



# Nutritional status, maternal knowledge, and chewing habits as factors associated with primary tooth persistence in children aged 6–12 years

*Status gizi, pengetahuan ibu, dan kebiasaan mengunyah sebagai faktor yang berkaitan dengan persisten gigi susu pada anak usia 6–12 tahun*

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## Abstract

Primary tooth persistence during the mixed dentition phase may influence occlusion and functional masticatory patterns. There is little community-based evidence for the combined effects of nutrition, maternal knowledge, and chewing behavior. This study aimed to determine the relationship between these factors and primary tooth persistence in children aged 6–12 years. A cross-sectional study was conducted in elementary schools in the Ingin Jaya District of Aceh Besar from September to October 2025. The sample included 120 children. They were identified during clinical examination as having persistent primary teeth. Anthropometric analysis was performed to assess nutritional status using BMI-for-age z-scores (BAZ), and a structured questionnaire was used to assess maternal knowledge and chewing habits. All data were analyzed using chi-square tests, and odds ratios (ORs) with 95% confidence intervals (CIs) were calculated. The prevalence of primary tooth persistence was 60.0%, which is relatively high compared to several school-based reports. Underweight (OR= 4.6) and overweight/obese children (OR= 4.2) were more likely to have persistent asthma than children with normal nutritional status ( $p=0.002$ ). Low maternal knowledge and poor chewing habits were also significantly linked, with chewing habits showing the strongest association (OR= 7.0;  $p < 0.001$ ). In conclusion, nutritional status, maternal knowledge, and chewing behavior were significantly related to the persistence of primary teeth. Longitudinal studies are suggested to clarify these causal associations.

**Keywords:** Chewing behavior, child health, maternal knowledge, nutritional status, primary tooth persistence

## Abstrak

Persistensi gigi susu pada tahap gigi campuran dapat mempengaruhi oklusi dan perilaku mengunyah fungsional. Bukti komunitas yang sedikit ada untuk nutrisi, pengetahuan ibu, dan perilaku mengunyah secara bersamaan. Penelitian ini dirancang untuk mengukur hubungan antara variabel-variabel ini dan persistensi gigi susu pada anak-anak usia 6 hingga 12 tahun. Sebuah studi cross-sectional dilakukan di sekolah dasar di Kecamatan Ingin Jaya, Aceh Besar, dari September hingga Oktober 2025. Sebanyak 120 anak dipilih secara acak. Mereka ditemukan memiliki gigi susu yang persisten setelah pemeriksaan klinis, sementara status gizi mereka diukur dengan z-score BMI-for-age (BAZ) dan kuesioner untuk pengetahuan ibu dan perilaku mengunyah. Semua data dianalisis menggunakan uji chi-square dan rasio odds (OR) dengan interval kepercayaan (CI) 95% dihitung. Prevalensi gigi susu persisten adalah 60,0%, cukup tinggi dibandingkan dengan beberapa laporan berbasis sekolah. Anak-anak dengan berat badan kurang (OR= 4,6) dan anak-anak dengan berat badan berlebih/obesitas (OR= 4,2) juga lebih

mungkin memiliki persistensi dibandingkan anak-anak dengan status gizi normal ( $p = 0,002$ ). Pengetahuan ibu yang rendah dan mengunyah yang buruk juga menunjukkan hubungan yang signifikan, dengan kebiasaan mengunyah yang buruk juga memiliki hubungan tertinggi ( $OR = 7,0$ ;  $p < 0,001$ ). Kesimpulan, pengetahuan ibu, nutrisi, dan mengunyah juga merupakan prediktor signifikan untuk persistensi gigi susu. Penelitian longitudinal diperlukan untuk menjelaskan hubungan kausal.

**Kata Kunci:** Kesehatan anak, kebiasaan mengunyah, pengetahuan ibu, persistensi gigi sulung, status gizi

## Introduction

The transition from primary to permanent teeth is an important part of a child's dentofacial development, and the age range of 6–12 years is considered a critical period for tooth replacement (Elkhatib et al., 2021; Traver-Ferrando & Barcia-González, 2022). Globally and nationally, oral health issues in children remain a concern, particularly in the context of growth and development (Gaffar et al., 2024). In Indonesia, the prevalence of dental eruption abnormalities, such as persistent primary teeth, has been reported in various clinical studies. This condition is not only related to odontology but can also affect chewing function, aesthetics, and overall oral health, making it an important issue in public health and nutrition (Maulanti et al., 2021; Thania et al., 2025).

