



ANALYSIS OF DENTAL CARIES RISK FACTORS BASED ON THE DEF-T INDEX IN CHILDREN AGED 6-7 YEARS

Kartini Fajarsari Bilondatu*, Margaretha Solang, Cecy Rahma Karim

Master of Public Health Program, Graduate School, Universitas Negeri Gorontalo, Jl. Jend. Sudirman No.6, Dulalowo Timur, Kota Tengah, Kota Gorontalo, Gorontalo 96128, Indonesia

*liawaty.usman.sidiki@gmail.com

ABSTRACT

Dental caries is a chronic disease characterized by the destruction of hard dental tissues, including enamel, dentin, and cementum, resulting from bacterial activity within dental plaque that produces acids from food residues, particularly sugars and carbohydrates, adhering to tooth surfaces. These acids cause enamel demineralization, which, if it progresses, leads to the formation of cavities. This study aimed to analyze the risk factors associated with dental caries occurrence based on the def-t index among children aged 6–7 years in Tolinggula District, North Gorontalo Regency. This cross-sectional study involved 74 children aged 6–7 years selected using purposive sampling. Data were collected through structured questionnaires and clinical examinations, including def-t index assessment and salivary pH measurement. The questionnaire had undergone expert content validation and demonstrated acceptable reliability (Cronbach's alpha > 0.70). Data were analyzed using the chi-square test and multiple linear regression. The findings revealed significant associations between dental caries occurrence based on the def-t index and the consumption behavior of cariogenic foods and beverages ($p = 0.000$), toothbrushing frequency ($p = 0.000$), and salivary pH ($p = 0.000$). Among these variables, salivary pH was identified as the most dominant factor associated with dental caries occurrence ($p = 0.000$). Several risk factors were found to be significantly associated with dental caries occurrence based on the def-t index among children aged 6–7 years in Tolinggula District, North Gorontalo Regency, with salivary pH being the strongest contributing factor.

Keywords: children aged 6–7 years; dental caries occurrence; DEF-T index; risk factors

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INTRODUCTION

Dental caries can have negative impacts not only on oral health but also on children's overall quality of life, including eating difficulties and decreased self-confidence. Children aged 6–7 years are in the transitional phase from primary to permanent dentition, making them a vulnerable group for the development of dental caries. At this stage, children often lack full awareness of the importance of maintaining oral hygiene and remain highly dependent on parental involvement in establishing proper toothbrushing habits. This is consistent with the study by Erawati et al. (2021), which reported that children aged 6–7 years are particularly susceptible to dental caries due to the eruption of permanent teeth during this period. Therefore, special attention is required to ensure timely exfoliation of primary teeth and proper growth and development of permanent teeth without complications.

Research conducted by Apro et al. (2020) revealed that dental caries has a significant impact on children's academic performance and can cause pain and discomfort, which interfere with concentration and focus at school. The World Health Organization (WHO, 2022) reported that nearly 90% of adults worldwide experience some form of dental caries, and approximately 514 million children suffer from caries of primary teeth. The prevalence of dental caries varies across regions, with higher rates observed in low- and middle-income countries. According to the WHO Global Oral Health Status Report toward Universal Health Coverage (UHC) for oral health by 2030 (Southeast Asia regional summary), the prevalence of dental caries among children in Indonesia in

2022 reached 46.9%, or approximately 135 million cases, placing Indonesia second highest in Southeast Asia (WHO, 2022).

Based on the Indonesian Health Survey (SKI) 2023, 56.9% of the population aged ≥ 3 years experienced oral and dental problems within the past year. This includes a dental caries prevalence of 49.9% among children aged 5–9 years nationwide, representing the highest prevalence among all age groups. The SKI 2023 results also indicated that Gorontalo Province ranked fifth highest in dental caries prevalence among all provinces in Indonesia, at 51.7%, exceeding the national average of 43.6%. The five provinces with the highest prevalence of oral health problems in the past year were West Sulawesi (58.5%), South Sulawesi (56.4%), Central Sulawesi (54.5%), North Sulawesi (52.0%), and Gorontalo (51.7%). These high figures indicate that preventive and control efforts for dental caries in children remain suboptimal. This situation is exacerbated by low public awareness of the importance of maintaining oral health from an early age and limited access to dental health services, particularly in rural or remote areas (Ministry of Health, 2023).

