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Original Article

Association of Body Mass Index and Chronology of Tooth Eruption in Children visiting a Dental Hospital in UAE: A Cross-sectional Study

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ABSTRACT

Aim: The objective of this research was to investigate the relationship between body mass index (BMI) and the mean age at which permanent teeth erupt in school-going children. **Materials and Method:** This cross-sectional study at RAK College of Dental Sciences, UAE, involved 89 children aged 6–14 years. Erupted teeth in the mouth were included. Statistical analysis, including t-tests, ANOVA, and Kruskal-Wallis, was conducted using SPSS version 29, with a significance threshold set at $p < 0.05$. **Results:** Out of 89 children (41 girls and 48 boys) in the study, 56.17 % had normal weight, 20.22 % were overweight, 17.97 % were underweight, and 5.6 % were obese. Female children generally experienced earlier permanent tooth eruption than males. Additionally, there was an observed trend of earlier tooth eruption with increasing weight or BMI. Underweight children notably displayed a delayed mean age of tooth eruption. **Conclusion:** This study demonstrates a notable correlation between BMI and the mean age at which permanent teeth erupt in school-going children aged 6 to 14 years who visited our dental hospital. To establish a more precise understanding of the connection between BMI and dental development, we recommend conducting further longitudinal studies involving multiple centers. **Clinical Significance:** Monitoring a child's BMI is crucial for assessing dental health and planning tailored treatment for those aged 6 to 14. Understanding the BMI's connection to permanent tooth eruption timing allows dental professionals to identify trends in early or delayed development. This enables them to customize treatment strategies, promoting a precise and personalized approach for better oral health outcomes in this age group.

1. Introduction

Body Mass Index (BMI) is a widely accepted measure reflecting the relationship between weight and height, offering insights into overall health and potential risks (Modesto et al., 2019). While commonly associated with cardiovascular health, BMI's impact on oral health is equally crucial but often overlooked (Vallogini et al., 2017; Nicholas et al., 2018). Recent attention from researchers and oral health professionals emphasizes the intricate connection between BMI and oral health (Nicholas et al., 2018; Dimaisip-Nabuab et al., 2018; Šindelářová et al., 2018). Neglecting oral health not only causes discomfort but can contribute to systemic health issues, highlighting the intricate link between oral and systemic health (Wong et al., 2017).

Dental development, a complex process from infancy to adulthood, is pivotal for oral health and overall well-being (Wong et al., 2017; Anu V et al., 2020). Odontogenesis, or tooth development, involves coordinated events leading to primary and permanent teeth formation (Anu et al., 2020). Understanding teething chronology is crucial for predicting and managing tooth growth, forming a foundation for lifelong oral health (Alnemer et al., 2017). Obesity's impact on tooth loss and eruption patterns, particularly in childhood, is an area of increasing interest (Garmash, 2017). Overweight individuals experience metabolic and

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hormonal changes affecting tooth development, potentially leading to delayed eruption and oral health issues (Nuttall, 2015).

This study explores the relationship between children's BMI and the mean age of dental eruption, especially permanent teeth, at RAKCODS pediatric dental clinics, UAE. It also investigates sex differences in eruption ages. The null hypothesis posits no significant association between BMI and dental eruption age or differences between male and female eruption ages.

2. Materials and methods

2.1. Ethical guidelines

A cross-sectional study at RAKCODS, RAKMHSU, UAE, aimed to explore the association between BMI and permanent teeth eruption ages in children attending dental clinics. It also sought to identify sex-based differences in eruption ages. Approved by university and health committees (Proposal/Approval number: RAKMHSU-REC-038–2022/23-UG-D, MOHAP/REC/2022/11–2023-UG-D), the research was conducted from Dec 2022 to May 2023. Consent and assent were obtained from parents and children, respectively, with participants being 6–14 years old and visiting RAKCODS pediatric clinics for screening and dental treatment as part of community services.

2.2. Sample power calculation

The sample size calculation utilized the G Power sample size calculator from the University of Kiel in Germany. The calculations indicated that, with an alpha of 0.05, (1-β) of 0.95, and an effect size of 0.4, a sample of 60 would be required. In the study, a total of 89 subjects were recruited, resulting in a post hoc power of 0.96. In the final sample there were 41 females and 48 males.

