to an increased risk of DDE, other studies, such as one involving Western Australian children, found no such connection. Similarly, conflicting results exist regarding the impact of otitis media, chickenpox, and maternal factors on enamel development[10].

Children in Swat may be at particular risk for enamel defects due to regional health disparities, limited access to dental care, and potential nutritional deficiencies common in rural areas. This study fills gaps in existing literature by focusing on a defined population in Swat, addressing region-specific concerns like local dietary habits and environmental factors that contribute to developmental dental defects (DDE). By identifying the primary risk factors, the study aims to improve clinical practices and inform public health policies, ultimately enhancing oral health outcomes for future generations in the region. This study addresses limitations in prior research by focusing on a defined population in Swat and incorporating factors like paternal education and medication use during lactation, which were often overlooked. It also ensures reliable clinical assessments through the use of validated diagnostic tools and experienced clinicians, offering more accurate, region-specific information into enamel defect risk factors.

The objective of this study was to determine the frequency and risk factors for enamel defects in patients reporting to Saidu College of Dentistry, Swat.

## MATERIALS AND METHODS

The study was designed as a descriptive cross-sectional investigation conducted over eight months, from October 1, 2023, to May 29, 2024. A non-probability consecutive sampling technique was employed, with ethical approval obtained from the hospital. Written informed consent was secured from all participants or their guardians if they were below 18 years of age. The calculated sample size was 192, determined using OpenEpi with a 5% margin of error and a 95% confidence level, based on a previously reported enamel defect frequency of 14.6%[11]. The inclusion criteria included children aged 8 to 12 years, of both genders, who were Pakistani nationals and willing to participate. Exclusion criteria encompassed participants with direct restorations, fractured teeth due to trauma, fixed orthodontic appliances, heavily restored teeth, or severely decayed teeth.

Data collection involved thorough clinical examinations conducted by trained dental professionals to accurately identify surface enamel defects. The examination process utilized light illumination to enhance visibility, mouth mirrors to reflect light and provide a clear view of the teeth, and dental explorers to gently probe and detect irregularities on the enamel surface. This meticulous approach ensured precise identification and assessment of any developmental defects present. The diagnostic criteria adhered to the standards set forth by the European meeting on Molar Incisor Hypomineralization (MIH) held in Athens in 2003. These criteria provided a comprehensive framework for diagnosing enamel defects and included several key indicators: 1) Presence or Absence of Demarcated Opacities: This criterion involved identifying distinct, well-defined areas of discoloration on the enamel, which could range in color from white to yellow or brown. These opacities indicate regions where the enamel has not developed properly. 2) Post-Eruptive Enamel Breakdown: This refers to the physical degradation of enamel that occurs after the tooth has erupted. Such breakdowns are typically found in areas where the enamel is weakened due to developmental defects, leading to increased susceptibility to wear and fracture. 3) Atypical Restorations: These are dental restorations that deviate from typical patterns, often used to repair teeth affected by MIH. Identifying atypical restorations helps in diagnosing DDE as these restorations are usually necessitated by underlying enamel defects. 4) Extraction of Molars Due to MIH: In some cases, the enamel defects are so severe that affected molars need to be extracted. This criterion considers past dental history, where extractions have occurred specifically due to the impact of MIH on

tooth integrity. 5) Failure of Eruption of a Molar or Incisor: This involves cases where a molar or incisor fails to erupt properly, often due to underlying developmental issues with the enamel that impede normal tooth eruption. The study used a validated diagnostic tool, with senior clinicians undergoing extensive training to ensure inter-examiner reliability. Medication use and birth complications were assessed through patient history.

Statistical analysis was carried out in R software. Descriptive statistics were computed. chi-square/ Fisher exact (if any cell has <20% count) tests to compare the distribution of risk factors (Mother education, Father education, Infection history, Medication lactation, Feeding milk formula, Complication during birth) across different types of enamel defects (Atypical restorations, Mild, Moderate, Severe). $p<0.05$ was used as significant level.

