**A Comparative Analysis of Teeth Exfoliation Patterns in Public and Private Primary Schools in Enugu, Nigeria: Results from a School-based Study**

**Abstract**

The exfoliation of primary teeth is a critical process in children's oral development, influenced by genetic, environmental, and socioeconomic factors. This study investigates the differences in teeth exfoliation patterns between children attending public and private primary schools in Enugu, Nigeria, and explores potential correlations with school environments. A descriptive survey design was employed, with data collected from 186 children (105 from public schools and 81 from private schools) using stratified sampling. Structured datasheets were utilized to record exfoliation timings, and statistical analyses, including descriptive statistics and hypothesis testing, were conducted.

Key findings revealed that public school students exhibited earlier exfoliation of deciduous teeth compared to private school students. In the 5–7 age group, 66 public school children experienced incisor exfoliation versus 24 in private schools. Similarly, in the 8–10 age group, 39 public school children shed incisors compared to 52 in private schools, suggesting delayed exfoliation in the latter. Canine and molar exfoliation followed comparable trends, with public school students showing earlier shedding. Gender distribution was balanced (public schools: 44.76% male, 55.24% female; private schools: 44.45% male, 55.55% female), and the 5–7 age group was most represented in both school types (public: 31.40%; private: 35.80%). A chi-square test yielded a highly significant *p*-value of 3.458e-13, confirming that exfoliation patterns differed substantially between school types.

These disparities may stem from socioeconomic factors, including differential access to dental care, nutritional habits, and oral hygiene practices. The results highlight the need for targeted interventions, such as school-based oral health programs and policies to improve preventive dental care access, particularly in public schools. This study underscores the role of socioeconomic context in oral health outcomes and provides a foundation for future research on equitable dental care strategies.

**Keywords:** *Teeth exfoliation, primary teeth, oral health, school environment, socioeconomic disparities, children.*

**Introduction**

The exfoliation of primary teeth, commonly known as "baby teeth," is a natural and crucial process in the oral development of children (Jain, 2023). The orderly sequence of primary teeth shedding and the eruption of permanent teeth contribute significantly to a child's overall oral health (Anthony *et al.,* 2018; Al-Dahan and Ismael, 2023). Understanding the exfoliation patterns of teeth provides valuable insights into the normal growth and development of dentition (Nyström & Peck, 2009; Setty, 2016).

The process of teeth exfoliation involves the gradual resorption of the roots of primary teeth, followed by their replacement with the emerging permanent teeth. (Xiao *et al.*, 2022). This intricate process is influenced by various factors, including genetic predispositions, systemic health, and environmental factors (Brook, 2009). As children progress through different stages of their development, variations in the timing and sequence of tooth exfoliation may occur (Khan *et al.*, 2020; Khan *et al.,* 2023).

Despite the importance of understanding teeth exfoliation patterns, there is a notable gap in research, particularly concerning the influence of school environments on these patterns. Children spend a significant portion of their formative years in school settings, and factors such as nutrition, oral hygiene practices, and overall well-being may differ among schools (Agius *et al.*, 2023). Exploring the potential impact of these variations on teeth exfoliation patterns is essential for promoting comprehensive oral health strategies tailored to specific educational contexts.

By investigating potential correlations between school environments and teeth exfoliation, we seek to contribute to the broader understanding of oral health in school-aged children and inform targeted oral care interventions for diverse educational settings.

This process is essential for making space for the eruption of permanent teeth, which will serve the individual throughout their adult life. The exfoliation of primary teeth typically begins around the age of six and continues into the early teenage years (Schupak *et al.*, 2015).

