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Original Article

Association between Body Mass Index and Permanent Teeth Eruption Among 6 to 13 Years Old School Children in Chengalpattu, India – A Cross-Sectional Study

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Abstract

Background: Tooth eruption is a vital developmental marker influenced by various factors, including genetics, environmental factors, and nutrition. Body Mass Index (BMI) is the most common indicator for nutritional status; therefore, it may be associated with the timing of permanent tooth eruption.

Objective: To investigate the association between Body Mass Index (BMI) and the eruption status of permanent teeth among school children aged 6–13 years in Chengalpattu, Tamil Nadu, India.

Methods: A cross-sectional analytical study was conducted among school children aged 6-13 years in Chengalpattu, Tamil Nadu, India. Using a multistage sampling technique, 933 children participated in the study. The Permanent teeth eruption status was determined by visual inspection, and the nutritional status indicator, Body Mass Index(BMI), was calculated using standardised anthropometric techniques. Children were categorised according to BMI Groups (Underweight: < 5th percentile, Normal weight: 5th–85th percentile, Overweight: 85th–95th percentile, and Obese: > 95th percentile) using CDC percentiles. Descriptive statistics, Pearson's correlation, chi-square tests, and linear regression were used to analyse the data; a p-value of <0.05 was considered statistically significant.

Results: A Significant positive correlation was observed between the Body Mass Index and the Number of overall permanent teeth erupted ($r=0.404$, $P<0.001$), but within individual age groups no significant correlation existed. The linear regression model showed that age was a significant predictor of permanent teeth erupted ($\beta=0.875$, $P<0.001$), while BMI was not a significant predictor ($\beta=-0.002$, $P=0.905$).

Conclusion: Even though an overall correlation between the Body Mass Index and the Number of overall permanent teeth erupted was observed, this association is strongly mediated by age. So, Age remains the primary determinant of permanent tooth eruption, and BMI alone could not be considered as a predictor in clinical or epidemiological settings.

Keywords: Body Mass Index, Tooth Eruption, Nutritional Status, Children

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Introduction

Permanent Tooth eruption is a physiological process of axial or occlusal movement of a tooth from its developmental position within the alveolar bone into its functional position in the oral cavity and is a significant milestone in a child's growth and development.[1] The timing and pattern of permanent teeth eruption are governed by various factors, including genetics, environmental, systemic and nutritional factors. Genetics primarily influences the initiation of calcification and the sequence of eruption,[2] but the actual timing and emergence of teeth into their functional position may be modulated by various external factors, including nutritional status and overall health.[3] Thus, making permanent tooth eruption status a sensitive and observable marker of general health, growth and developmental progress in the pediatric population.[4] In children, between the ages of 6 and 13 years, there is a transition from the primary to the permanent dentition, characterised by the exfoliation of deciduous teeth and the sequential eruption of permanent teeth, known as the mixed dentition phase. This stage of craniofacial development has substantial implications for oral function, facial aesthetics, speech and psychological well-being. Any variation in the timing of eruption, such as early or delayed eruption, can lead to several clinical complications like malocclusion, impaction, and asymmetries in the dental arch. These anomalies may influence the efficiency of mastication, phonetics and the overall quality of life of the child.[5]

The process of permanent tooth eruption is influenced by multiple factors of overall health, including metabolic and nutritional conditions; it reflects the physiological status of the individual. Among the various indicators of nutritional status, Body Mass Index (BMI) is widely used in pediatric populations. BMI, calculated as weight in kilograms divided by the square of height in meters (kg/m^2), is a simple yet effective screening tool for categorising individuals as underweight, normal weight, overweight, or obese.[6,7] It is also considered a surrogate marker of somatic growth and nutritional adequacy. Given that nutrition plays a key role in skeletal and soft tissue development, it is reasonable to explore its influence on dental development, specifically on the eruption of permanent teeth.[8]

The nutritional status of a child, as reflected by BMI, may have a direct or indirect effect on the pace of dental eruption. Undernutrition, insufficient intake of energy or essential nutrients such as protein, calcium, and vitamins, can impair skeletal development and delay the eruption of teeth. Whereas overnutrition can also alter metabolic and endocrine functions and impair development process. Therefore, Nutritional status assessed through the Body Mass Index acts as an indirect indicator of these systemic relationships with dental maturation.[8]

Children are exposed to a broad spectrum of dietary patterns, healthcare access, and lifestyle practices, all of which may affect their general and oral health.[6,9] The coexistence of both undernutrition and increasing rates of childhood overweight and obesity in such settings underscores the need for targeted studies examining the implications of nutritional status for key developmental processes such as tooth eruption. This cross-sectional study aims to investigate the association between BMI and the eruption status of permanent teeth among school-going children aged 6 to 13 years in Chengalpattu.