3. General information

Children without parental consent or with medical conditions were excluded to prevent bias. Demographic data was collected, and an oral hygiene assessment form was used to evaluate oral well-being and document dental eruption progress. BMI calculation involved measuring height and weight during the Initial Nursing Assessment (INA) in the clinics, using standard scales. Measurements were recorded for BMI calculation (Onis, 2007). Children were categorized according to CDC classification based on BMI values (About Child and Teen BMI. Available from: https://www.cdc.gov/healthyweight/assessing/bmi/childrens_bmi/about_childrens_bmi.Html).

Weight Status Category	Percentile Range
Underweight	Less than the 5th percentile
Normal Weight	5th percentile to less than the 85th percentile
Overweight	85th to less than the 95th percentile
Obese	Equal to or greater than the 95th percentile

Teeth visible in the oral cavity were considered erupted and documented through intraoral assessments in a dental chair with proper lighting and mirrors. Clinical eruption, defined as the visible breakthrough of a tooth through the gingival mucosa (Paz-Cortés et al., 2022), was examined. The principal investigator, also the faculty supervisor, conducted comprehensive training for co-investigators on data recording and dental examinations for children. To ensure impartiality, one co-investigator recorded data during clinic visits, including demographics, height, weight, and BMI calculation, while another received training for intraoral examinations.

3.1. Statistical analysis

The data underwent analysis using SPSS version 29 (IBM Corp. Released 2022). A *t*-test compared mean ages of permanent tooth eruption between females and males, determining statistical differences. ANOVA explored the relationship between BMI and mean age of permanent tooth eruption. Kruskal-Wallis tested ANOVA results, considering potential deviations from normality in the sample.

4. Results

In this study, 89 children aged 6 to 14, attending RAKCODS pediatric clinics for community screening, were assessed. Gender distribution included 41 females (46.07 %) and 48 males (53.93 %) with an average age of 7.23 ± 1.6 years. During initial screening, BMI and oral cavity examinations for selected index teeth were conducted. Of the participants, 56.17 % were of normal weight, 20.22 % overweight, 17.97 % underweight, and 5.6 % obese. Comparing mean eruption ages between sexes revealed significant differences ($p < 0.05$) for most teeth, indicating earlier eruption in females (Table 1). Lower arch teeth generally erupted earlier than upper arch teeth (Table 2 and Table 3). Analyzing mean eruption ages based on BMI indicated a trend of earlier eruption with increasing weight. Notably, underweight children showed a distinct delay in eruption ages, with statistical significance ($p < 0.05$) for most evaluated teeth.

5. Discussion

Recent dental research has increasingly focused on the intricate relationship between body mass index (BMI), nutrition, and tooth eruption age (Verma et al., 2017; Neto and Falcão, 2014; Esan, 2019; Pahel, 2017; Mohamedhussein, 2020; Hedayati, 2014). It is crucial to comprehend how BMI and nutritional status may influence the timing of tooth eruption (Verma et al., 2017; Neto and Falcão, 2014). Dental development, influenced by systemic and environmental factors, necessitates understanding the intricate interplay of BMI and nutrition with tooth eruption age, holding implications for clinical practice and broader health considerations (Esan and Schepartz, 2019). While existing literature explores the link between systemic health indicators like BMI and oral health, limited research specifically addresses the relationship between BMI, nutrition, and tooth eruption timing.

Teeth eruption age is a vital marker of a child's growth, with

Table 1
Mean Age of Eruption of Teeth Among Males and Females.

