
Growth and Development Factors of Infants and Maternal Conditions During Pregnancy for the Eruption of the First Deciduous Teeth (Literature Review)

Faktor Pertumbuhan dan Perkembangan Bayi
dan Persiapan Kondisi Ibu selama Masa Kehamilan
terhadap Erupsi Gigi Desidui Pertama
(Tinjauan Pustaka)

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Abstract

Tooth eruption is a condition in which the cusp or incisal of the tooth emerges through the gingiva, but not exceeding 3mm above this level after the corona is formed. The first human tooth that erupts is the mandibular primary central incisor, which is the reference for the eruption of others, including the primary and permanent teeth, that support the growth of the jaw, face, mastication, swallowing, speech, and aesthetics. Furthermore, tooth eruption is influenced by the growth and development of the fetus during pregnancy. Maternal conditions during pregnancy such as age, level of education, physical condition, and nutritional intake affect fetal nutrition which indicates the level of growth and development in the form of head circumference, birth weight, and height that affect the eruption time of the mandibular deciduous central incisor. During pregnancy, the maternal preparation to be considered is the age which might range from 20-35 years, adequate nutritional intake of carbohydrates, folic acid, protein, vitamin C, vitamin D, and minerals, prevention of physical fatigue, intelligence in choosing nutrition, and abstaining from alcohol and caffeine consumption. This study aims to provide information/education on the preparation of pregnant women for the eruption of the mandibular primary central incisor which is part of the infant's growth and development.

Keywords: tooth eruption, infant growth, pregnant women

Abstrak

Erupsi gigi merupakan keadaan tonjol atau insisal gigi muncul menembus gingiva dengan ketinggian tidak lebih dari 3mm di atas gingiva level setelah korona gigi terbentuk. Gigi manusia yang pertama kali erupsi adalah gigi insisivus sentralis desidui rahang bawah, yang merupakan acuan untuk erupsi gigi lainnya, baik gigi desidui maupun permanen, yang akan mendukung pertumbuhan rahang, wajah, mastikasi, penelanan, bicara, dan estetika. Erupsi gigi dipengaruhi oleh pertumbuhan dan perkembangan janin pada masa kehamilan. Kondisi ibu selama masa kehamilan seperti usia, tingkat pendidikan, kondisi fisik, dan asupan nutrisi akan memengaruhi nutrisi janin yang menunjukkan tingkat tumbuh kembang bayi berupa lingkaran kepala, berat badan lahir, dan tinggi badan bayi yang memengaruhi waktu erupsi gigi Insisivus sentralis desidui rahang bawah. Persiapan ibu yang harus diperhatikan selama masa kehamilan adalah usia 20-35 tahun, asupan nutrisi yang cukup (karbohidrat, asam folat, protein, Vitamin C, vitamin D, dan mineral), tidak mengalami kelelahan fisik, kecerdasan dalam memilih nutrisi (tingkat pendidikan tinggi), dan tidak mengonsumsi alkohol dan kafein. Tujuan tinjauan pustaka ini adalah sebagai informasi/penyuluhan persiapan ibu hamil terhadap erupsi gigi Insisivus sentralis desidui rahang bawah yang merupakan bagian dari tumbuh kembang bayi.

Kata kunci : Erupsi gigi, tumbuh kembang bayi, ibu hamil.

INTRODUCTION

Humans as diphyodonts have two periods of teeth during their life,^{1,2} the first is deciduous teeth also called primary, milk, infant, or lacteal teeth.¹⁻⁴ Meanwhile, the second is the permanent teeth also known as secondary, replacement, or adult teeth.¹⁻³ The total number of primary teeth is 20, which includes central and lateral incisors, canine, as well as the first and second molar. The total number of permanent teeth is 32, comprising of a central and lateral incisor, canine, first and second premolar, as well as the first, second, and third molar.¹⁻³ The teeth play a role in the mastication process, speech, predicting age, and supporting aesthetics. In addition, deciduous teeth provide a place for the eruption of the permanent teeth, to maintain and stimulate the development of the jaw and head.^{5,6}

