ORIGINAL ARTICLE

Correlation between central incisor eruption status and lower facial height in children aged 6-8: a cross-sectional study

Mutiara Putri Ednur[1]
Atiek Driana Rahmawati[2]*
Alfini Octavia[2]
Ana Medawati[3]

[1]Undergraduate Study Program Faculty of Dentistry, Universitas Muhammadiyah Yogyakarta, Indonesia
[2]Department of Pediatric Dentistry, Faculty of Dentistry, Universitas Muhammadiyah Yogyakarta, Indonesia
[3]Department of Biomedical Science, Faculty of Dentistry, Universitas Muhammadiyah Yogyakarta, Indonesia

* Correspondence:
atiek.driana@umy.ac.id

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ABSTRACT

Introduction: Tooth eruption is a key indicator of growth, influencing the timely appearance of permanent teeth essential for facial aesthetics. Age and tooth eruption sequence are crucial in clinical dental health care planning. Fully erupted incisors play a significant role in facial appearance, with facial height impacting facial shape throughout growth. This study aims to analyze the correlation between the eruption status of maxillary and mandibular central incisors and lower facial height in children aged 6-8. **Methods:** This research used a cross-sectional approach. The study's population consisted of 225 children aged 6 to 8 years from Muhammadiyah Purwodiningratan Elementary School. Sampling was conducted using a purposive sampling strategy based on the established inclusion and exclusion criteria, resulting in 102 children being sampled. Dental impressions were taken using alginate. The lower facial height was measured as the distance from the subnasale to the menton. Eruption status was categorized with a score of 0 for teeth not erupted, 1 for partially erupted teeth, and 2 for fully erupted teeth. Spearman analysis was conducted to assess the correlation between incisor eruption status and facial height. **Results:** A significant correlation was found between eruption status and lower facial height ($p<0.05$), with significance values for tooth 11 at 0.009, tooth 21 at 0.004, tooth 31 at 0.003, and tooth 41 at 0.002. **Conclusion:** The eruption status of central incisors exhibits a weak positive correlation with lower facial height, with mandibular incisors showing a stronger association than maxillary incisors in children aged 6-8.

KEYWORDS
Incisor, tooth eruption status, lower facial height, children aged 6-8

INTRODUCTION

Tooth development is one of the factors of growth and development that may be considered a reference since it controls whether or not permanent teeth will erupt according to time.[1-2] Tooth eruption is the movement of teeth from originating in the alveolar bone to the occlusal surface in the oral cavity.[1] A positive correlation was observed between somatic growth and tooth eruption.[3] The absorption that shapes the eruption path, rather than the root formation rate, determines the tooth eruption pattern. The eruption procedure is initiated as soon as the emission path is identified.[4] Humans have two stages of tooth growth: primary teeth in childhood and permanent teeth in adulthood.[2] The age and order of eruption of primary and permanent teeth are important events in child development and play a role in planning dental health care in clinical dentistry.[5] The eruption of teeth is essential for human survival, directly influencing the functions of craniofacial structures, including the development of the mid and lower face.[6] Tooth eruption is an important aspect related to physical growth and gauges a child's maturation. It provides a biological indicator for evaluating the age of adolescents and adults.[7] The process of tooth eruption can be classified into three stages: pre-eruption, eruption (or pre-functional), and post-eruption (or functional). These stages are determined by the movement of the crystal bone. Eruption of a tooth occurs when the crown becomes visible through the oral mucosa.[8] Eruption status is divided into three categories: not yet erupted, partially erupted, and fully erupted.[9]

The mandibular central incisor typically erupts at roughly 6-7 years of age, while the maxillary central incisor usually erupts at around 7-8 years of age.[10] Sockets of the teeth, which are created by a thick ridge of bone called the alveolar bones, are present in both the maxilla and mandible, the two bones that make up the jaw.[11] Beyond mastication, teeth perform various functions, such as establishing a foundation for the height of the face, breathing, supporting a patent airway, and influencing the kinetics of phonation.[12]

Facial height is an essential factor in facial balance, as changes in its dimensions affect the position and rotation of the mandible, contributing to conditions such as deep bite or open bite.[13] Facial height consists of upper and lower facial height. The upper facial height is the distance between the trichion and the glabella, the middle facial height is the distance between the glabella and the sub-nasal, and the lower facial height is the distance between the sub-nasal and the menton.[14]

Vertical facial growth, influenced by the maturation and expansion of facial bones as well as tooth eruption, leads to an increase in facial height over time and significantly impacts facial shape due to its dynamic nature.[13] Facial height is an important factor in facial balance, as changes in facial height affect the position and rotation of the mandible, contributing to conditions such as deep bite or open bite.[14]