Consequently, when the deciduous tooth is shed, it consists only of the crown and uppermost part of the root (Kjaer, 2017). The permanent teeth usually begin to erupt during the sixth year and continue to appear until early adulthood. The shape of the face is affected by the development of the [paranasal sinuses](https://www.sciencedirect.com/topics/medicine-and-dentistry/paranasal-sinuses) (air-filled cavities in the bones of the face) and the growth of the [maxilla](https://www.sciencedirect.com/topics/medicine-and-dentistry/maxilla) and [mandible](https://www.sciencedirect.com/topics/medicine-and-dentistry/mandible) to accommodate the teeth. Lengthening of the alveolar processes (tooth sockets supporting the teeth) increases the length of the face during childhood (Rachmawati *et al.*, 2020).

Teeth exfoliation is a complex process that begins in early childhood and continues throughout adolescence. The timing and sequence of teeth exfoliation can be influenced by a number of factors, including genetics, diet, oral hygiene, and exposure to environmental toxins (National Institute of Dental and Craniofacial Research (US), 2021). These factors can vary between individuals and groups, which can lead to differences in teeth exfoliation patterns. It is important to understand these patterns because they can provide insight into the overall health and development of

The study of teeth exfoliation patterns in children holds significant importance in gaining insights into various aspects of oral health. Understanding these patterns contributes to comprehensive dental care and has broader implications for the overall well-being of individuals (Balasooriyan *et al*., 2022).

**METHOD**

# Research designs

**This study employed a descriptive survey research design, which was deemed appropriate for this study. The research involved fact-finding and an inquiry into the tooth exfoliation patterns among students in selected public and private primary schools.**

# Area of Study

**The study was conducted across four primary schools in Enugu State, Nigeria, comprising both public [(i) Divine Love Nursery and Primary School, Trans-Ekulu, Enugu (ii) [(i) Housing Estate Primary School, Abakpa Nike, Enugu** (ii) **Ekulu Primary School, Trans-Ekulu, Enugu and private institutions: [(i) Divine Love Nursery and Primary School, Trans-Ekulu, Enugu (ii) Alpha British Primary School, Trans-Ekulu, Enugu]. Enugu State is situated in southeastern Nigeria, with geographical coordinates of approximately 6°30′N latitude and 7°30′E longitude.**

### **Study Population**

### The study population comprises an average of 730 pupils from four selected schools in Enugu:

1. **Divine Love Nursery and Primary School, Trans-Ekulu, Enugu:** 195 pupils
2. **Alpha British Primary School, Trans-Ekulu, Enugu:** 204 pupils
3. **Housing Estate Primary School, Abakpa Nike, Enugu:** 161 pupils
4. **Ekulu Primary School, Trans-Ekulu, Enugu:** 170 pupils

# Sampling Technique and Validity of the Instrument

A **stratified sampling technique** (a non-probability sampling method) was employed for participant selection. In this approach, the population was divided into subgroups (strata) based on shared characteristics specifically **age group and gender**. Children who were both **available and willing to participate** during the study period were included.The stratified method was chosen to ensure representation across key demographic variables while accommodating practical constraints. Final selection within each stratum was based on participants’ expressed interest and willingness to take part in the study.

### **Validity of the Instrument**

The structured data collection sheet was meticulously designed and reviewed by the research team, with necessary revisions implemented to ensure content validity. The study was conducted with rigorous attention to methodological precision to maintain data accuracy. All participant information was handled with strict confidentiality in compliance with ethical research standards set forth in the 2024 revised edition of the Declaration of Helsinki by the World Medical Association (World Medical Association, 2024).

### **Methods of Data Collection**

Data were collected using structured datasheets administered by the principal researcher through standardized oral interviews. These interviews were conducted with participants' parents/guardians during morning assembly periods to ensure optimal participation rates. The face-to-face interview format allowed for clarification of questions and verification of responses, thereby enhancing data quality.

### **Data Analysis and Presentation**

The collected data were analyzed using both quantitative and qualitative analytical approaches. Descriptive statistics, including frequencies, percentages, means, and standard deviations, were employed to examine participants' demographic characteristics and exfoliation patterns. These statistical measures facilitated systematic comparisons across study variables.

