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Evaluating The Relationship Between Body Mass Index, Nutritional Status And Tooth Eruption Among 6-12 Years Old School Children: A Cross-Sectional Study

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Abstract
The eruption of permanent teeth is a key developmental milestone for children, influenced by various genetic, ethnic, and environmental factors. This study aimed to evaluate the association between Body Mass Index (BMI) and the timing of permanent tooth eruption in 100 school-aged children (6–12 years) from Hindu Coronation school in Melmaruvathur. The children's height, weight, and eruption status of permanent first molars and incisors were recorded. The BMI was calculated, and children were categorized into underweight, normal weight, and overweight groups. The results showed that 78.4% of the children were underweight, 18.6% were normal weight, and 2.9% were overweight. Among the participants, 68.6% exhibited delayed eruption, 28.4% had normal eruption, and 3.9% showed early eruption. A significant association was observed between BMI and eruption status, with underweight children showing delayed eruption and overweight children experiencing early eruption of permanent teeth. Pearson's correlation analysis revealed a 60.7% positive correlation between BMI and eruption timing, with statistical significance ($p \leq 0.05$). The study highlights the role of BMI in predicting eruption patterns and suggests that nutritional status can be a crucial factor in managing dental health, particularly in children undergoing mixed dentition. These findings emphasize the importance of considering BMI in clinical assessments and preventive dental care strategies for children in their mixed dentition phase.

Keywords: *Permanent tooth eruption, Body Mass Index, BMI, Children, Mixed dentition, Nutritional status, Dental development, Tooth eruption timing*

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I. Introduction

Eruption is the process by which developing teeth move through the jaw bones and overlying mucosa, to emerge into their respective functional position within the oral cavity eventually.[1,2] The emergence of a

child's permanent teeth is a significant developmental milestone and a biological indicator of adulthood. The clinical maturity stage is indicated by the number of permanent teeth that have erupted in the child's oral cavity by a specific age.[2]

Logan and Kronfeld's 1933 eruption chronology is still frequently used as a benchmark for determining when permanent teeth may erupt.[3] Studies on Caucasians served as the basis for the current eruption schedule for both permanent and deciduous teeth. However, there are genetic, ethnic, and environmental differences between the Indian and Western populations. Both hereditary and environmental factors can influence when teeth first appear in the oral cavity. They can be separated into two groups: local and general factors. Composition of the body, diet, fluoride, and the socioeconomic background are among the general influences. The local factors include dental caries, damage to both primary and growing permanent teeth, and early loss of primary teeth and its after effects.[1, 2, 4]

Hormones and hormone-related proteins also have an impact on tooth eruption. There is a positive correlation between tooth calcification and wrist bone ossification, height, weight, and body fat.[1] The development and eruption of teeth are influenced by the child's general physical growth. An alternative to direct measurements of a child's total physical development is the body mass index, or BMI.

A child's BMI gives information about their dental development as well as an assessment of their general physical development.[5] Obese children may have rapid linear growth because a high body fat percentage influences hormone metabolism and growth.[6] The time of the eruption of permanent teeth may be impacted by changes in BMI. The first permanent tooth to erupt into the oral cavity is the lower first molar, which appears between the ages of 6 and 7. The upper first molar follows about the same time. In order of eruption, the incisors of the upper arch and the central and lateral incisors of the lower arch follow.[2] The most typical order in which permanent teeth erupt is the first molar, followed by the central incisor, and then lateral incisor.

Systemic and local factors are the two categories of elements that influence the eruption's timing and sequence. The child's growth, dietary state, genetic background, and existence or absence of any systemic diseases are examples of systemic influences. The condition of the previous main tooth, trauma, and the existence of any cysts or tumors are examples of local variables.[1,4] The eruption's timing and sequence appear to be mostly genetically driven.

Girls typically erupt their permanent teeth five months earlier than boys, with the exception of third molars. The growth spurts in both genders differ, which accounts for the variation in tooth eruption timings.

The first molars and permanent incisors, which erupt during the first few years of formal education, are crucial to a child's overall health and psychological well-being as well as their appearance and functionality. Parents frequently worry about "unerupted permanent teeth" because they believe that the child's age determines when the permanent teeth will erupt.

Different populations may experience eruptions at different times. Previous research on the timing of permanent tooth eruption in the Indian population has varied in terms of approach and geographic location.[7–11] Information on the timing of eruption of these teeth in India can be obtained from a current population-specific standard.

II. Materials And Methods

One hundred school-going children aged 6–12 years from Hindu Coronation school in Melmaruvathur were randomly selected for examination with prior permission from school authorities and District Educational Officers.