The first deciduous tooth to erupt is the mandibular central deciduous incisor. Hence, it can be used as a reference for the eruption of other teeth to avoid the risk of disrupting the growth of the jaw, face, mastication, swallowing, speech, and malocclusion that can interfere with aesthetics.⁷

The eruption process for both primary and permanent teeth occurs after the dental corona is formed through the odontogenesis process consisting of the bud, cap, and bell stage. Tooth eruption occurs due to the movement that pushes the teeth into the oral cavity originating from the formation of the root, the role of the periodontal ligament, fibroblast contraction, and vascular pressure thereby displacing the incisal and occlusal surfaces of the primary teeth to the alveolar bone, this process is known as the pre-eruptive stage. Subsequently, in the pre-functional stage, the crown erupts into the oral cavity through the epithelium-lined pathway due to oral epithelium fusion, reaching occlusion contact with the opposite tooth where the incisal edge of the lower incisor meets the cingulum of the maxillary incisor, this is known as the functional stage.⁸

Primary teeth are often overlooked because of their short time in the oral cavity, which is ± 6 years. However, they have an important role in maintaining as well as stimulating the jawbone and head growth and development.^{5,6} Therefore, this study aims to examine the factors that influence the eruption time of the first deciduous teeth to prevent delays in the optimal jaw and head growth as well as to support the survival of children to adulthood.

DISCUSSION

According to Kiran et al. (2011) (in Massignan 2016), tooth eruption is defined as the presence of the clinical crown in the oral cavity, not exceeding 3mm of the gingiva level.⁹

The first deciduous tooth to erupt is the mandibular central incisors, specifically when the infant is 6 months old. Tooth eruption can be influenced by various factors, such as infant's head circumference, birth weight, and length, as well as the maternal condition such as maternal age and education level.^{6,7,9,11}

Ntani et al. (2015) conducted a study on 2,915 children born in Southampton and reported a strong correlation between the size of the infant's head circumference and the eruption time of the mandibular deciduous central incisors. This is because head circumference is a skeletal measurement variable and is more likely to be associated with dental development.¹² Motamayel (2017) also performed a study on 126 infants at the Hamadan Health Center, Iran, while Vejdani et al. (2015) examined 648 infants aged 3-15 months at the Rasht Health Center. Iran reported that there was a significant correlation between the head circumference and tooth eruption, infants with a normal head circumference or >33 cm experienced tooth eruption time that was consistent with the pattern of the first deciduous teeth namely 6 months of age. Meanwhile, infants with a small head circumference <33 cm experienced delayed eruption of deciduous teeth.^{7,13}

This is presumably related to nutritional intake, which is one of the factors that affect the growth of various organs in the body. Although the growth rates of each organ system are different, there is a harmony of overall proportions. For example, the teeth begin to grow appropriately when the jaw is large enough to accommodate them, therefore a large head circumference is associated with a rapid eruption time. This is because the large head circumference is in line with the growth of the jaw which acts as a place for the teeth to erupt. In contrast, infants with a small head circumference, caused by premature births and severe malnutrition might experience delayed tooth eruption.^{14,15}

A study conducted by Zarabadipour et al. (2019) on 160 infants at the Tabriz Medical Center reported that there was a significant relationship between birth weight and the eruption time of the mandibular deciduous central incisors.⁶ Furthermore, Ntani et al. (2015) et al. stated that infants with higher birth

weight experienced an early eruption of the mandibular deciduous central incisors,¹² while Motamayel et al. (2017) revealed that there is a difference in the teeth eruption time between infants with normal and low birth weight (LBW), where infants who have a normal birth weight ranging from 2,500-3,500 experienced tooth eruption times consistent with the pattern of deciduous teeth namely 6 months of age. Meanwhile, infants who have low birth weight <2,500 g will experience delayed eruption of deciduous teeth after 6 months.⁷

This is related to an infant's nutritional intake such as Vitamin B12, iron, folic acid, and essential fatty acids¹⁸, where nutritional deficiencies lead to low infant weight and delayed tooth eruption. This is because nutrition plays an important role in the formation of teeth, hence, a typical infant weight will cause a normal tooth eruption time, while low body weight leads to a delay in tooth eruption.^{7,19,20}