Results were presented through tables, charts, and narrative summaries to ensure comprehensive data interpretation. The combination of statistical analysis and visual representation allowed for clear communication of key findings while maintaining methodological rigor.

# Test for hypothesis

The hypothesis will be tested using z-test, which is mathematically represented as

Z = Ẍ - µ

S**/√N**

Where, X = Sample mean

µ = Population mean

S = Sample standard deviation N = Sample size

**RESULTS**

#### **Gender Distribution of Public and Private Schools**

**In Public Schools**, the gender distribution revealed high predominant of Females: 58 (55.24%) over male Males: 47 (44.76%). Similarly in **Private Schools,** Females gender accounted 45 (55.55%) over Males 36 (44.45%). The gender distribution was nearly identical in both school types, with a slight predominance of females (55%) in Private school **(Table 1).** This suggests no gender bias in the sample and aligns with literature showing no significant gender differences in oral health outcomes

#### **Age Distribution of Study Participants**

**Age Distribution of Study Participants *indicated that*** largest group: 5–7 years (31.40%) while the smallest group: 14–16 years (1.92%) in **Public Schools.**

**Age Distribution of Study Participants in Private Schools** revealed that Largest group: 5–7 years (35.80%) and Smallest group: 14–16 years (4.96%) **[Table 2].** The 5–7 age group was most represented in both school types, consistent with the typical onset of deciduous teeth exfoliation. Private schools had a higher proportion of younger children (0–4 years), possibly reflecting enrollment trends.

#### **School Class Distribution (Primary 1–6)**

**In Private Schools**, Highest enrollment was common in Primary 2 (24.69%) but Lowest in Primary 6 (8.65%). In **Public Schools** Highest enrollment was found in Primary 2 (20.95%) and Lowest in Primary 3 (17.14%) **[Table 3].** Both school types showed declining enrollment in higher classes (e.g., Primary 6), which may reflect dropout rates or demographic shifts. Private schools had more uniform distribution across classes.

***Exfoliation Patterns by Tooth Type and Age***

**Incisors:** Public school children aged 5–7 had significantly higher exfoliation (66 versus 24 in private schools). Private school children showed delayed exfoliation in older age groups (e.g., 52 in 8–10 years versus 39 in public schools).

**Canines and Molars:** Similar trends, with public school students shedding earlier. For example, in 8–10 years, 58 public school children shed canines versus 26 in private schools.

Public school students consistently exhibited earlier exfoliation across all tooth types, likely due to socioeconomic factors (e.g., poorer nutrition, limited dental care) **[Table 4]**.

#### **Hypothesis Testing (Chi-Square Test)**

**From the result:** A *p*-value of **3.458e-13**(extremely significant) confirmed that exfoliation patterns differed substantially between public and private schools **[Table 5]**. The **implication** is that the null hypothesis (no difference) was rejected, supporting the influence of school type (a proxy for socioeconomic status) on exfoliation timing.

# Table 1: Gender distribution of both Public and Private schools

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| --- |
| **GENDER FREQUENCY DISTRIBUTION** |
| **Gender** | **PUBLIC SCHOOLS** | **PRIVATE SCHOOLS** |
|  | **Frequency** | **Percentage %** | **Frequency** | **Percentage %** |
| **Male** | 47 | 44.76 | 36 | 44.45 |
| **Female** | 58 | 55.24 | 45 | 55.55 |
| **Total** | **105** | **100** | **81** | **100** |

# Table 2: Age distribution of the study participants

|  |
| --- |
| **AGE FREQUENCY DISTRIBUTION** |
|  | **PUBLIC SCHOOLS** | **PRIVATE SCHOOLS** |
| **AGE****(Years)** | **Frequency** | **Percentage****%** | **Frequency** | **Percentage (%)** |
| **0-4 years** | 16 | 15.20 | 21 | 25.92 |
| **5- 7 years** | 33 | 31.40 | 29 | 35.80 |
| **8-10 years** | 28 | 26.60 | 15 | 18.51 |
| **11-13 years** | 26 | 24.70 | 12 | 14.81 |
| **14 - 16 years** | 2 | 1.92 | 4 | 4.96 |
| **TOTAL** | **105** | **100** | **81** | **100** |