Dental caries indices are widely used tools in dental epidemiology to measure caries experience at both individual and population levels. The DMF-T (Decayed, Missing, Filled Teeth) index for permanent teeth and the def-t (decayed, extracted, filled teeth) index for primary teeth are the most commonly applied. These indices provide essential information on the prevalence and severity of dental caries, supporting the planning and evaluation of community oral health programs (Sulung et al., 2021). According to the SKI 2023, the prevalence of dental caries in the Indonesian population was 56.9%, with a DMF-T index of 5.4, which is classified as high.

The consumption of cariogenic foods is another factor influencing the occurrence of dental caries in children. Studies by Assiri et al. (2022), Hang et al. (2024), and Basir et al. (2020) reported that children with systemic diseases, such as diabetes, and those with high body mass index (BMI) tend to have a higher risk of developing caries due to physiological conditions that may affect oral microbial balance and salivary production. Meanwhile, Wahyuni (2023), in a literature review study, found that four out of five reviewed journals reported a significant association between the frequency of consuming cariogenic foods and beverages and the incidence of dental caries among elementary school children.

Other factors, such as toothbrushing frequency and technique, also show a significant relationship with dental caries occurrence in children. A study by Laiya et al. (2023) revealed that children who brush their teeth less than twice a day are more likely to experience caries compared to those who brush regularly. In line with this, Mawar et al. (2024) found that education on combined toothbrushing techniques significantly improved children's oral hygiene and reduced plaque index, which is one of the primary causes of dental caries. Oral hygiene status and salivary pH also play critical roles in the development of dental caries in children. Poor oral hygiene, characterized by plaque accumulation and food debris, creates an environment conducive to the growth of cariogenic bacteria. Karminska et al. (2022) and Jupriyanto et al. (2023) reported that children with poor oral hygiene had a significantly higher prevalence of dental caries compared to those with good oral hygiene. Additionally, salivary pH greatly influences caries development, as acidic saliva can lead to enamel demineralization, thereby triggering caries formation.

Despite existing evidence, research on risk factors for dental caries among children aged 6–7 years remains limited, particularly in North Gorontalo Regency. Given the persistently high prevalence of caries in this age group, further investigation is necessary. Therefore, this study aims to analyze risk factors for dental caries based on the def-t index among children aged 6–7 years in Tolinggula District, North Gorontalo Regency, entitled “Analysis of Risk Factors for Dental Caries Based on the def-t Index Among Children Aged 6–7 Years in Tolinggula District, North Gorontalo Regency.”

METHOD

This study employed a quantitative research approach using an analytic observational design with a cross-sectional methodology. The research was conducted in Tolinggula District, Gorontalo Regency, from September to October 2025. A total of 74 respondents were recruited using purposive sampling. The inclusion criteria were as follows: (1) children aged 6–7 years at the time of data collection, as verified by a birth certificate or family card; (2) children registered as active students in 2025 at public elementary schools in Tolinggula District; (3) children and their parents who had resided in Tolinggula District for at least the previous six months; (4) children who had dental caries at the time of the study; (5) children who still had primary teeth, allowing assessment of the def-t index; (6) children who were cooperative during intraoral examination; (7) parents who provided written informed consent for participation in the study; and (8) children and parents who completed all study procedures. Data were collected using standardized questionnaires. Ethical approval for this study was obtained from the Research Ethics Committee (Approval No. 172/UN47.B7/KE/2025; Protocol No. 0090227571111142025091200016). Statistical analysis was performed using the chi-square test, and multivariate analysis was conducted using multiple linear regression. Statistical significance was set at $p < 0.05$. Variables included in the multivariate analysis were all independent variables with p -values < 0.05 .