Methods

This cross-sectional study was conducted among school-going children aged 6 to 13 years in Chengalpattu district, Tamil Nadu, India. Ethical approval (KIDS/IEC/2025/I/08) was obtained from the Institutional Review Board before the commencement of the study. Prior approval was obtained from the school authorities after explaining the aims, objectives, and methodology of the study, followed by informed consent from the participants' parents/guardians were also secured.

The participants were recruited from government and private schools in the region using the multistage sampling technique. Using G*Power V 3.0 software, the Total sample size was calculated to be 933, employing standard deviation values from previous studies.[10] Children aged between 6 and 13 years who were present on the day of the survey with parental consent were included; the date of birth of the children was confirmed from the school records. Children with systemic diseases, syndromes affecting growth or dentition, and those undergoing orthodontic treatment were excluded.

Each participant underwent a clinical oral examination by a single calibrated examiner to determine the eruption status of permanent teeth. Teeth were categorised as "erupted" if any part of the crown had penetrated the oral mucosa and was visible in the mouth and as "unerupted" otherwise. The total number of erupted permanent teeth per child was recorded and documented. Anthropometric measurements were taken under standardised conditions. Weight was measured using an Omron HN-286 (KRELL PRECISION (YANGZHOU) CO., LTD) digital weighing scale, calibrated before each session, and recorded to the nearest 0.1 kg.[11] Height was measured using a SECA 213 portable stadiometer (SECA Asia Pacific SDN BHD), with the child standing upright without shoes, heels together, and looking straight ahead; the measurement was recorded to the nearest 0.1 cm.[12]

Body Mass Index (BMI) was calculated using the formula weight (kg)/height^2 (m^2). BMI-for-age percentiles were used to categorise children into four nutritional groups according to CDC (Centers for Disease Control) growth charts 6: Underweight: < 5th percentile, Normal weight: 5th–85th percentile, Overweight: 85th–95th percentile, and Obese: > 95th percentile.[7]

Statistical Analysis

All data were entered into Microsoft Excel and analysed using IBM SPSS version 26. Descriptive statistics, including mean, standard deviation, and frequencies, were used to summarise the characteristics of the study population. Correlation analysis was performed to examine the relationship between BMI and the number of erupted permanent teeth. The association between BMI Categories and Dental eruption status was tested using the Chi-Square test. To determine the predictive influence of BMI and age on the number of erupted teeth, a linear regression model was used. A statistical significance of p-value < 0.05 was considered.

Results

A total of 933 school-going children aged between 6 and 13 years participated in this cross-sectional study. The gender distribution across age groups included 490 males (52.5%) and 443 females (47.5%). The sample was nearly evenly distributed across all age groups, with the highest proportion from the 9-year-old category (n = 156, 16.7%) and the lowest from the 7-year-old category (n = 47, 5.0%) (Table 1).

As expected, both BMI and the number of erupted teeth increased progressively with age. The mean BMI was 14.5 ± 2.02, and the average number of erupted permanent teeth was 4.9 ± 1.64 for the age group of 6 years. By age 13, the mean BMI had increased to 20.1 ± 4.29, with an average of 27.5 ± 1.39 erupted teeth (Figures 1 & 2). Near-complete eruption of the permanent dentition was observed by the age of 12–13 years.

A statistically significant positive correlation was found overall ($r = 0.404$, $P < 0.001$) (Table 2), indicating that children with higher BMI tended to have more erupted permanent teeth. However, when the correlation was stratified by age groups, no statistically significant correlation was observed within any specific age group ($P > 0.05$). The above findings prove that Age acted as a confounding factor when BMI and dental eruption

Table 1. Mean BMI and Mean Number of Erupted Permanent Teeth Across Various Age Groups and Between Genders