Primary tooth persistence is a significant problem in this context, affecting not only dental health but also chewing function, aesthetics, and overall oral health (Rizal et al., 2021; Wardani et al., 2021). In Indonesia, various studies have shown the prevalence of tooth eruption abnormalities, including persistent primary teeth, which vary across regions. For example, a study at RSGM-FKG recorded a prevalence of persistence of 23.26% in children aged 6–12 years, while additional research in Jakarta revealed a similar figure of 24% in children aged 9–12 years (Kurniasih et al., 2022; Rahma et al., 2020; Rizal et al., 2021). Approximately 4.3% of the study population experienced delayed eruption of permanent teeth. Nutritional status is an important determinant of the timing of tooth eruption. Protein–energy deficiency may hinder odontogenic cellular proliferation and matrix formation, while micronutrient deficiencies, including calcium, vitamin D, and zinc, lead to disruption of mineralization, alveolar bone formation, and formation of periodontal tissues (Jasmine, 2021; Sutela et al., 2019). These biological pathways provide an

exciting connection between malnutrition and delayed tooth eruption. Malnutrition should be considered a distinct entity. Chronic undernutrition, often experienced as stunting, may indicate a prolonged deficiency affecting bone and craniofacial growth, whereas acute undernutrition indicates a short-term energy imbalance. Both of these conditions and poor dietary choices can affect dental tissue development in different ways. Studies have revealed that stunting associated with children experience delayed tooth eruption as compared to healthy growth in comparison to normal development children, as seen but stunting is only one sign of chronic nutritional deficiency (Rahmawati et al., 2022; Setiawan et al., 2022).

Thus, anthropometric status and persistence of teeth require a broader nutritional evaluation to identify and understand the relationship between anthropometric status and tooth persistence. Different physical and systemic variables contribute to the persistence of primary teeth in several dimensions, both locally and systemically. Nutritional status, maternal knowledge, and children's chewing behaviors are complex, often interacting factors through which eruption patterns can be influenced from a public health perspective (Cieślińska et al., 2022). Dietary intake regulates nutrient availability for growth and influences food texture, which influences mastication and craniofacial stimulation. In particular, in the context of balanced diet composition and protein adequacy, micronutrient intake, meal structure, and progression of foods with appropriate texture during childhood feeding, maternal knowledge is particularly critical in this pathway. In addition to decreased dietary quality, lack of knowledge regarding oral intake and exposure to foods that require adequate chewing could indirectly affect growth and tooth eruption. A study in Tasikmalaya reported a major association between maternal knowledge

and tooth persistence, with only a limited strength of association observed (Rahma et al., 2020).

Chewing is a functional pathway that connects diet quality and dentofacial development in children. A diet rich in fibrous foods, including fruits and vegetables, provides mechanical stimulation, which is vital for remodeling the alveolar bone and leading it toward eruption (Dimopoulou et al., 2023). However, excessive dependence on soft-textured diets might decrease the masticatory load and consequently influence jaw development and eruption patterns. Despite a lack of empirical evidence, mastication is increasingly acknowledged as a significant contributor to oral and craniofacial growth (Setyawan et al., 2021).

However, few community-based studies have integrated anthropometric nutritional status, maternal nutrition-related knowledge, and chewing habits within a framework. From a nutritional epidemiology perspective, the analysis of growth indicators, diet-related behaviors, and parental knowledge is limited. This understanding of interconnected pathways may contribute to both nutrition-specific and nutrition-sensitive interventions, including school feeding programs that consider food texture and maternal nutrition education programs. Hence, the objective of this study was to estimate the relationship between nutritional status, maternal knowledge, and chewing habits and primary tooth persistence in a group of 6- to 12-year-old children, which might provide evidence to support integrated oral and nutritional health strategies in a community environment.

## Methods

### Research Design

This study used an observational analytical design with a cross-sectional approach. This design enabled the evaluation of associations between nutritional status, maternal knowledge, oral habits of chewing, and persistence of primary teeth at one point in time among children (aged 6–12 years). It was found that the cross-sectional design is efficient for community-based field research; however, it severely restricts temporal and causal relationships between exposure and outcomes. Hence, the results were understood as associations rather than causal ones.