The facial height measurement and evaluation can be conducted using direct anthropometric methods. This approach requires minimal equipment and is non-invasive, effective, and easy to use.[15] Recent studies have examined the proportion of facial height across various populations by considering factors such as age, race, and gender. Age, gender, race, genetics, bad behaviors, nutritional status, and malocclusion significantly influence the growth of facial height.[16]

The age of 6-7 years is the age of eruption of the first permanent teeth, namely the mandibular central incisor and maxillary first molar, and the maxillary central incisor usually erupts at around 7-8 years of age.[17] The novelty of this research lies in its examination of the 6–8-year age range, focusing on the early correlation between teeth eruption and facial growth. This approach provides valuable insights into craniofacial development during a crucial stage of childhood, offering potential benefits for early orthodontic intervention and better understanding of facial growth patterns in children. Therefore, this study aims to examine the association between the eruption status of the central incisors and the lower facial height of children aged 6-8 years.

METHODS

The research participants were students enrolled at Muhammadiyah Purwodiningratan and Kasihan Elementary School in Yogyakarta. Screening was conducted for all primary school students based on inclusion and exclusion criteria, with parental consent obtained. The inclusion criteria were Javanese children aged 6 to 8 who were in a healthy nutritional condition, without any craniofacial abnormalities or other diseases, and had significant skeletal asymmetry. This study excluded children who had received orthodontic treatment in the past or present, had visible tooth structure loss from attrition, fracture, caries, or restorations, or had apparent problems that could deform or otherwise affect the face and dentition. Furthermore, those with a systemic condition were excluded through other criteria.

The subjects for this study were selected using a stratified random sampling method. The number of research subjects was determined using the formula n = n/1+ne^2; n = number of samples needed; n = number of population (225); d = validity level selected (d = 0.1). The minimum sample size was 69, but the study included 102 children, comprising both male and female participants. The 102 subjects were evenly divided by gender, with 51 boys and 51 girls, and further grouped by age: 6, 7, and 8 years, with each age group containing 34 children. The assessment of children's nutritional status was conducted by measuring their Body Mass Index (BMI) according to their age.

The study utilized the conventional standards for optimal nutrition. A digital scale with a maximum capacity of 180 kg (QC Pass P: ES-BG00 DO01193281) was employed to measure children's weight. The height was established by attaching a conventional measuring tape to the wall. The children kept standing up while the Frankfurt plane kept in a straight line. The head-pressing device was carefully lowered until it made contact with the peak of their heads.

Using eyebrow liner, the anthropometric landmarks for measuring lower facial height (subnasal-mention) were delineated on the subject's face. Participants were asked to sit, keeping their heads and shoulders in a natural and typical alignment. The arms were positioned to hang naturally at the sides of the body to measure the facial dimensions. A Japanese Mitutoyo digimatic sliding caliper, model number 573-721-20, with serial number 0000644, was used to measure the lower facial height.

To reduce measurement mistakes, a sole operator performed all measurements and assessments of the required parameters. A single operator was responsible for conducting all measurements and assessments of the necessary parameters to minimize measurement mistakes. For high reliability, repeated measurements were conducted on the same subjects under the same conditions at different times. Consistent findings across several occasions indicate high reliability. Providing that measurements are collected consistently and accurately, the data obtained from direct anthropometric methods can be fairly accurate.

Alginate impressions (Aroma fine plus normal set, GC Corporation, Tokyo, Japan) were used to make negative impressions. The dental study models were created by filling the negative impressions with stone plaster, resulting in positive impressions. The study model detected the state of eruption. The teeth analyzed were maxillary permanent teeth that erupted in children between 6 and 8, specifically teeth 11, 21, 31, and 41. The eruption status was classified into three levels: a score of 0 for teeth that had not yet erupted, a score of 1 for partially erupted teeth, and a score of 2 for fully erupted teeth. The data analysis in this study utilized Spearman's rank correlation test to examine the correlation between central incisor eruption status and lower facial height in children aged 6-8. Lower facial height data were analyzed using ANOVA to determine differences between ages 6, 7, and 8-year-old age groups.

RESULTS

The results of the study on the correlation between the eruption status of the maxillary and mandibular central incisors with the lower facial height of children aged 6-8 years were as follows.