Vitamin B12 has a potential role in elevating plasma homocysteine levels in pregnancy and is implicated in adverse outcomes such as low birth weight. Only a small amount of 3 micrograms is needed daily. Meanwhile, iron deficiency anemia is associated with low birth weight, preterm babies, and might also affect immune function, as well as increase susceptibility to infections. Supplementation of 60 mg ferrous iron and 250µgm folic acid twice a day is recommended. DHA (docosahexaenoic acid) and Arachidonic acid are essential long-chain PUFA (polyunsaturated fatty acids) that are important structural components of the lipid membrane of the central nervous system and are very critical for normal growth and development.^{18,21}

Aside from these nongenetic mechanisms in the form of nutritional intake, the association between maternal height and birth outcomes consisting of infant's weight and length can be attributed to genetics, given that genetic polymorphisms which influence maternal height might also have direct functional effects on pregnancy outcomes in the fetus.²²

Ntani et al. (2015) stated that taller infants tend to erupt mandibular deciduous incisors earlier.¹² Meanwhile, Vejdani (2015) reported that the infant's length has a relationship with the tooth eruption time, where those with a normal length of 48 cm experienced a pattern that was consistent with the deciduous teeth namely 6 months. In contrast, infants born with a length below 48 cm experienced a delayed eruption of deciduous teeth >6 months.¹³

This is associated with body length which is closely related to skeletal growth. In general, the skeletal growth is in line with the development of the skull

and jawbones, hence, normal body length facilitates a fast tooth eruption time.⁷

Apart from nongenetic mechanisms, specifically nutrient intake, the relationship between maternal height and birth outcomes such as infant weight and height might be regulated by genetics, where genetic polymorphisms which affect maternal height can also directly influence pregnancy outcomes.²² Samalisto describes the type, symbol, locus, and function of genes that affect human height in table 1. Based on the table, mutations in genes such as GHR, GHRHR, IGFBP3, IGF1, IGFIR, IGFALS, STAT5b, and SHOX can trigger growth disorders that might lead to short stature. In contrast, mutations in the ESR1 gene potentially cause heights that are higher than normal. Other genes such as JAK2, VDR, DRDD2 are also involved in growth hormone signaling.²⁴

Genes that affect tooth eruption are RANKL and ALK-2. The Receptor Activator of Nuclear Factor K-β Ligand (RANKL) and the activin receptor-like kinase 2 (ALK-2) gene are known to bind bone morphogenetic protein-2 (BMP-2) growth factor which plays a role in the process of tooth eruption. The RANKL gene controls osteoclastogenesis for alveolar bone resorption and the expression also causes bone resorption in the coronal follicle to form the course of tooth eruption. BMPs act through transmembrane serine and threonine protein kinase receptors that have multiple functions during cell morphogenesis and differentiation. They are also considered to be part of the epithelial-mesenchymal network signaling molecules that regulate the initiation of dental crown formation.²⁵

Meanwhile, BMP-2 has greater expression at the basal site of dental follicles, causing bone formation at the base of the alveolar bone which indicates tooth eruption. This morphogen binds to the BMP receptor, activin receptor-like kinase 2 (ALK-2) for transactivation and forms a heterodimeric complex which is then translocated to the cell nucleus and acts directly with other molecules to regulate the transcription of target genes.

The coordination between bone formation and resorption is subsequently maintained by several combined mechanisms between osteoblasts and osteoclasts.^{3,25,26} For the process of tooth eruption, more osteoblasts are needed to cause bone damage at the top of the alveolus which forms the path of tooth eruption.