### Research Location and Time

The research was conducted in elementary schools in the Ingin Jaya District of Aceh Besar Regency, selected to be representative of elementary school-aged children in the district. Data were collected from September to October 2025 after administrative permissions and ethical approval were secured.

### Sample, Sample Size, and Sampling Technique

The study participants were all 6-12 years-old in elementary schools in the Aceh Besar District. The inclusion criteria were as follows: (1) active student children aged 6–12 years who were enrolled as active students in participating schools; (2) living with their natural mother or a mother serving as the main caregiver; and (3) willingness of the mother and child to participate and provide informed consent. We excluded children who did not live with their mothers to ensure a consistent evaluation of maternal knowledge as the primary exposure variable. The exclusion criteria included craniofacial congenital abnormalities, severe systemic disease, developmental defects affecting tooth and jaw growth, current orthodontic treatment or primary tooth extraction for orthodontic purposes, absence on examination day, or incomplete data.

The sample size was calculated using the formula for cross-sectional studies estimating proportions, with a population sample size assumed to be approximately 24% for primary tooth persistence based on previous Indonesian studies, a 95% confidence level, and a 5% margin of error. A minimum sample size of 112 was estimated with a 10-percent increase to account for non-response, yielding a final target of 120 children. Participants were recruited through basic random sampling and the inclusion of eligible student lists.

### Data Collection Procedure

The study variables were analyzed as predictors of data collection. Initially, primary tooth persistence was assessed by trained dentists or dental nurses using mouth mirrors accompanied by adequate light. Tooth persistence was defined as prolonged retention within the dental arch beyond the expected age of exfoliation, as indicated by the standard eruption requirements. This was followed by the eruption or clinical appearance of the permanent

successor. Results were noted on standardized observation sheets and were graded as “persistence present” or “persistence absent.”

Children's nutritional status was assessed using BMI-for-age z-scores (BAZ). Body weight was measured using a calibrated SAGA digital scale (0.1 kg accuracy), with children wearing light clothing and no footwear. Height was measured using a SAGA stadiometer (accuracy 0.1 cm) with children standing tall, barefoot, and in the Frankfurt plane. BMI was calculated and converted into z-scores using the 2007 WHO Growth Reference (World Health Organization AnthroPlus Software). Nutritional status was classified as severely thin ( $< -3$  SD), thin ( $-3$  SD to  $< -2$  SD), normal ( $-2$  SD to  $+1$  SD), overweight ( $> +1$  SD to  $+2$  SD), or obese ( $> +2$  SD) (Al Rahmad et al., 2023). While BMI-for-age seems to be appropriate for children of school age, potential misclassification could be possible between age groups, as growth rhythm would differ and the body would develop in the pubertal stage within the gap between ages 6 and 12; therefore, age-specific z-scores were appropriately applied.

Mothers' knowledge of their children's dentition status, tooth replacement processes, balanced diet composition, protein and micronutrient intakes, meal structure, and appropriate food texture progression was assessed using a structured questionnaire. The questionnaire comprised multiple-choice and absolute (true–false) items previously tested in a pilot study, and Cronbach's alpha was  $\geq 0.7$ . Knowledge scores were based on the percentage of correct responses and classified using modified Bloom's cut-off points ( $\geq 80\%$  = high;  $60\text{--}79\%$  = moderate;  $< 60\%$  = low), thereby increasing comparability and construct validity.

Children's chewing behavior was measured using a semi-quantitative food frequency questionnaire (FFQ) that recorded the frequency of weekly consumption of foods requiring mastication (e.g., raw vegetables, fresh fruit, nuts, meat, and other firm-textured foods). Chewing was rated as “good” (with frequent consumption  $\geq 3$  times/week of hard-textured foods) and “poor” (with food of predominantly soft-textured texture). FFQ measured frequency but did not quantify portion size, texture strength, or chewing time, which may have introduced exposure misclassification error, which was reflected in the interpretation.

### **Data Analysis and Statistical Testing Models**

The data were analyzed in stages. Univariate analyses were used to depict respondents' characteristics, including age, sex, nutritional status, maternal knowledge level, chewing habits, and persistent primary dental prevalence.