AGE (Years)	n(%) (N = 933)			BMI MEAN ± SD			Number of Erupted Permanent Teeth MEAN ± SD		
	Male (490)	Female (443)	Total	Male	Female	Total	Male	Female	Total
6 Years	62 (50.82)	60 (49.18)	122 (13.1)	14.4 ± 1.69	14.58 ± 2.32	14.5 ± 2.02	4.8 ± 1.76	4.9 ± 1.51	4.9 ± 1.64
7 Years	35 (74.47)	12 (25.53)	47 (5.0)	14.6 ± 2.37	14.4 ± 1.83	14.6 ± 2.23	4.8 ± 2.32	4.3 ± 1.50	4.7 ± 2.14
8 Years	59 (42.45)	80 (57.55)	139 (14.9)	15.9 ± 4.92	15.43 ± 2.78	15.6 ± 3.83	13.1 ± 5.66	12.4 ± 5.06	12.7 ± 5.32
9 Years	78 (50.00)	78 (50.00)	156 (16.7)	15.8 ± 2.88	15.9 ± 2.82	15.8 ± 2.84	12.9 ± 4.00	12.6 ± 3.71	12.7 ± 3.85
10 Years	73 (54.07)	62 (45.93)	135 (14.5)	17.3 ± 3.44	16.9 ± 3.29	17.1 ± 3.36	15.9 ± 5.00	15.7 ± 5.19	15.8 ± 5.07
11 Years	54 (52.43)	49 (47.57)	103 (11.0)	17.8 ± 3.87	17.1 ± 3.51	17.5 ± 3.70	21.9 ± 4.94	20.6 ± 5.50	21.3 ± 5.23
12 Years	54 (57.45)	40 (42.55)	94 (10.1)	19.9 ± 5.19	18.5 ± 4.17	19.3 ± 4.81	26.3 ± 3.10	26.2 ± 3.50	26.2 ± 3.26
13 Years	75 (54.74)	62 (45.26)	137 (14.7)	20.4 ± 4.27	19.7 ± 4.32	20.1 ± 4.29	27.5 ± 1.58	27.6 ± 1.13	27.5 ± 1.39

N – Total number of participants, n – Frequency, % - Percentage, SD – Standard Deviation

Table 2. Overall and Age-Wise Correlation Between BMI and Mean Number of Permanent Teeth Erupted

BMI vs Total Number of Permanent Teeth Erupted	n(%)	R	*P*
Overall	933(100)	.404**	.000
Age Groups			
6 Years	122 (13.1)	-.045	.626
7 Years	47 (5.0)	.102	.496
8 Years	139 (14.9)	-.028	.746
9 Years	156 (16.7)	.020	.802
10 Years	135 (14.5)	-.145	.092
11 Years	103 (11.0)	-.035	.728
12 Years	94 (10.1)	.045	.666
13 Years	137 (14.7)	.034	.691

N – Total number of participants, n – Frequency, % - Percentage, SD – Standard Deviation

appeared associated at the population level.

To explore the categorical relationships, analysis was conducted according to the grouped data of CDC BMI-for-age percentile classifications: underweight, healthy weight, overweight, and obese (Table 3). BMI categories and number of erupted permanent teeth across all age groups showed no statistical significance (P values > 0.05). The above findings reinforce the earlier observations of no significant association of BMI and dental eruption within individual groups, but an overall modest correlation. Age remained the highly significant predictor for the number of erupted permanent teeth ($B = 3.377$, $\beta = 0.875$, $P < 0.001$) (Table 4). Each additional year of age predicted approximately 3.4 more erupted permanent teeth. BMI was excluded from the final model, as it was not a significant predictor ($\beta = -0.002$, $P = 0.905$). This suggests that, rather than BMI, age remains the more robust and independent determinant of permanent teeth eruption status.

Discussion

Permanent Tooth eruption status reflects the child's general physical and nutritional status. In the present study, Body Mass Index(BMI), a marker for nutritional health, was related to the number of permanent teeth erupted in children aged 6 to 13 years.

Erupted permanent teeth were visibly confirmed by considering if any part of the crown was visible above the gingival margin. As the present study was field-based, this method was easy to reproduce, less prone to interpretation bias and was practical for large populations. Over radiographic assessments, this approach was adapted from previous community-based surveys to assess permanent teeth eruption status in school-aged children.[13,14] The findings of the present study showed a positive correlation between chronological age and permanent teeth eruption status, which was highly significant ($P < 0.001$), and age was the strongest predictor in the linear regression model ($\beta = 0.875$, $P < 0.001$). This observation acknowledges the literature evidence that the permanent teeth eruption follows a predictable age sequence, which may be affected due to confounders like population ethnicity, nutritional, and environmental influences.[15,16]