Wu et al. (2019) conducted a study on 1,296 mothers at the Affiliated Obstetrics and Gynecology Hospital of Nanjing Medical University and reported that the reproductive age of women is associated with the delay in eruption of the mandibular deciduous

central incisors.²⁷ The recommended age for women to undergo pregnancy is 20-35 years, because the maturity of the reproductive organs has been completed at this age.^{28,29}

Women aged <20 years are at risk of experiencing nutritional deficiencies due to competition for nutrients between mother and fetus. Meanwhile, women aged > 35 years tend to experience complications such as sclerosis of the small arteries and myometrial arterioles, thereby inhibiting nutrients from being delivered to the fetus.¹⁵

Additionally, at the age <20 years and >35 years complications such as preeclampsia can occur. This is a syndrome characterized by high blood pressure and protein in the urine that usually appears at the end of the 2nd or 3rd trimester. It is often accompanied by edema, sudden weight gain, headaches, and vision changes. The consequences of preeclampsia on the fetus include premature birth, growth retardation, and death. This condition is caused by reduced blood flow to the placenta, which interferes with the supply of nutrients to the fetus and potentially leads to a lack of food and subsequent starvation.^{17,29,30}

Based on these conditions, pregnancies at ages <20 years and >35 years can disrupt fetal nutritional intake thereby making the infants to have low birth weight. Seow (1996) in Alshukairi (2019) reviewed and identified tooth development in infants with a weight less than 1,000g and gestational age less than 30 weeks having delays in tooth maturation.³¹

The mother's education level indirectly contributes to the knowledge about food or drinks that are good for consumption during pregnancy. Maternal nutrition during pregnancy also has a major role in supporting the growth and development of the fetus as well as the timing of the infant's teeth eruption. Some of the nutrients needed include carbohydrates, folic acid, minerals, protein, as well as vitamin C and D.³²

Carbohydrates are needed in fetal growth as a source of energy in the form of glucose. Meanwhile, folic acid does not only contribute to the infant's weight but also minimizes disturbances in the formation of the neural tube which is the forerunner of the neural crest to support craniofacial growth and development of teeth. Minerals consist of calcium, phosphorus, and fluorine which play a role in the formation of bones and teeth. Protein acts to provide the basic ingredients for the formation of enzymes, antibodies, muscles, and collagen. Moreover, protein and vitamin C are essential nutrients for the synthesis of collagen which plays a role in the formation of the tooth matrix. Vitamin D is needed to help build and maintain strong bones and teeth, hence, it is highly needed during fetal development.^{15,20,32}

The correlation between maternal education level and the knowledge about food or drinks that are good for consumption during pregnancy was reported by Bech et al. in Marisiantini (2018) which stated that high caffeine consumption can cause uteroplacental vasoconstriction, leading to low birth weight. This is also in line with a study conducted by Mardawati (2011) in Marisiantini (2018) at Bengkulu City, Indonesia which showed that there is a significant relationship between caffeine consumption and birth weight.³³

Low body weight has a relationship with the timing of tooth eruptions, hence, infants with low body weight tend to experience delayed tooth eruption.^{7,20} A similar statement was also presented by Demelash et al. (2015) who conducted a study on 387 mothers in Southeast Ethiopia. The results showed that mothers with no formal education had a higher risk of giving birth to infants with low body weight compared to those with higher education.³⁵ Similarly, another study carried out in Sumenep city, Indonesia by Festy (2011) in Nuryani (2017) found that mothers with low education had a 4.4 times risk of giving birth to infants with low birth weight.³⁶

Education generally has a relationship with the mother's socioeconomic level. Mauludyani et al. (2012) in Nuryani (2017) stated that a good socioeconomic status helps pregnant women to live in a better environment far from exposure to cigarette smoke as well as abstain from heavy work.³⁶ Furthermore, Marisiantini et al. (2015) stated that women exposed to cigarette smoke during pregnancy are at risk of giving birth to infants with low birth weight. This will affect the eruption time of the deciduous teeth as previously described.³³

Based on previous studies, mothers with low socioeconomic backgrounds tend to work extra. Meanwhile, there is a relationship between small head circumference and the long working hours of mothers during pregnancy. Small head circumference is more common in infants born to women who work for >40 hours per week. There is also an increased risk with standing or walking for 4 hours per day during the second trimester of gestation and with lifting a weight of 25 kg by hand in the last trimester.³⁷ A study conducted by Peoples Sheps in Marisiantini (2018) showed that pregnant women who stand too long every day will give birth to infants whose head size is 1 cm smaller than those who do not stand for too long. The small head circumference is associated with delayed tooth eruption time, as described in the previous discussion.^{7,20,33}

The size of the infant's head circumference, weight, height, as well as the mother's age during pregnancy,

and education level affect the eruption time of the first deciduous teeth.