The results were displayed as frequency distributions, percentages, means or standard deviations, or medians and interquartile ranges according to the data distribution. Associations between nutritional status, maternal knowledge, and chewing behavior for each independent variable were analyzed using the chi-square test for primary teeth persistence. Crude odds ratios (ORs) with 95% confidence intervals (CIs) were calculated to estimate the strength and consistency of the association. Statistical significance was set at  $p < 0.05$ .

No multivariable analysis was employed; hence, the potential confounding factors, such as age and sex, were not accounted for statistically, which was acknowledged as an important drawback of the study.

### **Ethical Clearance**

Ethics approval and procedures of the study were obtained following ethical approval of the Health Research Ethics Committee of Sari Mulia University, Banjarmasin (Number: 011/KEP-UNISM/VI/2025). All activities are considered ethical in research on human subjects, and respect for autonomy, confidentiality of data, minimization of risk, and dissemination of clear information about the study purpose and advantages were honored.

Prior to participation, the mothers or legal guardians provided written informed consent. Verbal and age-appropriate written assent was also obtained from the participants' children. Respondents were informed that they could refuse or withdraw from the study at any point and without consequences.

## **Result and Discussion**

### **Sample and Respondent Characteristics**

Descriptions of the children (Table 1) showed that the vast majority were aged 10–12 years (43.3%), followed by 8–9 years (31.7%) and 6–7 years (25.0%), with an average age of  $9.3 \pm 1.8$  y. The sex distribution was 54.2% boys and 45.8% girls. The mean body weight was  $29.8 \pm 6.1$  kg,

and the mean height was  $131.5 \pm 9.2$  cm. Regarding recent oral health complaints, 23.3% of children reported toothaches, 15.8% reported bleeding gums, and 60.8% reported no oral health complaints in the past month. The mean age of mothers was  $35.8 \pm 5.4$  years, and most mothers were in the 20–35-year-old age cluster (57.5%). The majority of the women (48.3%) had completed high school, and 25.0% had completed higher education. Most were housewives (58.3%), followed by merchants (15.0%), civil servants or temporary employees (12.5%), and other occupations (14.2%).

Such features portray the demographic, anthropometric, and socioeconomic profiles of the selected study partners and offer some context for subsequent studies on the relationship between nutritional status and

maternal knowledge, chewing habits, and primary tooth persistence. The characteristics of the children in this study show that most were in the 10–12 age range, which is the critical period for permanent tooth replacement. During this period, various eruption abnormalities, including persistent primary teeth, are more likely to be identified because tooth replacement activity peaks (Reshitaj et al., 2022). This age range is consistent with the mixed dentition phase, a transitional phase heavily influenced by growth factors, dietary patterns and oral health status. The relatively balanced sex composition strengthens the generalization of the findings, as the prevalence of tooth eruption disorders generally does not show significant differences between boys and girls (Yirsaw et al., 2024).

**Table 1.** characteristics of children and mothers (n = 120)

| Characteristics                         | n  | %    | Mean $\pm$ SD   |
|-----------------------------------------|----|------|-----------------|
| Child age (years)                       |    |      | 9.3 $\pm$ 1.8   |
| 6-7                                     | 30 | 25   |                 |
| 8-9                                     | 38 | 31.7 |                 |
| 10-12                                   | 52 | 43.3 |                 |
| Gender                                  |    |      |                 |
| Male                                    | 65 | 54.2 |                 |
| Female                                  | 55 | 45.8 |                 |
| Weight (kg)                             |    |      | 29.8 $\pm$ 6.1  |
| Height (cm)                             |    |      | 131.5 $\pm$ 9.2 |
| Dental health history in the last month |    |      |                 |
| Toothache                               | 28 | 23.3 |                 |
| Bleeding gums                           | 19 | 15.8 |                 |
| No complaints                           | 73 | 60.8 |                 |
| Mother's age (years)                    |    |      | 35.8 $\pm$ 5.4  |
| 20 - 35                                 | 69 | 57.5 |                 |
| 36 - 45                                 | 39 | 32.5 |                 |
| 46 - 65                                 | 12 | 10   |                 |
| Highest level of education              |    |      |                 |
| Elementary                              | 10 | 8.3  |                 |
| Junior High School                      | 22 | 18.3 |                 |
| High School                             | 58 | 48.3 |                 |
| Higher Education                        | 30 | 25.0 |                 |
| Occupation                              |    |      |                 |
| Housewife                               | 70 | 58.3 |                 |
| Merchant                                | 18 | 15.0 |                 |
| Civil Servant/Temporary Employee        | 15 | 12.5 |                 |
| Others                                  | 17 | 14.2 |                 |