Teeth	Mean age (males)	Mean age (females)	p Value
UR first molar	6.89 ± 0.87	5.75 ± 0.61	0.046*
UL First molar	6.91 ± 0.83	5.67 ± 0.57	0.042*
UR Central incisor	7.88 ± 1.86	6.85 ± 0.35	0.045*
UR Lateral Incisor	8.85 ± 1.44	7.75 ± 1.11	0.39
UR Canine	11.81 ± 1.12	11.46 ± 1.1	0.015*
UL Canine	11.96 ± 1.11	11.64 ± 1.23	0.043*
UR First Premolar	10.68 ± 1.31	10.14 ± 1.34	0.047*
UL First Premolar	10.66 ± 1.29	10.12 ± 1.16	0.05*
UR Second Premolar	11.67 ± 1.15	10.95 ± 1.23	0.32
UL Second Premolar	11.54 ± 1.26	10.75 ± 1.27	0.048*
LR First Molar	6.04 ± 1.28	5.45 ± 1.27	0.041*
LL First Molar	6.11 ± 1.17	5.38 ± 0.97	0.04*
LR Central Incisor	6.45 ± 1.47	6.06 ± 0.27	0.039*
LR Lateral Incisor	7.59 ± 1.80	7.10 ± 0.23	0.048*
LL Central Incisor	6.39 ± 1.48	5.96 ± 0.85	0.061*
LL Lateral Incisor	7.68 ± 1.97	7.19 ± 0.22	0.048*
LR Canine	10.43 ± 1.21	10.24 ± 1.21	0.42
LL Canine	10.35 ± 1.45	10.08 ± 1.32	0.46
LR First Premolar	10.62 ± 1.31	10.51 ± 1.1	0.52
LL First Premolar	10.58 ± 1.34	10.21 ± 1.2	0.37
LR Second Premolar	12.10 ± 1.32	11.86 ± 1.31	0.046*
LL Second Premolar	12.43 ± 1.1	12.36 ± 1.2	0.043*
UR Second Molar	12.12 ± 1.1	11.89 ± 1.31	0.048*
UL Second Molar	12.23 ± 1.22	11.96 ± 1.24	0.047*
LR Second Molar	12.10 ± 1.1	11.84 ± 1.2	0.046*
LL Second Molar	12.33 ± 1.28	11.92 ± 1.1	0.38*

Table 2
Comparison of Mean Age of Eruption vs BMI: Maxillary Teeth.

BMI Final	UR First Molar	UR Lateral Incisor	UR Central Incisor	UL Central Incisor	UL Lateral Incisor	UL First Molar	UR Canine	UL Canine	UR First Premolar	UR Second Premolar	UL First Premolar	UL Second Premolar	UR Second Molar	UL Second Molar
Obese	5.84 ± 1.21	6.02 ± 1.15	6.18 ± 1.18	6.67 ± 1.83	6.19 ± 2.12	5.58 ± 1.32	11.13± 1.23	11.51± 1.1	10.08± 1.12	10.98± 1.12	10.59± 1.12	10.98± 1.12	11.86± 1.21	12.02± 1.1
Overweight	6.71 ± 0.31	6.73 ± 1.31	6.84 ± 1.24	6.96 ± 1.35	6.62 ± 2.40	6.60 ± 0.40	11.49± 1.24	11.69± 1.42	10.38± 1.42	11.20± 1.42	10.86± 1.24	11.26± 1.38	11.98± 1.12	12.18± 1.28
Normal	7.42 ± 1.50	7.98 ± 1.43	7.86 ± 2.52	7.02 ± 1.32	7.63 ± 1.43	7.96 ± 1.61	11.65 ± 1.12	11.78 ± 1.23	10.52 ± 1.31	11.52± 1.43	10.65 ± 1.23	11.18 ± 1.34	12.13± 1.1	12.34± 1.26
Underweight	8.71 ± 1.32	9.91 ± 1.31	8.71 ± 1.42	8.96± 1.12	9.72 ± 1.32	8.53 ± 1.37	11.92± 1.04	11.89± 1.13	11.22± 1.21	11.84± 1.18	10.92± 1.1	11.45± 1.24	12.84± 1.42	12.92± 1.53
Total	7.29 ± 1.08	7.66 ± 1.30	7.39 ± 1.59	7.40 ± 1.40	7.54 ± 1.81	7.16 ± 1.17	11.54± 1.15	11.71± 1.22	10.55± 1.26	11.38± 1.28	10.75± 1.27	11.21± 1.27	11.61± 1.21	12.36± 1.29
p value (Anova)	0.001*	0.02*	0.002*	0.02*	0.002*	0.001*	0.03*	0.05*	0.065	0.004*	0.063	0.048*	0.041*	0.047*
Kruskal Wallis test	15.171	11.042	13.053	9.143	14.817	15.241	10.320	9.723	5.231	14.944	3.312	10.213	11.126	11.891
p value	0.001*	0.021*	0.002*	0.01*	0.002*	0.05*	0.03*	0.05*	0.072	0.004*	0.076	0.047*	0.04*	0.04*

Table 3
Comparison of Mean Age of Eruption vs BMI: Mandibular Teeth.