Table 1. Frequency distribution of tooth eruption status

Tooth Element	Age (years)	Eruption Status Score							
		0		1		2		Total	
		Freq	(%)	Freq.	(%)	Freq.	(%)	Freq.	(%)
	6	26	76.5	6	17.6	2	5.9	34	100
	7	13	38.2	12	35.3	9	26.5	34	100
11	8	1	2.9	9	26.5	24	70.6	34	100
	Total	40	39.2	27	26.5	35	34.3	102	100
	6	27	79.4	5	14.7	2	5.9	34	100
	7	14	41.2	11	32.4	9	26.5	34	100
21	8	0	0	10	29.4	24	70.6	34	100
	Total	41	40.2	26	25.5	35	34.3	102	100
	6	16	47.1	9	26.5	9	26.5	34	100
	7	5	14.7	12	35.3	17	50	34	100
31	8	0	0	3	8.8	31	91.2	34	100
	Total	21	20.6	24	23.5	57	55.9	102	100
	6	14	41.2	11	32.4	9	26.5	34	100
	7	7	20.6	8	23.5	19	55.9	34	100
41	8	0	0	3	8.8	31	91.2	34	100
	Total	21	20.6	22	21.6	59	57.8	102	100

Table 1 indicates that in children aged 6 years, the central incisors, specifically in the maxilla, are most frequently unerupted (scoring 0); however, by 8 years of age, a large percentage of central incisors have erupted fully (score 2).

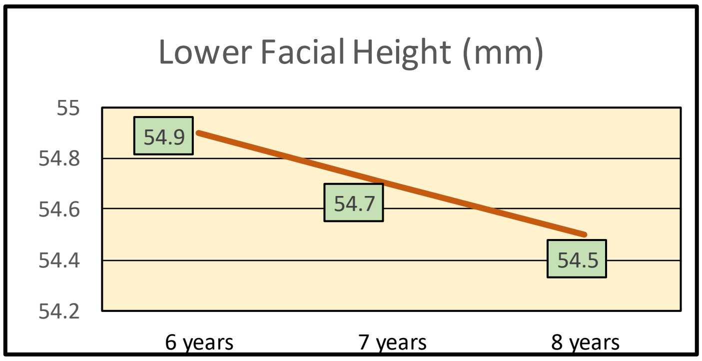

Figure 1. Means of Lower Facial Height Based on Age

Table 2. Test difference in lower facial height aged 6-8 years with anova

Age	N	Mean	Std. Deviation	Minimum	Maximum	F	Sig.
6	34	54.9	3.9	46.2	62.0	0.08	0.92
7	34	54.7	4.2	45.3	62.1		
8	34	54.5	4.7	46.0	63.5		
Total	**102**	**54.7**	**4.2**	**45.3**	**63.5**		

Figure 1 presents the average lower face height of children aged 6 to 8 years. The figure shows a decline from ages 6 to 8 years but indicates that the lower face height is almost the same between groups.

Table 3. Correlation Between Maxillary Central Incisors, Maxillary Molars, and Lower Facial Height

Tooth Element		Middle Facial Height
11	Correlation coefficient	0.258*
	Significance (*2-tailed*)	0.009
	n	102
21	Correlation coefficient	0.283*
	Significance (*2-tailed*)	0.004
	n	102
31	Correlation coefficient	0.289*
	Significance (*2-tailed*)	0.003
	n	102
41	Correlation coefficient	0.310*
	Significance (*2-tailed*)	0.002
	n	102

Correlation is significant at the 0.05 level (2-tailed).

Table 3 reveals the Spearman analysis results between the lower facial height and teeth 11, 21, 31, and 41 in terms of their eruption status. The eruption status of teeth 11 and 21 show statistically significant results, with p-values of 0.009 ($p < 0.05$) and 0.004 ($p < 0.05$), respectively. These findings indicate a significant correlation between the eruption of teeth 11 and 21 and the lower facial height in children aged 6 to 8 years.

The correlation coefficient indicates that tooth 11 has a value of 0.258, while tooth 21 has a value of 0.283, suggesting a weak correlation between the eruption of teeth 11 and 21 and the lower facial height. Table 3 shows a p-value of 0.003 ($p < 0.05$) for tooth 31, indicating a significant correlation between tooth 31 and lower facial height. The examination of tooth 41 reveals a p-value of 0.002, indicating statistical significance ($p<0.05$), and demonstrating a significant correlation between tooth 41 and the lower facial height. The correlation coefficient indicates that tooth 31 has a value of 0.283, while tooth 41 has a value of 0.310, suggesting a weak correlation level between the eruption of teeth 31 and 41 and the height of the lower facial height.

DISCUSSION

Research was conducted to examine the relationship between the eruption status of the maxillary and mandibular central incisors and the size of the lower facial height in children aged 6-8 years. A total of 102 subjects participated in the study, comprising 51 boys and 51 girls to ensure equal gender distribution.