The average weight and height of the children described a varied growth profile, consistent with national findings that show disparities in the nutritional status of school-aged children in Indonesia (Indonesian Ministry

of Health, 2024). This variation is important because nutritional status plays a role in the development of the jaw, alveolar bone, and periodontal tissue, which in turn affects the pattern of tooth eruption (Kirilov et al., 2025). In

addition, the proportion of children who still experience oral health complaints, such as toothaches or bleeding gums, indicates that dental health problems remain a burden on children's health, even though some are not always reported clinically. This condition is in line with studies in various countries that report that gingivitis and caries remain common problems in school-aged children and can interfere with the process of primary tooth exfoliation (Nadeeshani et al., 2023).

Furthermore, the profile of mothers as primary caregivers, with the majority being of productive age and having a secondary education, indicates their potential to play an important role in maintaining their children's health. Mothers' education has repeatedly been linked to family health behaviors, including diet, dental hygiene, and utilization of dental health services. Mothers with secondary education tend to have a better capacity to understand basic information about child growth but still require additional education to detect dental abnormalities that are not visible to the naked eye, such as persistent primary teeth (Khairinisa et al., 2023; Rahayuwati et al., 2023). Additionally, the diversity of mothers' occupations, which reflects variations in socioeconomic status, can influence access to quality dental health services and the ability to facilitate routine childcare (Yirsaw et al., 2024).

Therefore, the demographic and socioeconomic characteristics of this study made an important contribution to the factors that influence the persistence of primary teeth. The profile of children at the peak of tooth replacement, coupled with variations in education and maternal caregiving roles, provides a strong foundation for understanding how nutritional, behavioral, and family knowledge factors contribute to the persistence of primary teeth in children aged 6-12 years in Aceh Besar.

### **Nutrition, Knowledge, Eating Behavior, and Primary Tooth Persistence**

The nutritional status, maternal knowledge, chewing habits, and primary tooth persistence of the participants are summarized in Table 2. Although most children had a normal nutritional status, a large proportion were classified as underweight or overweight/obese. Similarly, while more than half of the mothers showed a good level of knowledge, a significant proportion

had moderate or low knowledge. Over half of the children reported primarily consuming soft-textured diets. The reported prevalence of primary tooth persistence (60%) was higher than that in several regional clinical studies in Indonesia, which ranged from 23% to 24%, indicating a larger burden in this community-based population.

**Table 2.** Distribution of children's nutritional status, maternal knowledge, chewing habits, and primary tooth persistence (n = 120)

| Variable                               | n  | %    |
|----------------------------------------|----|------|
| Child Nutritional Status (BAZ)         |    |      |
| Normal                                 | 78 | 65.0 |
| Underweight                            | 27 | 22.5 |
| Overweight / Obese                     | 15 | 12.5 |
| Mother's Knowledge                     |    |      |
| Good                                   | 70 | 58.3 |
| Adequate                               | 32 | 26.7 |
| Insufficient                           | 18 | 15.0 |
| Children's Chewing Habits              |    |      |
| Good (hard foods $\geq 3\times$ /week) | 55 | 45.0 |
| Poor (predominantly soft foods)        | 65 | 54.0 |
| Persistence of Primary Teeth           |    |      |
| Persistence                            | 72 | 60.0 |
| No persistence                         | 48 | 40.0 |

The results of the study (Table 2) show that most children had a normal nutritional status, but the proportion of children with malnutrition (22.5%) was still significant enough to be a cause for concern. Meanwhile, more than half of the mothers had good knowledge of dental and nutritional health, but there were still groups of mothers with adequate and poor knowledge, numbering almost 42%. Another important finding was that more than half of the children had poor chewing habits, consuming soft foods more often than hard foods. This condition can affect the physiological process of tooth replacement. In addition, persistent primary teeth were found in 60% of children, indicating that this problem is quite common and may be related to nutritional factors, parenting knowledge, and children's eating behaviors.