BMI Final	LL First Molar	LL Lateral Incisor	LL Central Incisor	LR Central Incisor	LR Lateral Incisor	LR First Molar	LR Canine	LL Canine	LR First Premolar	LR Second Premolar	LL First Premolar	LL Second Premolar	LR Second Molar	LL Second Molar
Obese	4.84 ± 1.21	5.92 ± 1.22	5.18 ± 1.28	5.14 ± 1.62	5.81 ± 1.32	4.58 ± 1.21	11.10± 1.1	11.21± 1.42	10.02± 1.21	11.02± 1.23	9.89± 1.22	10.43± 1.54	12.04± 1.42	12.02± 1.26
Overweight	5.23 ± 1.12	6.73 ± 1.25	5.94 ± 1.12	5.96 ± 1.12	6.41 ± 1.22	5.60 ± 1.32	11.42 ± 1.45	11.37± 1.32	10.18± 1.22	11.15± 1.21	10.19± 1.12	11.14± 1.2	12.14± 1.21	12.41± 1.24
Normal	6.34 ± 1.12	7.28 ± 1.34	6.26 ± 2.52	6.22 ± 1.24	7.14 ± 1.12	6.16 ± 1.32	11.43 ± 1.23	11.49 ± 1.12	10.27 ± 1.43	11.22 ± 1.23	10.23 ± 1.38	11.32 ± 1.14	12.35± 1.32	12.45± 1.1
Underweight	7.85 ± 1.10	8.91 ± 1.42	7.71 ± 1.42	7.16± 1.32	8.48 ± 2.12	7.67 ± 1.08	11.89± 1.21	11.91± 1.13	10.89± 1.2	11.87± 1.45	10.98± 1.1	11.58± 1.42	12.88± 1.14	12.97± 1.1
Total	6.06 ± 1.23	7.21 ± 1.30	6.27 ± 1.58	6.12 ± 1.32	6.96 ± 1.44	6.00 ± 1.23	11.46± 1.24	11.49± 1.27	10.34± 1.26	11.31± 1.28	10.32± 1.20	11.11± 1.32	12.35± 1.27	12.46± 1.17
p value (Anova)	0.001*	0.013*	0.011*	0.001*	0.04*	0.05*	0.03*	0.04*	0.068	0.023*	0.064	0.047*	0.04*	0.05*
Kruskal Wallis test	15.171	12.013	11.089	15.143	8.817	9.653	10.320	8.816	4.657	7.546	4.873	7.651	8.083	8.891
p value	0.001*	0.021*	0.012*	0.001*	0.04*	0.05*	0.03*	0.04*	0.072	0.024*	0.076	0.037*	0.02*	0.04*

nutritional status, reflected in BMI and dietary intake, likely playing a substantial role (Esan and Schepartz, 2019; Pahel, 2017; Mohamedhussein, 2020). Given nutrition's well-established impact on overall growth and development, it's reasonable to hypothesize its influence on dental maturation (Hedayati, 2014). Understanding the potential interdependencies between nutritional intake, BMI, and tooth eruption age could provide valuable insights into their collective contribution to oral health trajectories. Such insights might guide targeted interventions and preventive strategies in pediatric dental care.

This study explores the relationships among BMI, nutritional factors, and tooth eruption age in school-aged children. The findings indicate that females experience statistically significant earlier tooth eruption than males, aligning with existing studies (Fatemifar et al., 2014; Wong et al., 2019). This observation mirrors broader developmental patterns where females mature faster due to hormonal, genetic, and physiological factors (Oznurhan et al., 2016). The earlier tooth eruption in females carries clinical implications for pediatric dentistry, necessitating attention to sex-related differences in dental maturation (Šindelárová et al., 2017). Recognizing such temporal variations can contribute to more accurate age-related tooth emergence guidelines and prompt consideration of long-term oral health implications, especially regarding orthodontic needs and treatment timing.