RESULT

Table 1.
Frequency Distribution of Respondent Characteristics by Age

Characteristics		f	%
Age	6 Years	42	56,7
	7 Years	32	43,3
Gender	Man	36	48,6
	Women	38	51,4
Nutritional Status	Malnutrition	3	4,1
	Good Nutrition	63	85,1
	More Nutrition	4	5,40
	Obesity	4	5,40

Table 1, it shows that of the 74 respondents, the majority of respondents are 6 years old, namely 42 respondents (56.7%), for the majority gender is female, which is 38 respondents (51.4%) and the majority nutritional status is Good Nutrition, which is 63 respondents (85.1%).

Table 2. Analysis of the Relationship between Kariogenic Food and Beverage Consumption Behavior and the Incidence of Dental Caries Based on the Def-t Index in Children Aged 6-7 Years

Kariogenic Food and Beverage Consumption Behavior									
Incidence of Dental Caries based on <i>def-t</i> index							Total		<i>P-Value</i>
	Frequent		Sometimes		Never				
	f	%	f	%	f	%	f	%	
Very High	29	39,2	11	14,9	0	0	40	54,1	0,000
High	13	17,5	3	4,1	0	0	16	21,6	
Medium	2	2,7	9	12,2	0	0	11	14,9	
Low	0	0	6	8,1	0	0	6	8,1	
Very Low	0	0	1	1,3	0	0	1	1,3	

Based on the analysis of the relationship between dental caries occurrence as measured by the def-t index and cariogenic food and beverage consumption behavior, it was found that the majority of respondents experienced very high levels of dental caries, totaling 40 children (54.1%). This group consisted of 29 respondents (39.2%) who frequently consumed cariogenic foods and beverages and 11 respondents (14.9%) who occasionally consumed cariogenic foods and beverages. Respondents with high levels of dental caries accounted for 16 children (21.6%), comprising 13 respondents (17.5%) who frequently consumed cariogenic foods and beverages and 3 respondents (4.1%) who occasionally consumed cariogenic foods and beverages. A moderate level of dental caries was

observed in 11 respondents (14.9%), including 2 respondents (2.7%) with frequent consumption of cariogenic foods and beverages and 9 respondents (12.2%) with occasional consumption. Low levels of dental caries were identified in 6 respondents (8.1%), while very low levels were observed in 1 respondent (1.3%), all of whom occasionally consumed cariogenic foods and beverages. Statistical analysis using the Chi-square test yielded a p-value of 0.000 (< 0.05), indicating a statistically significant association between cariogenic food and beverage consumption behavior and dental caries occurrence as measured by the def-t index among children aged 6–7 years in Tolinggula District, North Gorontalo Regency.

Table 3.

The Relationship between Tooth Brushing Frequency and the Incidence of Dental Caries Based on the Def-t Index in Children Aged 6-7 Years

Incidence of Dental Caries based on def-t index	Frequency of Brushing Teeth				Total		P-Value
	Less		Enough				
	f	%	f	%	f	%	
Very High	38	51,3	2	2,7	40	54,1	0,000
High	14	18,9	2	2,7	16	21,6	
Medium	0	0	11	14,9	11	14,9	
Low	1	1,3	5	6,8	6	8,1	
Very Low	0	0	1	1,3	1	1,3	

Based on the analysis of the relationship between dental caries occurrence as measured by the def-t index and toothbrushing frequency, it was found that the majority of respondents experienced very high levels of dental caries, totaling 40 children (54.1%). This group consisted of 38 respondents (51.3%) with inadequate toothbrushing frequency and 2 respondents (2.7%) with adequate toothbrushing frequency. Respondents with high levels of dental caries accounted for 16 children (21.6%), including 14 respondents (18.9%) with inadequate toothbrushing frequency and 2 respondents (2.7%) with adequate toothbrushing frequency. Moderate levels of dental caries were observed in 11 respondents (14.9%), all of whom had adequate toothbrushing frequency.