The distribution of undernutrition noted in studies such as ours may also contribute to the association between growth status and eruption patterns. Nevertheless, due to the cross-sectional design, such findings should be considered correlations rather than cause-and-

effect. Growth disturbances are known to be correlated with changes in alveolar bone development and permanent tooth eruption timing (Kirilov et al., 2025), thus adding biological plausibility to the association found in the present study.

The proportion of mothers with low knowledge further strengthens the assumption that a limited understanding of the tooth replacement period can lead to a delayed detection of persistent primary teeth. Rahayuwati et al. (2023) and Khairinisa et al. (2023) showed that the level of education and knowledge of mothers is closely related to children's dental health behaviors, including monitoring tooth growth and development.

Poor chewing habits should also be considered. A diet dominated by soft foods can reduce the masticatory stimulation necessary to support primary tooth root resorption and permanent tooth eruption. These findings are consistent with the mastication study by Nadeeshani et al. (2023), which confirmed that chewing function plays a role in the maturation of orofacial structures. It is not surprising that the prevalence of primary tooth persistence in this study reached 60%, which is higher than that in several regional clinical studies.

The combination of nutritional factors, maternal knowledge, and eating habits shows a multidimensional contribution to the occurrence of primary tooth persistence, demonstrating the

importance of an integrative intervention approach in efforts to prevent dental and child health problems.

### **The Relationship between Nutritional Status, Maternal Knowledge, and Chewing Habits with Primary Tooth Persistence in Children Aged 6–12 Years**

The results of this study (Table 3) show a clear risk pattern for primary tooth persistence. Compared with children with normal nutritional status, thin children showed a 4.6 times greater chance of persistence, and overweight/obese children showed a 4.2 times greater chance ( $p = 0.002$ ). In terms of parenting, children whose mothers had adequate and insufficient knowledge had a sharply increased chance of persistence, approximately 4.2 and 5.9 times higher, respectively, than the group of mothers with good knowledge ( $p = 0.001$ ).

The strongest finding emerged in chewing habits: children with poor chewing habits had a 7.0 times higher chance of having persistent habits than children with good chewing habits ( $p < 0.001$ ). Practically speaking, this suggests that primary tooth persistence is not solely a clinical dental issue but is closely related to a child's growth status, quality of parenting, and eating behavior.

**Table 3.** Relationship between nutritional status, maternal knowledge, and chewing habits with primary tooth persistence in children aged 6–12 years ( $n = 120$ )

| Variable                 | Persistence of Primary Teeth |                       | Total | p-value | OR (95% CI)    |
|--------------------------|------------------------------|-----------------------|-------|---------|----------------|
|                          | No;<br>n (%)                 | Persistence;<br>n (%) |       |         |                |
| Nutritional Status (BAZ) |                              |                       |       |         |                |
| Normal                   | 40 (51.3)                    | 38 (48.7)             | 78    | 0.002   | 1.0 (ref)      |
| Underweight              | 5 (18.5)                     | 22 (81.5)             | 27    |         | 4.6 (1.6–13.4) |
| Overweight/Obese         | 3 (20.0)                     | 12 (80.0)             | 15    |         | 4.2 (1.1–16.4) |
| Mother's knowledge       |                              |                       |       |         |                |
| Good                     | 38 (54.3)                    | 32 (45.7)             | 70    | 0.001   | 1.0 (ref)      |
| Moderate                 | 7 (21.9)                     | 25 (78.1)             | 32    |         | 4.2 (1.7–10.4) |
| Less                     | 3 (16.7)                     | 15 (83.3)             | 18    |         | 5.9 (1.6–21.7) |
| Chewing Habits           |                              |                       |       |         |                |
| Good                     | 35 (63.6)                    | 20 (36.4)             | 55    | <0.001  | 1.0 (ref)      |
| Less                     | 13 (20.0)                    | 52 (80.0)             | 65    |         | 7.0 (3.2–15.2) |

The relationship between nutritional status and primary tooth persistence observed in this study must be interpreted using BMI-for-age (BAZ) as the index. BMI-for-age is the relative body mass in relation to age, which can

also reflect undernutrition and overweight conditions but fails to directly measure linear growth deficits (i.e., stunting). While existing research has associated chronic undernutrition and stunting with delayed tooth eruption (Agung

et al., 2023; Mahata et al., 2023; Sumantri et al., 2025), the current results more directly support the notion that underweight or overweight/obesity deviations from the normal BMI-for-age were related to the persistence of primary teeth. Underweight may represent insufficient energy and nutrients, with resultant degradation related to tissue development and mineralization, and an overweight/obese status may be related to a change in the rate and influences of hormones on maturation. Genetic and environmental factors and general nutritional status have been reported to affect dental development and eruption timing (Shen et al., 2019). Therefore, the findings need to be considered as BMI-for-age bands and patterns of persistence, as opposed to direct evidence of mechanisms related to stunting.