# Table 3: School class of the study participants from Primary 1 - 6

|  |
| --- |
| **CLASS FREQUENCY DISTRIBUTION** |
|  | **PRIVATE SCHOOLS** | **PUBLIC SCHOOLS** |
| **CLASS****(Primary)** | **Frequency** | **Percentage %** | **Frequency** | **Percentage (%)** |
| **1** | 16 | 19.75 | 19 | 18.10 |
| **2** | 20 | 24.69 | 22 | 20.95 |
| **3** | 16 | 19.75 | 18 | 17.14 |
| **4** | 10 | 12.35 | 13 | 12.38 |
| **5** | 12 | 14.81 | 17 | 16.20 |
| **6** | 7 | 8.65 | 16 | 15.23 |

# Table 4: The exfoliation pattern of the study participants

|  |
| --- |
| **TEETH EXFOLIATION PATTERNS** |
| **TEETH TYPE** | **AGE (YEAR)** | **PRIVATE SCHOOLS** | **PUBLIC SCHOOLS** |
|  |  | **Male** | **Female** | **Male** | **Female** |
| **INCISORS** | 5- 7 | 11 | 13 | 37 | 29 |
|  | 8-10 | 16 | 36 | 28 | 11 |
|  | 11-13 | 3 | 2 | 0 | 0 |
| **CANINES** | 5- 7 | 5 | 2 | 2 | 4 |
|  | 8-10 | 16 | 10 | 34 | 24 |
|  | 11-13 | 26 | 22 | 22 | 19 |
| **MOLARS** | 5- 7 | 3 | 3 | 4 | 5 |
|  | 8-10 | 27 | 15 | 16 | 11 |
|  | 11-13 | 20 | 13 | 41 | 28 |

**TABLE 5: TEST OF HYPOTHESIS**

|  |  |
| --- | --- |
| *X* | *X2* |
| *90* | 8100 |
| *91* | 8281 |
| *5* | 25 |
| *13* | 169 |
| *84* | 7056 |
| *89* | 7921 |
| *15* | 225 |
| *69* | 4761 |
| *102* | 10404 |
| ∑ 𝑋 *=558* | ∑ 𝑋2 =47,111 |

### **Discussion**

The study examined the teeth exfoliation patterns in children from public and private primary schools, revealing significant differences influenced by socioeconomic factors, oral hygiene practices, and access to dental care.

* 1. ***Gender and Age Distribution***

**Gender**: Our findings shows a balanced gender distribution (55% female, 45% male) in both public and private schools, indicating no gender bias in the sample. The study found a slightly higher percentage of females in both public (55.24%) and private (55.55%) schools. This aligns with studies like Tadin *et al.* (2022), which noted no significant gender-based differences in oral health outcomes but emphasized the need for gender-inclusive oral health programs.

**Age**: The majority of participants were aged 5–7 years (public: 31.40%; private: 35.80%), group was the most represented in both school types, aligning with the typical onset of deciduous teeth exfoliation (Setty, 2016; Xiao *et al*., 2022*;* Dunn *et al*., 2022; Ogodescu *et al.,* 2022). The 5–7 age group dominated the sample, and gender distribution was balanced, eliminating gender as a confounding variable. This age group is critical for monitoring oral development, as delayed or premature exfoliation can indicate nutritional or systemic health issues (Dhamo *et al*., 2019; Spodzieja, & Olczak‐Kowalczyk, 2022).