Additionally, the study establishes a significant link between BMI and tooth eruption, suggesting an association between overall health and dental maturation. Obese children exhibited earlier tooth eruption compared to normal and underweight counterparts, consistent with global studies (Plamena Sapunarova et al., 2020; Cheng et al., 2014; Yamauchi et al., 2014). Hormonal imbalances, particularly elevated leptin levels, in obese children may contribute to premature tooth eruption (Evangelista et al., 2018). The impact of diet, characterized by nutrient-poor but energy-dense choices, and genetic and epigenetic factors further influences tooth development and eruption timing (Javaneh Vejdani et al. ,2015; Chava et al., 2018). Chronic low-grade inflammation associated with obesity may also affect signaling pathways regulating tooth eruption, contributing to early permanent tooth emergence (Traver et al.,2022). Understanding these interplays has broader implications for pediatric health, as early tooth eruption in obese children may increase susceptibility to decay and misalignment. Dental professionals should consider these factors for effective preventive care, emphasizing the complex relationship between systemic health and dental development. Further research is essential to unravel the precise mechanisms, contributing to improved oral health strategies for children of diverse body types.

The relationship between delayed tooth eruption in underweight or malnourished children is intricate and influenced by various factors. Proper tooth mineralization and growth hinge on sufficient nutrition, including vital nutrients like calcium, vitamin D, and phosphorus (Dean et al.,2021). Malnutrition can affect the endocrine system, impacting crucial hormones like growth and thyroid hormones necessary for normal tooth development (Cameron and Widmer, 2021). Underweight or malnourished children may experience delayed overall growth, affecting facial bone and jaw development, influencing tooth eruption (Pinkham et al., 2013). Systemic conditions associated with malnutrition may contribute to delayed tooth eruption, requiring a multidisciplinary approach with nutritionists, pediatricians, and dentists for thorough evaluation and intervention (Touger-Decker et al., 2013). In the current study, the authors observed delayed tooth eruption among underweight children, echoing findings from previous research (Alvarez and Navia, 1989; Alvarez et al., 1990, 1993). Nevertheless, some studies have not detected a correlation between malnutrition and delayed eruption (Elamin and Liversidge, 2013). It's crucial to highlight that although evidence hints at a link, additional research may be necessary to fully grasp the underlying mechanisms.

The study has limitations that warrant consideration. Firstly, the relatively small and non-diverse sample size may constrain the generalizability of findings. The cross-sectional design may inadequately capture the dynamic BMI-tooth eruption relationship. Unaccounted variables like genetics, hormones, socioeconomic status, and dietary habits could compromise internal validity. Relying solely on BMI may oversimplify body composition and adipose tissue distribution complexities. The study's attribution of differences solely to BMI and the considerable individual variability in tooth eruption timing may affect result precision. Generalizing findings beyond the studied population and establishing a causal link between BMI and delayed tooth eruption pose challenges.

6. Conclusion

This study in Ras Al Khaimah, UAE, found a notable link between BMI and average permanent tooth eruption age in 6–14-year-old schoolchildren. Females generally had earlier tooth eruption than males. Overweight or obese children with higher BMI experienced accelerated permanent tooth eruption compared to those with lower BMI.

CRediT authorship contribution statement

Vivek Padmanabhan: Conceptualization, Writing – original draft, Investigation, Validation, Formal analysis, Methodology, Supervision, Resources. **Kusai Baroudi:** Review and editing. **Shamsa Abdulla:** Data curation. **Sara Hesham:** Data curation. **Mohamed Ahmed Elsayed:** Visualization. **Muhammad Mustahsen Rahman:** Review and editing. **Md Sofiqul Islam:** Review and editing.

References

Alnemer, K., Pani, S., Althubaiti, A., Bawazeer, M., 2017. Impact of birth characteristics, breast feeding and vital statistics on the eruption of primary teeth among healthy infants in Saudi Arabia: an observational study. BMJ. 7, e018621.

Alvarez, J.O., Eguren, J.C., Caceda, J., Navia, J.M., 1990. The effect of nutritional status on the age distribution of dental caries in primary teeth. JDentRes. 69 (9), 1564–1566.