Furthermore, it has also been reported that mothers' knowledge is related to the persistence of primary teeth in children aged 6-12 years. This is because most mothers are responsible for decisions related to their children's diet and dental hygiene. Evidence from research conducted in Indonesia shows that parental knowledge and practices are closely related to children's oral health (Andries et al., 2021). Lack of knowledge about the tooth replacement schedule can lead to delays in recognizing the symptoms of persistence, where permanent teeth continue to grow under primary teeth that have not fallen out (Utari et al., 2024). Proper education of parents about the tooth eruption process is crucial to prevent delays in intervention (Huew et al., 2023). The timely replacement of baby teeth with permanent teeth is a critical phase in children's dental health, directly affecting the overall development of oral health. A lack of knowledge about tooth misalignment, occlusion issues, or caries risk not only affects individual health outcomes but also requires additional health interventions, adding to the already significant burden on health services (Reis et al., 2021).

Finally, the empirical data suggested an association between chewing, chewing frequency of hard-textured food consumption, and primary tooth persistence as an outcome of chewing habits. The FFQ used in this study measured weekly frequency but did not directly assess chewing strength, bite force, or functional use. Therefore, the interpretation of stomatognathic stimulation should be approached with caution. Food texture has been reported in earlier literature to affect orofacial

growth and eruption patterns (Agung et al., 2023; Shrestha & Acharya, 2020; Sitinjak et al., 2019; Rajendran, 2020). However, the current study reported a connection between the reported frequency of hard-food consumption and persistence status, as opposed to being specifically evaluated with masticatory biomechanics. These findings underscore the necessity of developing additional studies with objective functional assessments to elucidate these mechanisms.

While this study found significant associations, some limitations should be considered when interpreting these findings. As this study design was cross-sectional, temporal relationships between exposure and primary tooth persistence could not be established, restricting causal inferences. The lack of multivariate analysis may have led to residual confounding by factors such as age and sex, potentially influencing the magnitude of the observed associations. Second, unmeasured factors, ranging from genetic predisposition to broader environmental influences, could have driven the variation in eruption among individuals. Measurement limitations, namely BMI-for-age as a proxy for nutritional status and the frequency-based FFQ evaluation of chewing habits, may have also added misclassification bias. These issues should be considered when extrapolating the findings and constructing future longitudinal investigations.

## Conclusion

The present study demonstrated that the durability of primary teeth in children aged 6-12 years was highly dependent on diet, maternal knowledge, and chewing methods. Pupils classified as underweight and overweight/obese exhibited a heightened likelihood of persistence compared to those with an adequate nutritional status. There were greater odds of persistence in underweight and overweight/obese children. There was a relationship between parental knowledge, with lower knowledge being associated with higher persistence. Among the evaluated parameters, insufficient mastication showed the strongest correlation with primary tooth retention. The findings provide evidence of a relationship between preserved primary teeth and clinical dental issues, growth parameters, caregiver awareness, and dietary habits in the household. However, because the study

employed a cross-sectional design, the findings should be interpreted as associations rather than conclusive evidence of causal relationships.

Recommendations and preventive measures should be aimed at school-aged children (6–12 years) and their mothers or primary caregivers. School health programs during the mixed dentition phase could include routine dental checkups, routine BMI-for-age assessments to monitor nutrition, and family education workshops on when to replace teeth and transition to hard foods. Oral health counselling may be integrated within a maternity and child nutrition program in the context of primary health care provision. These programs should emphasize the need for balanced meals and frequent exposure to age-appropriate chewable foods. We recommend further longitudinal and multivariable analyses to elucidate the causal pathways and increase the evidence base for comprehensive oral-nutrition treatment.

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