## RESULT

TIn our study cohort of 192 participants, the mean age was 10.06 years (SD ±1.371). Gender distribution showed a slight predominance of males, comprising 57.81% (n=111), compared to females at 42.19% (n=81). Maternal education levels varied, with a majority having attained a master's degree (59.16%, n=113), followed by those who were illiterate (27.75%, n=54). Paternal education primarily consisted of individuals with a master's degree (64.58%, n=124), while a smaller proportion were illiterate (16.15%, n=31). (Table 1) Overall the frequency of enamel defects was 27(14.6%). (Fig 1)

This most common mild defects in 5.21% (n=10), followed by moderate defects in 3.13% (n=6), severe defects in 3.65% (n=7), and atypical restorations in 1.56% (n=3) of individuals. (Fig 2)

Table 2 presents the distribution of potential risk factors for enamel defects among 27 participants Maternal education levels varied significantly, with the majority of mothers being illiterate (92.59%, n=25), while a small proportion had achieved either a master's degree (3.70%, n=1) or matriculation level education (3.70%, n=1). Paternal education similarly showed a predominant trend towards illiteracy (62.96%, n=17), followed by those with a master's degree (7.41%, n=2) and matriculation (29.63%, n=8). Regarding infection history, 44.44% (n=12) of participants reported a history of infections, whereas 55.56% (n=15) did not. Medication use during lactation was reported by 48.15% (n=13) of participants, while 33.33% (n=9) did not use medication, and 18.52% (n=5) were uncertain about their medication status. The use of feeding milk formula was evenly split, with 51.85% (n=14) reporting its use and 48.15% (n=13) not using it. Complications during birth were noted by 37.04% (n=10) of participants, whereas 51.85% (n=14) reported no complications and 11.11% (n=3) were uncertain about birth complications.

Table 3 presents the comparison of risk factors stratified by different types of enamel defects among our study participants. The distribution of maternal education across enamel defect types showed no

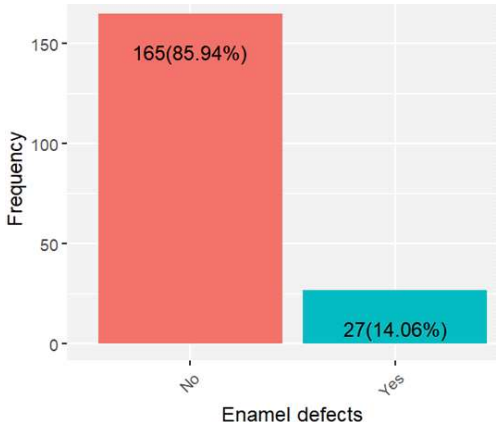


**Fig 1: Distribution of enamel defects**

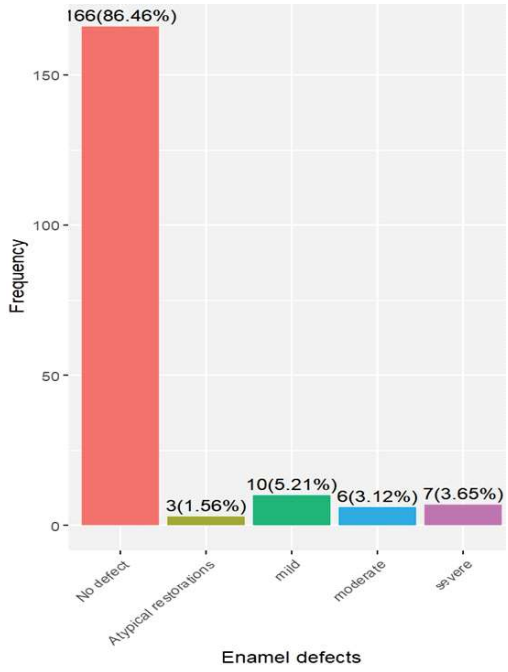


**Fig 2: Type of enamel defects among children**

statistically significant differences (p =0.99). Among participants with atypical restorations, all had mothers who were illiterate (100.00%, n=3), while in other defect categories, maternal education varied similarly. Paternal education exhibited a significant association with enamel defect severity (p = 0.4), with a higher proportion of illiteracy observed among those with severe defects (85.71%, n=6). Infection history did not show significant associations across enamel defect types (p = 0.7), although a trend towards higher infection rates was noted among participants with no enamel defects (71.43%, n=5). Medication use during lactation displayed a significant association (p=0.04), with all participants with atypical restorations reporting medication use (100.00%, n=3). Conversely, complications during birth did not significantly vary across defect types (p = 0.3), despite a higher prevalence observed among those with moderate defects (83.33%, n=5).