Tooth development, or odontogenesis, is a process of tooth formation, eruption, and unification with periodontal tissue, jaw bone, blood circulation, and the nervous system.[17] The eruption of deciduous teeth occurs between the ages of 1 and 3 years, while the eruption of permanent teeth usually occurs between the ages of 6 and 14 years. The eruption of teeth correlates with normal facial development.[10]

The research findings in Table 1 show that the mandibular central incisors erupt before maxillary central incisors. The first teeth to erupt were 31 and 41, followed by 11 and 21. This is in accordance with McDonald et al.'s statement that the mandibular central incisor erupts in children aged 6 to 7 years, while the maxillary central incisor erupts between 7 and 8 years.[17] The results of this study indicate the important patterns in tooth eruption status for elements 11, 21, 31, and 41 among individuals aged 6 to 8 years. At age 6, most maxillary central incisors (11 and 21) are not yet erupted (76.5% and 79.4%, respectively), but by age 8, the majority have fully erupted (70.6%). Mandibular central incisors (31 and 41) erupt earlier, with more than half fully erupted by age 7 (50% for 31 and 55.9% for 41) and nearly all fully erupted by age 8 (91.2%). This result is consistent with research by Jain et al., who found that the eruption of mandibular teeth on both the left and right sides typically occurs before that of maxillary teeth.[18] Eruption patterns are symmetrical between the right (11 and 41) and left (21 and 31) central incisors, indicating consistent bilateral development. These results provide a reference for normal tooth eruption; deviations from this pattern may suggest developmental anomalies requiring further evaluation. This study showed that between the ages of 6 and 8 years, teeth 31 and 41 had typically fully erupted to the occlusal plane or contacted the opposite tooth. This finding is in line with research conducted by Rahmawati et al., which states that the age of 6-7 years is the age of the first eruption of permanent teeth in children, progressing gradually with age.[9]

Figure 1 illustrates the average lower facial height of children aged 6 to 8 years. It shows a slight but consistent decline in lower facial height, with an average of 54.9 mm at age 6, decreasing to 54.7 mm at age 7, and further reducing to 54.5 mm at age 8. While the trend shows a gradual reduction, the variation between the age groups is minimal, with p-value = 0.92, as shown in Table 2., and likely reflects normal growth patterns during this developmental stage. The age period of 6-8 years is a transition period from primary teeth to permanent teeth, where changes in the alveolar bone and eruption of permanent teeth can affect the lower facial height. However, the growing process of the mandible during this period is slower than in the pre-pubertal phase, resulting in minimal growth of the lower face height.[19,20] This finding suggests that this age period represents a stable growth phase in lower facial height, characterized by minimal changes mostly resulting from dental and alveolar bone adjustments rather than significant skeletal growth. This indicates relative stability of facial proportions during the stage of childhood development.

Table 3 reveals a statistically significant positive correlation between the eruption status of central incisors (both maxillary and mandibular) and lower facial height in children aged 6 to 8 years. These results indicate that tooth eruption stimulates the development of alveolar bone in both the maxilla and mandible. Tooth development is an integral component of craniofacial growth.[21] The association between the eruption status of the maxillary central incisors (11 and 21) and lower facial height is weak and positive, with statistically significant correlation coefficients of 0.258 for tooth 11 and 0.283 for tooth 21 ($p < 0.05$). These findings suggest that the maxillary central incisors have a weak but significant positive correlation with lower facial height, contributing to vertical facial dimensions during development. Similarly, the mandibular central incisors (31 and 41) show a weak positive correlation with lower facial height, as indicated by correlation coefficients of 0.289 for tooth 31 and 0.310 for tooth 41, both of which are statistically significant ($p<0.05$). These results suggest that the eruption of the anterior teeth contributes to an increase in vertical facial dimensions, particularly during the growth phase. However, it is not strongly correlated with other developmental and maturation processes.[21] Although classified as a weak association, the coefficients for the mandibular central incisors are slightly higher compared to those for the maxillary incisors. This indicates that mandibular incisors have a bit more effect on lower facial height during this developmental period. The slightly stronger correlation between the eruption of mandibular central incisors (teeth 31 and 41) and lower facial height, compared to maxillary central incisors (teeth 11 and 21), might be related to several developmental and biomechanical factors.[22]

Mandibular incisors generally erupt earlier, significantly influencing vertical facial dimensions during the early mixed dentition period. The mandible's dynamic growth pattern, which moves downward and forward, has a more significant impact on lower facial height than the relatively stable maxilla. Furthermore, the mandibular incisors are more involved in the formation of anterior occlusion and mastication, which contributes to the vertical facial development.