Women or mothers need to pay more attention to age during pregnancy, regulate nutritional intake, and improve lifestyles such as reducing caffeine intake, as well as avoiding exposure to cigarette smoke and al-

cohol consumption to obtain optimal infant growth and development in the eruption of deciduous teeth.

Further studies are needed in Indonesia regarding the factors that can affect the eruption of deciduous teeth, especially those related to the infant's head circumference, weight, height, as well as the mother's age during pregnancy, and level of education.

TABLES

Table 1. Selected genes that influence height²⁴

Gene name	Gene Symbol	Locus	Function
Growth hormone receptor	GHR	5p12	Mutations in GHR have been associated with Laron syndrome, also known as the growth hormone insensitivity syndrome (GHIS), a disorder characterized by short stature.
Estrogen receptor 1	ESR1	6q25	Nuclear hormone receptor. Loss-of-function of ESR1 leads to estrogen resistance and tall stature due to incomplete epiphyseal closure.
Growth hormone-releasing hormone receptor	GHRHR	7p15	Mutations in this gene have been associated with isolated growth hormone deficiency (IGHD), also known as Dwarfism of Sindh, which is characterized by short stature.
Insulin-like growth factor-binding protein 3	IGFBP3	7p13	Mutations may cause biologically inactive IGF-1 resulting in short stature.
Janus kinase 2	JAK2	9p24	Involved in growth hormone signaling.
Dopamine D2 receptor gene	DRDD2	11q23	The receptor of dopamine which plays a major role in the regulation of appetite and growth hormone.
Insulin-like growth factor	IGF1	12q23	Mediates many of the growth-promoting effects of growth hormone. IGF1 deficiency is an autosomal recessive disorder characterized by growth retardation, sensorineural deafness, and mental retardation.
Vitamin D3 receptor	VDR	12q13	Nuclear hormone receptor mediates the action of vitamin D3 by controlling the expression of hormone-sensitive genes.
Cytochrome P450, family 19	CYP19A1	15q21	Involved in estrogen biosynthesis. CYP19A1 mutation has been associated with height via estrogen dosage.
Insulin-like growth factor 1 receptor	IGFIR	15q26	The loss-of-function mutation leads to IGF-1 insensitivity as well as pre and postnatal growth retardation.
Acid-liable subunit	IGFALS	16p13	The mutation may cause biologically inactive IGF-1 resulting in short stature.
Signal transducer and activator of transcription 5B	STAT5b	17q21	Involved in growth hormone signaling. Defects in STAT5B are the cause of Laron type dwarfism II (LTD2) which is characterized by growth hormone insensitivity.
Short stature homeobox-containing gene	SHOX	Xp22/Yp11	Involved in idiopathic growth retardation and the short stature phenotype of Turner syndrome patients.

FIGURES

Figure 1. Tooth eruption in 9 months old infant.¹⁰



Figure 2. Assessing the infant's head circumference using a measuring tape.¹⁶



Figure 3. Measurement of infant's weight using a digital scale.¹⁷



Figure 4. Measurement of infant's height using an infantometer.²³

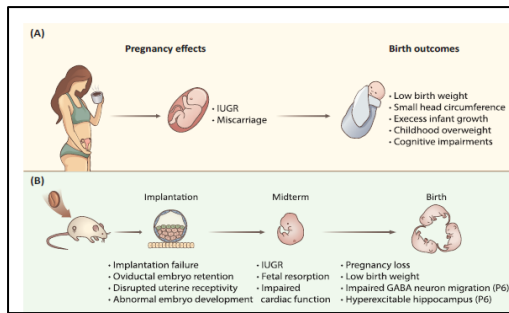


Figure 5. Effects of caffeine on the fetus.³⁴

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