Body Mass Index was not significantly associated with the number of permanent teeth erupted when adjusted for age. A moderate positive correlation was observed between BMI and the number of permanent teeth erupted ($r = 0.404$, $P < 0.001$), but there was no significant association observed when age was stratified. BMI in the regression model did not add any predictive value once age was stratified. This observation implies that children's height and weight increase with age; so that we could interpret that age has a dual influence as a primary determinant for the number of permanent teeth erupted and also the BMI itself, which leads to the misleading correlation observed between BMI and tooth eruption; this aligns with the results of Parner et al. 2001[13] and Selakri et al. 2013.[17]

Other studies, however, have reported contrasting outcomes. For example, Hilgers et al. 2006 [18] observed that obese children exhibited accelerated dental development, as measured by radiographic dental age, compared with

Table 3. Association Between BMI and Mean Number of Permanent Teeth Erupted among Various Age Groups

AGE	Underweight		Healthy Weight		Overweight		Obese		Chi-Square	*P* value
	N	Mean Rank	N	Mean Rank	N	Mean Rank	N	Mean Rank		
6	45	66.22	65	57.72	7	59.07	5	71.60	2.515	.473
7	16	21.16	27	24.46	3	32.33	1	32.00	2.404	.493
8	40	69.96	78	68.21	9	69.22	12	82.38	1.378	.711
9	36	88.67	95	73.81	14	73.86	11	91.64	4.314	.230
10	25	75.70	82	67.86	16	59.47	12	64.29	1.900	.593
11	21	50.43	60	52.93	14	57.21	8	40.06	1.844	.605
12	13	51.81	53	45.05	15	54.90	13	44.65	2.711	.438
13	23	66.43	72	71.61	29	63.95	13	70.35	2.035	.565

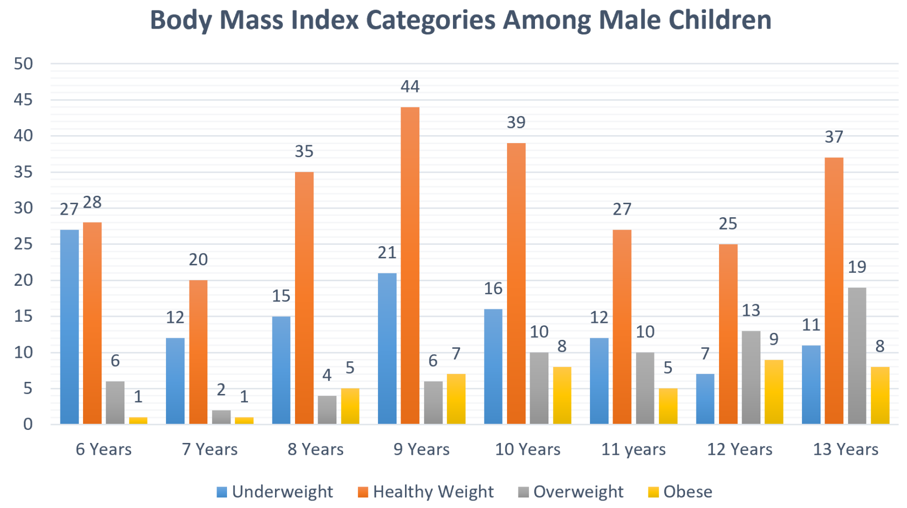

Figure 1. Age-Wise Distribution of Body Mass Index (BMI) Categories Among Male Children

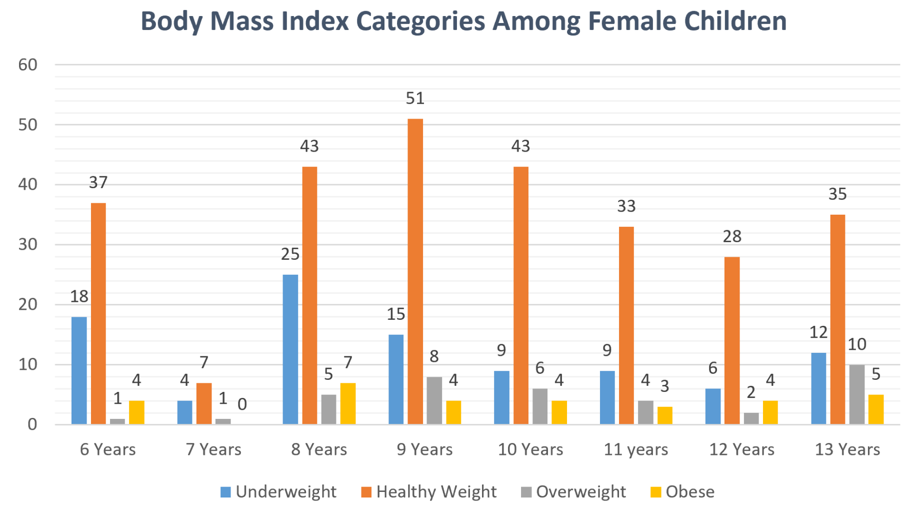

Figure 2. Age-Wise Distribution of Body Mass Index (BMI) Categories Among Female Children