Alvarez, J.O., Navia, J.M., 1989. Nutritional status, tooth eruption and dental caries: a review. Am J Clin Nutr. 49 (3), 417–426.

Alvarez, J.O., Caceda, J., Woolley, T.W., et al., 1993. A longitudinal study of dental caries in the primary teeth of children who suffer from infant malnutrition. J Dent Res. 72, 1573–1576.

Anu, V., Brindha, J.R., Carol, P.T., Diana, P.C., Elsy, J.D., Sharma, G., 2020. Does Body Mass Index affect Tooth Eruption Sequence? A Study among 6–7 Years Old Schoolchildren in Chennai. India. Int J Clin Pediatr Dent. 13, 261–263.

Cameron, A.C., Widmer, R.P., 2021. Handbook of Pediatric Dentistry, 5th ed. Elsevier Health Sciences.

Chava, S., Chennakesavulu, S., Gayatri, B.M., Reddy, A.B.M., 2018. A Novel Phosphorylation yb AMP-Activated Kinase Regulates RUNX2 From Ubiquitination in Osteogenesis Over Adipogenesis. Cell Death Dis. 9, 754.

Cheng, K.K., Lam, K.S., Wang, B., Xu, A., 2014. Signaling Mechanisms Underlying the Insulin-Sensitizing Effects of Adiponectin. Best Pract. Res. Clin. Endocrinol. Metab. 28, 3–13.

Dean, J.A., Avery, D.R., McDonald, R.E., 2021. McDonald and Avery's Dentistry for the Child and Adolescent, 11th ed. Elsevier Health Sciences.

Dimaisip-Nabuab, J., Duijster, D., Benzian, H., Heinrich-Weltzien, R., Homsavath, A., Monse, B., et al., 2018. Nutritional status, dental caries and tooth eruption in children: a longitudinal study in Cambodia. Indonesia and Lao PDR. BMC Pediatr. 18, 300.

Elamin, F., Liversidge, H.M., 2013 Aug 30. Malnutrition has no effect on the timing of human tooth formation. PLoS One. 8 (8), e72274.

Esan, T.A., Schepartz, L.A., 2019. Does nutrition have an effect on the timing of tooth formation? A J Phys Antropol. 171 (3), 470–480 [PubMed] [Google Scholar].

Evangelista, S., Regina, K., Vasconcelos, F., Xavier, A., Oliveira, S., Luiz, A., et al., 2018. Timing of Permanent Tooth Emergence is Associated with Overweight/Obesity in Children from the Amazon Region. Braz Dent J. 29, 465–468.

Fatemifar, G., Evans, D.M., Tobias, J.H., 2014. The association between primary tooth emergence and anthropometric measures in young adults: Findings from a large prospective cohort study. PLoS One. 9, e96355.

Garmash, O., 2017. An eruption pattern of deciduous teeth in children born with fetal macrosomia during the first year of life. Georg Med Newa. 2, 14–23.

Hedayati, Z., Khalafinejad, F., 2014. Relationship between Body Mass Index, Skeletal Maturation and Dental Development in 6- to 15-Year-Old Orthodontic Patients in a Sample of Iranian Population. J. Dent. Shiraz. Univ. Med. Sci. 15, 180–186.

Modesto, A., Jacas, C., Kim, S., Desman, A., West, I., Lebow, M., 2019. Childhood Obesity, Genetic Variation, and Dental Age. Am Acad Pediatr Dent. 41, 132–135.

Mohamedhussein, N., Busuttil-Naudi, A., Mohammed, H., Uihaq, A., 2020. Association of obesity with the eruption of first and second permanent molars in children: a systematic review. Eur Arch Paediatr Dent. 21 (1), 13–23.