The correlation between mandibular incisors and the fundamental skeletal and functional systems explains their stronger correlation with the lower facial height.[23] This aligns with the results of this study, which show that the level of correlation coefficient in mandibular incisors with lower facial height is slightly higher than that for maxillary incisors. This indicates that the eruption and position of mandibular incisors significantly influence the vertical dimensions of the lower face.

The result of this study, as shown in Table 3, suggests that there are associations between the eruption status of the incisors and the lower facial height. Weak positive correlations were found between incisor eruptions and lower facial height. This is consistent with research by Davidopoulou and Chatzigianni, which states that tooth eruption is an important part of craniofacial development, including the facial structure, but it is not strongly associated with.[22]

Tooth eruption stimulates alveolar bone growth in both the maxilla and mandible, contributing to the vertical dimensions of the face, particularly during the growth period. The eruption of teeth significantly affects the size and shape of the dental arch.[24]

The eruption period of permanent teeth is the initial phase of facial growth, playing a major role and accounting for 40% of total facial growth.[2] This research result is in line with a previous study that states dental development is associated with the growth of the bimaxillary region in the craniofacial complex and changes in vertical facial dimensions.[25] The maxilla and mandible exhibit different rates and patterns of growth. The maxilla tends to grow forward and downward, mainly influenced by the nasomaxillary complex and the cranial base. In contrast, the mandible develops forward rotation and vertical development, which significantly influences the height of the lower facial region.[26]

According to Dung et al.,[27] tooth eruption plays a significant role in influencing the size and shape of the dental arch, along with factors such as rotation, inclination, genetics, osseous development, and environmental influences. The eruption of teeth stimulates the vertical growth of the alveolar bone by initiating the remodeling and deposition of bone in their supporting structures, which increases the vertical dimension.[28] The increase in the vertical dimension of the face is due to alveolar bone deposition at the basal synchondrosis of the occipital and sphenoid bones, condylar growth, and maxillary suture growth, as evidenced by the increased ramus height and lower anterior facial height.[22]

Teeth eruption, particularly in the anterior maxillary and mandibular regions, exerts pressure on the periodontal ligament and surrounding alveolar bone, stimulating bone remodeling essential for jaw bone growth and development. The remodeling supports vertical and horizontal jaw growth, creating optimal occlusion and facial symmetry. This process directly impacts vertical facial height.[29] The functional requirements of chewing, swallowing, and breathing stimulate the growth and transformation of these structures. Increased masticatory activity, particularly during tooth eruption, impacts biomechanical stress on the mandible, stimulating its remodeling and growth.[26]

Based on the findings of this study, the correlation between tooth eruption, maxillary and mandibular growth, and lower facial height is established through a complex interaction of biological, functional, and structural factors during human growth. Tooth eruption, particularly of the maxillary and mandibular incisors, primarily triggers vertical bone growth. This process exerts biomechanical forces on the alveolar bone, leading to its remodeling. This remodeling facilitates the functional tooth positioning and contributes to maxillary and mandibular elongation. As a result, these changes significantly increase lower facial height.

A limitation of this study is its cross-sectional design, which restricts the ability to observe the dynamic progression of tooth eruption status and craniofacial growth over time. Consequently, the findings present only an overview of the association between incisor eruption status and lower facial height rather than illustrating the possible development of this relationship. It is recommended that future research employ a longitudinal approach to monitor changes in dental eruption status and facial height over time, as this might provide researchers a more profound comprehension of these interactions. Additionally, including a greater variety of dental elements could also provide insights into how various teeth contribute to overall facial proportion, enhancing an understanding of eruption patterns and their clinical implications in pediatric orthodontics. Further longitudinal studies could provide deeper insights into the dynamic interplay between dental eruption and craniofacial growth during different developmental stages.

CONCLUSION

The eruption status of central incisors is weakly correlated to lower facial height, with mandibular incisors showing a stronger association than maxillary incisors. These findings support existing theories of craniofacial growth, emphasizing the role of mandibular development in influencing vertical facial dimensions. The implications of this research suggest that understanding tooth eruption status and craniofacial growth can improve orthodontic treatment planning, especially for vertical growth patients. This information may help predict craniofacial changes and determine when dentists should use braces or other corrective procedures to improve aesthetic and functional outcomes. Knowing that the eruption of the lower mandibular incisor is more closely related to the lower face can help orthodontists focus on lower jaw development when examining face height and width and skeletal abnormalities. This study also emphasizes the need for more research on how these associations vary across age groups, genders, and communities to improve orthodontic diagnosis and treatment.

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