Ethical clearance from the institutional ethics review board was obtained and the school authorities provided written consent for the study. Children who were agreeable, healthy, and free of systemic ailments or developmental disorders were chosen for the study. Before oral examination, the children were instructed to rinse well. To improve sight, sterile cotton swabs were used to remove any food debris from the teeth. A single-trained, calibrated examiner performed oral examinations under sufficient illumination using a sterile mouth mirror and a Community Periodontal Index for Treatment Needs (CPITN) probe. Any portion of a permanent tooth's crown that was visible in the oral cavity and had broken through the gingiva was considered to have "erupted." A CPITN probe was utilized to determine whether or not the tooth had erupted in situations where the erupted tooth was covered by gingival flap. Each and every child's incisors and permanent first molars that had erupted were recorded in all of the four quadrants.

Before the height and weight of each child were recorded, they were requested to take off their shoes. A standardized portable digital weighing scale (model: HSB1, Hesley Inc., Germany) was utilized to measure weight. After the child stood on the weighing scale and it was stable for five seconds, the reading was recorded. The weight was rounded to the closest two decimal places and recorded in kilograms.

Next, each child's BMI was determined by the formula: BMI = weight in kilograms/height in meters square.[2] The children were categorized into four groups based on their BMI: underweight, normal weight, overweight, and obese. This was accomplished utilizing the Centers for Disease Control and Prevention's (CDC)

gender-specific BMI-for-age growth charts. A child is considered underweight if their BMI is below the fifth percentile, normal weight if it is between the fifth and 85th percentiles, overweight if it is between the 85th and 95th percentiles, and obese if it is beyond the 95th percentile, according to the CDC.[12]

III. Statistical Analysis

The collected data were entered into Microsoft excel spreadsheet and were subjected to statistical analysis using SPSS Software version 20.0 , IBM USA. The descriptive analysis was performed with respect to age, gender, BMI and eruption status. Likewise, the association between eruption status and body mass index was done by using chi square test and Pearson correlation coefficient test with statistical significance difference p value less than or equal to 0.05 as statistical significance respectively.

IV. Results

Table 1 represents distribution of study population based on age, gender, and BMI in which 6-13 years age group were included in the study. Among them, maximum were from 10 years (18.6%) followed by 12 years (15.7%), 6 years (13.7%), 7 and 8 years (12.7%), least among 11 years (9.8%) and 13 years (1%). With respect to gender-wise distribution, 39.2% were males and 59.8% were females. Likewise, the body mass index when considered among the study groups, 78.4% were underweight, 18.6% were normal weight, 2.9% were overweight. With respect to eruption status, it was found that among the study population, 70.3% had delayed eruption and 29.7% had normal eruption status.

Table 2 and Graph 2 represents the association between body mass index and eruption status among the study population using chi-square test with a significant difference kept at p value less than or equal to 0.05 as statistically significant differences. It was shown that out of 80 underweight children, 70 showed delayed eruption, 8 of them showed normal eruption and out of 3 overweight children, 2 of them showed early eruption and 1 showed normal eruption. Apart from that, the remaining study population with normal weight had normal eruption status. A Pearson correlation of 60.7% has been seen among eruption status and body mass index with defined statistical significance difference with p value 0.000 which infers that there was a good discrimination ability that body mass index (when it is less underweight), there exists a delayed eruption of the permanent dentition. Likewise, large body mass index (overweight) showed early eruption of permanent dentition.

V. Discussion

The emergence of permanent teeth is a significant developmental milestone for children and is a biological indicator of adulthood. The rate and timing of permanent tooth eruption are influenced by numerous biological and environmental factors. The 1930s marked the beginning of the global chronological norms for the timing of the permanent teeth's eruption.[3] Since the eruption times were calculated using a very small sample of the Caucasian population, these eruption standards could not be extended to the Asian population.

The time of eruption was investigated using a cross-sectional study methodology as, in contrast to the longitudinal approach, it is feasible to incorporate bigger samples, producing findings that are more typical of a community. The permanent first molars and incisors were the teeth analyzed in this investigation. The first permanent tooth to erupt into the oral cavity is the permanent first molar. It is regarded as the secret to occlusion as well. The permanent incisors will erupt at roughly the same time.

The development and eruption of teeth are influenced by a child's total physical growth. The child's entire physical development can be inferred from the BMI value. An individual's genetic composition has a significant impact on their BMI. Globally, people of Asian, Mongoloid, and South American heritage have lesser BMI values, while populations of European, African, and North American descent have higher BMI values.[14] Research on how BMI affects when permanent teeth erupt has shown inconsistent findings worldwide.[5, 15–18]

The eruption age of that specific tooth would be overestimated if it were only to be deemed "erupted" if it was in occlusion. As a result, in this study, a tooth was deemed to have erupted if any portion of it was visible in the oral cavity after penetrating the gingiva.[13, 19] Only a small number of studies have further categorized eruption timing according to the oral cavity's exposed tooth surface area.[20, 21]

In line with Logan and Kronfeld's chronology, the current investigation determined that the lower first molar was the first permanent tooth to emerge.[3] This was similar to other findings published in a number of investigations over the previous ten years.[9, 20, 22, 23] This conclusion was supported by numerous research done on the Indian people.[7,10,11,13,24]