children with normal BMI. Reis et al. 2010 found [14] that overweight Mexican schoolchildren had more erupted teeth than their normal- or underweight peers. However, both studies were either longitudinal or based on radiographic evaluation of dental maturity (e.g., Demirjian's method [4]) rather than clinical eruption status, which may account for the differences in results.

Closer to the study location, a recent study conducted in Chennai by Anusha et al. [19] investigated the association between BMI and the mean age of permanent tooth eruption and reported that overweight and obese children showed delayed eruption. They hypothesized that systemic inflammation, hormonal imbalances (e.g., altered leptin and insulin levels), and physical factors such as increased soft tissue thickness might delay the penetration of teeth into the oral cavity.

Table 4. Regression Between Age, BMI, and Mean Number of Permanent Teeth Erupted

Coefficients[a]									
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B	
		B	Std. Error	Beta			Lower Bound	Upper Bound
1	(Constant)	-16.249	.603		-26.932	.000	-17.433	-15.065
	AGE	3.377	.061	.875	55.240	.000	3.257	3.497
a. Dependent Variable: TNE								

Excluded Variables[a]						
Model		Beta In	t	Sig.	Partial Correlation	Collinearity Statistics Tolerance
1	BMI	-.002[b]	-.119	.905	-.004	.785
2	Gender	-.008[b]	-.508	.612	-.017	.999
a. Dependent Variable: TNE						
b. Predictors in the Model: (Constant), AGE						

It is worth noting that the classification of children based on CDC BMI-for-age percentiles allowed for standardized categorization into underweight, normal weight, overweight, and obese. This classification is based on the 2000 CDC growth charts.[6] The dual influence of age on both BMI and dental eruption, that, as the children grow, both their somatic indices and dental development progress. Therefore, a longitudinal study is needed to address the BMI changes over time for the same children to reveal the interplay between factors.

These findings highlight the importance of chronological age for assessing dental development and BMI for nutritional risk. From a clinical and public health perspective, any preventive school-based or clinical dental programs should primarily be planned considering chronological age and clinical findings.[20]

Our study has several strengths, including a large sample size (n = 933), inclusion of a wide age range, objective measurement of eruption status, and standardised anthropometric assessments using calibrated devices. However, some limitations must be acknowledged. Because this was a cross-sectional design, causality cannot be inferred. In addition, pubertal status was not assessed, which could independently influence both BMI and dental eruption. A longitudinal study with pubertal markers may offer deeper insight, and in addition, true dental development may have been underestimated as radiographic assessment was not done.[21]

Conclusion

The present study showed a bidirectional influence of age on both Body mass index and the number of erupted permanent teeth in children aged 6 to 13 years. Age remained the primary determinant for both Body mass index and permanent tooth eruption. These results suggest that BMI alone may not be a reliable indicator for evaluating dental eruption, emphasising the importance of age-based assessments in both clinical and public health contexts.

Authors' Contribution

Conceptualization: Rathish Guna, Vishnuprasad Subramanian, Mahesh Jagadeson
Data Curation: Rathish Guna, Vishnuprasad Subramanian, Mahesh Jagadeson
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Methodology: Rathish Guna, Vishnuprasad Subramanian, Mahesh Jagadeson
Project Administration: Rathish Guna
Supervision: Vishnuprasad Subramanian, Mahesh Jagadeson
Software: Rathish Guna, Mahesh Jagadeson
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Visualization: Rathish Guna, Vishnuprasad Subramanian, Mahesh Jagadeson
Writing - Original Draft: Rathish Guna
Writing - Review & Editing: Rathish Guna, Vishnuprasad Subramanian, Mahesh Jagadeson

Competing Interests

I declare that no conflict of interest exists.

Data Availability Statement

The data set is available upon request.

Ethical Approval

The Karpaga Vinayaga Institute of Dental Sciences Ethics Review Board approved the study protocol (KIDS/IEC/2025/I/010).

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