* 1. ***Exfoliation Patterns***

**Public and Private Schools**: Public school students exhibited earlier exfoliation of incisors (66% in 5–7-year-olds) compared to private schools (24%). This disparity may reflect socioeconomic influences, such as poorer nutrition or limited access to dental care in public schools (Northridge *et al*., 2020; Grigsby‐Duffy *et al.,* 2022; Mazurkiewicz *et al.,* 2023). Table 3 indicates declining enrollment in higher primary classes (e.g., Primary 6) in both school types, with private schools having a more uniform distribution. Exfoliated primary teeth hold unique cultural and developmental importance for children worldwide. Unlike other biospecimens, they are finite in number and carry sentimental value for parents, who often view tooth exfoliation as a key developmental milestone. Consequently, families frequently engage in rituals and traditions to commemorate the loss of a child’s primary teeth, further underscoring their emotional and social significance.

**Canines and Molars**: Private school students showed delayed exfoliation of canines and molars, possibly due to better preventive care and healthier diets (Aslan Ceylan *et al*., 2022). Studies like Reis *et al*. (2021) link delayed exfoliation to higher socioeconomic status and better nutritional intake. Our results demonstrates that public school students experienced earlier exfoliation of incisors, canines, and molars compared to private school students, likely due to socioeconomic disparities. **Additionallysocioeconomic and environmental Factors has been reported to influence** exfoliation.The study highlights the role of socioeconomic status (SES) in oral health, corroborating findings by Gargano *et al*. (2019), who noted that children from lower SES backgrounds often experience earlier tooth loss due to caries or malnutrition. Environmental toxins (e.g., dioxins) and poor oral hygiene practices, as discussed by Alaluusua *et al*. (2004), can accelerate root resorption and exfoliation, which may explain the earlier patterns in public school students.

* 1. ***Hypothesis Testing***

Our study confirms a statistically significant difference (*p* = 3.458e-13) in exfoliation patterns between school types (a proxy for SES), reinforcing the impact of socioeconomic factors on oral health. It clear that most public are attend by children from family with low SES. This aligns with Jackson *et al.* (2011), who found that SES disparities significantly impact oral health outcomes, including tooth eruption and loss.

The study limitation stern from a cross-sectional sample’s geographic area (Enugu, Nigeria) and calls for broader studies to enhance generalizability, as seen in multinational research by Vučić *et al*. (2017) on thyroid function and dental development. The strengths of this study, indicate our measures of comparison in tooth exfoliation. Further exploration of genetic factors (Townsend *et al*., 2009) and maternal knowledge (Adimoulame *et al.,* 2019) could deepen understanding of exfoliation variability. These findings highlight the need for policies addressing socioeconomic inequities in children’s oral health.

**Conclusion**

The findings of this study shed light on the disparities in teeth exfoliation patterns between students attending public and private schools. The observed trend of earlier exfoliation among public school students indicates that SES profoundly influences exfoliation timing, with public school students at higher risk for early exfoliation due to systemic inequities. It suggests that children from lower-income backgrounds may face greater challenges in maintaining optimal oral health, including timely tooth exfoliation, thus

1. These study advocates for **Targeted Interventions** for School-specific programs addressing nutrition, hygiene, and access to care are critical, as supported by global evidence (Saccomanno *et al*., 2023; Nakre and Harikiran, 2013).
2. Integration of oral health education into curricula, as suggested, mirrors successful models in Brazil and Uganda (Reis *et al*., 2021; Akera *et al*., 2023).
3. Combining education, community health initiatives, and policy changes can mitigate disparities, a strategy validated by Ziso *et al.* (2022) in low-income communities.

This study contributes to the growing body of evidence underscoring the need for equitable oral health strategies tailored to children’s socioeconomic contexts. Future research should expand demographic diversity and explore longitudinal impacts of interventions and explore the oral health behaviors, beliefs, and attitudes of public and private school students and their families.

## DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

## CONSENT AND ETHICAL APPROVAL

### Ethical approval for this study was obtained from the Enugu State Ministry of Education with reference No: ENS/MOE/RES/0035. Written consent was secured from the schools before gaining access to the pupils and obtaining the necessary information. The research was conducted over a period of five working days, ensuring minimal disruption to academic activities.

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