Neto, P.G.F., Falcão, M.C., 2014. Eruption chronology of the first deciduous teeth in children born prematurely with birth weight less than 1500 g. Rev Paul Pediatr. 32 (1), 17–23.
Nicholas, C.L., Kadavy, K., Holton, N.E., Marshall, T., Richter, A., Southard, T., 2018. Childhood body mass index is associated with early dental development and eruption in a longitudinal sample from the Iowa Facial Growth Study. Am J Orthod Dentofac Orthop. 154, 72–81.
Nuttall, F.Q., 2015. Body Mass Index Obesity, BMI, and Health: A Critical Review. Nutrition Today 50 (3), 117–128. https://doi.org/10.1097/NT.0000000000000092.
Onis, M., Onyango, A.W., et al., 2007. Development of a WHO growth reference for school-aged children and adolescents. Bulletin of the World Health Organization 85 (9), 660–667. https://doi.org/10.2471/BLT.07.043497.
Oznurhan, F., Ekci, E.S., Ozalp, S., Deveci, C., Delilbasi, A.E., Bani, M., Oztas, N., 2016. Time and sequence of eruption of permanent teeth in Ankara. Turkey. Pediatric Dental Journal. 26 (1), 1–7.
Pahel Jr, B.T., Vann, W.F., Divaris, K., Rozier, R.G., 2017. A contemporary examination of first and second permanent molar emergence. J Dent Res. 96 (10), 1115–1121 [PMC free article] [PubMed] [Google Scholar].
Paz-Cortés, M.M., Muñoz-Cano, L., Diéguez-Pérez, M., 2022. Evaluation of the Relationship between the BMI and the Sequence and Chronology of Eruption in Permanent Dentition in Spanish Population. Healthcare (basel). 10 (6), 1046. https://doi.org/10.3390/healthcare10061046. PMID: 35742098; PMCID: PMC9222528.
Pinkham, J.R., Casamassimo, P.S., Fields Jr, H.W., McTigue, D.J., Nowak, A., 2013. Pediatric Dentistry: Infancy through Adolescence, 5th ed. Elsevier Health Sciences.
Plamena Sapunarova, Tanya Nihtyanova, Svetla Petrova, Maria Kukleva. Association between obesity and permanent tooth eruption. J of IMAB. 2020 Jan-Mar;26(1): 2871-2874.
Šindelářová, R., Soukup, P., Broukal, Z., 2018. The relationship of obesity to the timing of permanent tooth emergence in Czech children. Acta Odontol Scand. 76, 220–225.
Šindelárová, R., Žáková, L., Broukal, Z., 2017. Standards for permanent tooth emergence in Czech children. BMC Oral Health. 17 (1), 1–8.
Touger-Decker, R., Mobley, C., Academy of Nutrition and Dietetics (U.S.), 2013. Position of the Academy of Nutrition and Dietetics: Oral Health and Nutrition. J Acad Nutr Diet. 113 (5), 693–701.
Traver, C., Miralles, L., Barcia, J.M., 2022. Association between Molecular Mechanisms and Tooth Eruption in Children with Obesity. Children. 9 (8), 1209. https://doi.org/10.3390/children9081209.
Vallogini, G., Nobili, V., Rongo, R., De Rosa, S., Magliardit, F., DÀntò V, et al., 2017. Evaluation of the relationship between obesity, dental caries and periodontal disease in adolescents. Eur J Paediatr Dent. 18, 268–272.
Vejdani, J., Heidarzadeh, A., Darkaneh, S.M., 2015. Eruption time of the first Primary Tooth and its Relationship with Growth Parameters in Children. Journal of Dentomaxillofacial Radiology Pathology and Surgery. 3 (4), 15–19.
Verma, N., Bansal, A., Tyagi, P., Jain, A., Tiwari, U., Gupta, R., 2017. Eruption chronology in children: a cross-sectional study. Int J Clin Pediatri. Dent. 10 (3), 278–282 [PMC free article] [PubMed] [Google Scholar].
Wong, H., Peng, S., Yang, Y., King, N., McGrath, C., 2017. Tooth eruption and obesity in 12 year-old children. J Dent Sci. 12, 126–132.
Wong, H.M., Peng, S.M., McGrath, C.P.J., 2019. Association of infant growth with emergence of permanent dentition among 12 year-aged southern Chinese school children. BMC Oral Health 19 (1), 1–9.
Yamauchi, T., Iwabu, M., Okada-Iwabu, M., Kadowaki, T., 2014. Adiponectin Receptors: A Review of Their Structure, Function and How They Work. Best Pract. Res. Clin. Endocrinol. Metab. 28, 15–23.