## DISCUSSION

In our study cohort of 192 participants, the mean age was 10.06 years. Gender distribution showed a slight predominance of males. Maternal education levels varied, with the majority having attained a master's degree, followed by those who were illiterate. Paternal education primarily consisted of individuals with a master's degree, while a smaller proportion was illiterate. Maternal education levels among participants with enamel defects showed that most mothers were illiterate, while a few had achieved higher education levels. Similarly, a significant number of fathers were illiterate, with fewer having higher education. Other studies also show that dental problems are most common in parents' with low educational level[12].

The overall frequency of enamel defects in the study population was 14.6%. The most common type of enamel defect was mild, followed by severe, moderate defects, and atypical restorations. A study was conducted in Spain on 1414 healthy school children and reported that that prevalence of enamel defects was 40.2% in primary dentition and 52% in permanent dentition[13]. Another study conducted in Chin on 514 children and reported that opacities in enamel was 8.6%[14]. The difference in results may be due to variations in population characteristics, diagnostic criteria, and regional factors such as health disparities and nutritional differences between the study areas.

Infection history revealed that nearly half of

**Table 1: Distribution of age, gender, mother's education and father's education**

| Characteristic | N = 192 |
|---|---|
| Age (years) | 10.06±1.371 |
| **Gender** | |
| Female | 81 (42.19) |
| Male | 111 (57.81) |
| **Mother education** | |
| Illiterate | 54 (27.75) |
| Intermediate | 21 (10.99) |
| Master | 113 (59.16) |
| Matric | 4 (2.09) |
| **Father education** | |
| Higher | 4 (2.08) |
| Illiterate | 31 (16.15) |
| Intermediate | 25 (13.02) |
| Master | 124 (64.58) |
| Matric | 8 (4.17) |

**Table 2: Distribution of risk factors for enamel defects among children**

| Characteristic | N = 27 |
|---|---|
| **Mother's education** | |
| Illiterate | 25 (92.59) |
| Master | 1 (3.70) |
| Matric | 1 (3.70) |
| **Father's education** | |
| Illiterate | 17 (62.96) |
| Master | 2 (7.41) |
| Matric | 8 (29.63) |
| **Infection history** | |
| No | 15 (55.56) |
| Yes | 12 (44.44) |
| **Medication during lactation** | |
| No | 9 (33.33) |
| Don't know | 5 (18.52) |
| Yes | 13 (48.15) |
| **Use of feeding milk formula** | |
| No | 13 (48.15) |
| Yes | 14 (51.85) |
| **Complications during birth** | |
| No | 14 (51.85) |
| Don't know | 3 (11.11) |
| Yes | 10 (37.04) |

* n (%)

**Table 3: Comparison of risk factors by type of enamel defects among children**

| Characteristic | Atypical restorations, N = 3 | Mild, N = 11 | Moderate, N = 6 | Severe, N = 7 | p-value* |
|---|---|---|---|---|---|
| **Mother's education** | | | | | |
| Illiterate | 3 (100.00) | 9 (81.82) | 6 (100.00) | 7 (100.00) | 0.99 |
| Master | 0 (0.00) | 1 (9.09) | 0 (0.00) | 0 (0.00) | |
| Matric | 0 (0.00) | 1 (9.09) | 0 (0.00) | 0 (0.00) | |
| **Father's education** | | | | | |
| Illiterate | 3 (100.00) | 5 (45.45) | 3 (50.00) | 6 (85.71) | 0.4 |
| Master | 0 (0.00) | 2 (18.18) | 0 (0.00) | 0 (0.00) | |
| Matric | 0 (0.00) | 4 (36.36) | 3 (50.00) | 1 (14.29) | |
| **Infection history** | | | | | |
| No | 2 (66.67) | 5 (45.45) | 3 (50.00) | 5 (71.43) | 0.7 |
| Yes | 1 (33.33) | 6 (54.55) | 3 (50.00) | 2 (28.57) | |
| **Medication during lactation** | | | | | |
| No | 0 (0.00) | 4 (36.36) | 4 (66.67) | 1 (14.29) | 0.04 |
| Don't know | 0 (0.00) | 4 (36.36) | 1 (16.67) | 0 (0.00) | |
| Yes | 3 (100.00) | 3 (27.27) | 1 (16.67) | 6 (85.71) | |
| **Use of feeding milk formula** | | | | | |
| No | 2 (66.67) | 4 (36.36) | 3 (50.00) | 4 (57.14) | 0.7 |
| Yes | 1 (33.33) | 7 (63.64) | 3 (50.00) | 3 (42.86) | |
| **Complications during birth** | | | | | |
| No | 2 (66.67) | 5 (45.45) | 5 (83.33) | 2 (28.57) | 0.3 |
| Don't know | 0 (0.00) | 1 (9.09) | 1 (16.67) | 1 (14.29) | |
| Yes | 1 (33.33) | 5 (45.45) | 0 (0.00) | 4 (57.14) | |