Nevertheless, according to other research, the mandibular central incisor erupts before the first molar as the first permanent tooth.[25–29] According to a study done on people in Iran, the lower first molar has a greater chance than any other permanent teeth of erupting first.[30] The lower first molar was the first permanent tooth to erupt in both boys and girls in our study. The mandibular first molar in girls was the first permanent tooth to erupt, according to studies done on the Czech and Greek populations, although the mandibular central incisor was the first tooth to erupt in boys.[23, 31]

According to Logan and Kronfled's well-established tooth eruption chronology, the lower first permanent molar erupts between the ages of 6 and 7. Research conducted on kids worldwide has also revealed that the mandibular first molar erupts at a comparable time.[19, 23, 31, 32] The mandibular first molar in our study, however, erupted sooner, at about 5 years and 8 months.

The intricate process of tooth eruption depends on osteoclastic and osteoblastic activity. The timing of eruption is determined by the quantity of bone that covers the permanent tooth before it erupts. The mandible and maxilla have different bone structures; the former is thinner and less dense, particularly in the anterior portion.[1] The lower teeth may emerge earlier than the maxillary teeth as a result of this. According to multiple studies, the median eruption date of all the lower teeth under examination was sooner than that of the upper permanent teeth.[19, 22, 29, 32] Other prior research done in India, where the mandibular teeth erupt before the maxillary teeth in both sexes, also confirmed this conclusion.[8, 13, 24, 33] According to Shaweesh, Iranian children's mandibular and maxillary first tooth eruption timings did not differ much.[20] Before the primary incisors are exfoliated, the permanent mandibular incisor tooth buds can erupt into the oral cavity because they are positioned lingual to the primary incisors.[1, 2, 4] Additionally, the mandibular incisors may erupt earlier than the maxillary incisors as a result of this.

Permanent teeth have been seen to erupt earlier in children with higher BMI values. [6,8,10,11,15–18] Junk foods and lifestyle choices made as a youngster can raise insulin-like growth factor-1 (IGF-1) and cause hyperinsulinemia. These youngsters experience an early eruption of their permanent teeth as a result of the IGF-1 hormone's significant contribution to the acceleration of bone maturation [6]. In a same vein, children who were overweight or obese had an earlier age of eruption. Regardless of their gender, the children in the underweight group all had delayed tooth eruption times. This result is also consistent with research showing that children with lower BMIs experience a delay in eruption.[8,10,11,15]

The current study demonstrates a correlation between tooth eruption and BMI. Instead of depending solely on chronological age, the BMI estimate can be useful in clinical practice for estimating eruption time. An initial BMI measurement in children who report delayed eruption may help determine when an eruption will occur and likely reduce the need for multiple radiographs. The calculation of BMI is a simple and affordable way to screen for weight categories. When the time period between the eruption of permanent incisors and the exfoliation of primary incisors is extended, parents frequently show signs of concern. In these circumstances, the results of the current study may have clinical significance for Bengaluru's clinicians.

Since tooth eruption is a complicated process, further research should be done to determine how eruption timing relates to other variables such nutritional status, the age at which the predecessor tooth exfoliated, developmental abnormalities, and trauma to the primary dentition. Because the children in this study did not have radiographs collected, congenitally absent or impacted incisors might have gone unnoticed and been assumed to have not yet erupted. In order to establish more precise time for the eruption of permanent teeth, additional longitudinal studies on children through adolescents can be conducted.

VI. Conclusion

The study concludes that the eruption pattern is directly associated positively with that of the children's Body Mass Index. In which we have found that children who are underweight showed a delayed eruption and children who are overweight had early eruption of their permanent teeth. Thus the nutrition and eruption are directly proportional to each other which must be considered as a public health and preventive aspects on planning dental preventive treatments for children who are under mixed dentition phase. The role of nutrition and oral health is considered to be an important aspect on preventive ailments from oral diseases.

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Tables And Graphs

Table 1 Represents The Distribution Of Study Population Based On Age, Gender, Bmi And Eruption Status.

Factors	Parameters	Frequency	Percentage
Age In Years	6	14	13.7
	7	13	12.7
	8	13	12.7
	9	16	15.7
	10	19	18.6
	11	10	9.8
	12	16	15.7
	13	1	1.0
Gender	Male	41	59.8
	Female	61	40.2
Body Mass Index	Normal	18	18.6
	Overweight	3	2.9
	Underweight	80	78.4
Nutritional Status	Normal	102	100
	Malnourished	0	0
Eruption Status	Normal	29	28.4
	Early	04	3.9

	Delayed	70	68.6

Table 2 Represents The Association Between Body Mass Index And Eruption Status Among The Study Population

Body Mass Index	Eruption Status			Significance
	Normal	Early	Delayed	
Normal	20	2	-	
Underweight	8	-	70	
Overweight	1	2	-	0.000

Graph 1 Represents The Association Between Body Mass Index And Eruption Status Among The Study Population