*Fisher exact test

the participants with enamel defects had a history of infections, indicating a potential link between systemic infections and enamel development. The trend towards higher enamel defect rates among children with a history of infections underscores the role of systemic health in dental development. Infections during critical developmental periods may disrupt enamel formation, leading to defects. Previous studies shows positive association between infection and enamel defects[14,15].

Medication use during lactation was also common among participants with enamel defects, suggesting that certain medications may impact dental health. This indicates that certain medications taken by mothers during lactation could adversely affect enamel formation in children. Previous literature documented positive role of medications in the development of enamel defects[16,17].

The use of feeding milk formula and complications during birth were evenly distributed among those with enamel defects, pointing to these as potential contributing factors. Similar findings were found in previous study[14].

Paternal education showed a significant association with enamel defect severity, with a higher proportion of severe defects observed among children of illiterate fathers. This suggests that socioeconomic factors, reflected in lower paternal education levels, may contribute to more severe enamel defects due to limited access to dental care and nutritional deficits. The significant association between medication use during lactation and enamel defects, especially atypical restorations, points to the potential impact of certain drugs on dental development. This warrants further research to identify specific medications that pose risks and develop guidelines for safer medication practices during lactation[18].

Complications during birth did not significantly vary across enamel defect types, although there was a higher prevalence among those with moderate defects. This suggests that birth complications may impact enamel development, but their effect may

not be uniformly strong across all types of defects. Previous study reported similar findings[9].

The high prevalence of enamel defects among children of illiterate parents, particularly fathers, suggests that socioeconomic factors and education significantly influence dental health outcomes. Lower educational attainment may correlate with reduced health literacy, limited access to healthcare resources, and lower prioritization of preventive dental practices.

A limitation of this study is the reliance on self-reported data for risk factors such as medication use during lactation and birth complications. This can introduce recall bias, as participants or their guardians may struggle to accurately recall or may unintentionally provide incorrect information. These inaccuracies could affect the reliability of the data, particularly for factors that are difficult to remember or quantify, such as specific medications or the timing of birth complications. While structured questionnaires were used to minimize bias, this remains an important consideration when interpreting the results.

## CONCLUSION

The overall frequency of enamel defects was 14.6%. Mild defects were the most common, followed by moderate, severe defects, and atypical restorations. Our analysis revealed significant associations between the severity of enamel defects and paternal education as well as medication use during lactation. Specifically, a higher proportion of severe defects was observed among children with illiterate fathers, and all participants with atypical restorations reported medication use during lactation. Maternal education, infection history, and birth complications did not show statistically significant associations with enamel defect types.

It is recommended to raise awareness among fathers with low education about the risks of enamel defects and to advise mothers on the impact of medication use during lactation. Further research is needed to explore the role of maternal education, infection history, and birth complications in enamel defect.

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CONFLICT OF INTEREST
Authors declare no conflict of interest.
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## AUTHORS' CONTRIBUTION

The following authors have made substantial contributions to the manuscript as under:

| | |
|---|---|
| Conception or Design: | FA, BY, |
| Acquisition, Analysis or Interpretation of Data: | FA, BY, AU, KG |
| Manuscript Writing & Approval: | FA, BY, AU, JA |

All the authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.