Low levels of dental caries were identified in 6 respondents (8.1%), comprising 1 respondent (1.3%) with inadequate toothbrushing frequency and 5 respondents (6.8%) with adequate toothbrushing frequency. Very low levels of dental caries were observed in 1 respondent (1.3%), who also had adequate toothbrushing frequency. Bivariate analysis using the Chi-square test yielded a p-value of 0.000 (< 0.05), indicating a statistically significant association between toothbrushing frequency and dental caries occurrence as measured by the def-t index among children aged 6–7 years in Tolinggula District, North Gorontalo Regency.

Table 4.

Relationship between Saliva pH and the Incidence of Dental Caries Based on the DEF-T Index in Children Aged 6-7 Years

Incidence of Dental Caries based on def-t index	Saliva pH								Total	P- Value	
	Highly Acidic		Acidic		Slightly Acidic		Normal				
	f	%	f	%	f	%	f	%	f		%
Very High	0	0	12	16,2	27	36,4	1	1,3	40	54,1	0,000
High	0	0	0	0	12	16,2	4	5,4	16	21,6	
Medium	0	0	0	0	0	0	11	14,9	11	14,9	
Low	0	0	0	0	0	0	6	8,1	6	8,1	
Very Low	0	0	0	0	0	0	1	1,3	1	1,3	

Based on the analysis of the relationship between dental caries occurrence as measured by the def-t index and salivary pH, it was found that the majority of respondents experienced very high levels of dental caries, totaling 40 children (54.1%). This group consisted of 12 respondents (16.2%) with acidic salivary pH, 27 respondents (36.4%) with slightly acidic salivary pH, and 1 respondent (1.3%) with normal salivary pH. Respondents with high levels of dental caries accounted for 16 children (21.6%), including 12 respondents (16.2%) with slightly acidic salivary pH and 4

respondents (5.4%) with normal salivary pH. Moderate levels of dental caries were observed in 11 respondents (14.9%), all of whom had normal salivary pH. Low levels of dental caries were identified in 6 respondents (8.1%), all of whom had normal salivary pH. Very low levels of dental caries were observed in 1 respondent (1.3%), who also had normal salivary pH. Bivariate analysis using the Chi-square test yielded a p-value of 0.000 (< 0.05), indicating a statistically significant association between salivary pH and dental caries occurrence as measured by the def-t index among children aged 6–7 years in Tolinggula District, North Gorontalo Regency.

Table 5.

Table of Test Results of the Most Significant Multiple Linear Regression Coefficients of Independent Variables

Model	Unstandardized Coefficients		Standardized Coefficients	T	Sig.
	B	Std. Error	Beta		
Caryogenic Food and Beverage Consumption Behavior	0.090	0.141	0.042	0.642	0.523
Frequency of Brushing Teeth	0.457	0.196	0.197	2.338	0.023
Saliva pH	0.474	0.124	0.304	3.834	0.000

Based on the table above, the most relevant variable is saliva pH ($p=0.000$) which has the most significant relationship with the incidence of dental caries based on the def-t index in children aged 6-7 years in Tolinggula District, North Gorontalo Regency.

DISCUSSION

Based on the analysis results, a highly significant association was found between the consumption behavior of cariogenic foods and beverages and the occurrence of dental caries as measured by the def-t index ($p = 0.000$). This indicates that the more frequently children consume cariogenic foods and drinks such as candies, chocolate, sweet biscuits, sugary beverages, and sticky snacks the greater the severity of dental caries experienced. The data show that children who frequently consumed cariogenic foods and beverages predominated in the very high caries category (39.2%), followed by the high caries category (17.5%). Notably, none of the children who reported never consuming cariogenic foods exhibited high or very high caries severity, highlighting the strong influence of dietary patterns on caries development among children aged 6–7 years. In contrast, children who only occasionally consumed cariogenic foods showed a milder pattern, with a lower proportion classified in the very high caries category (14.9%).

These findings demonstrate a significant relationship between cariogenic dietary behavior and the occurrence of dental caries in children aged 6–7 years, as assessed using the def-t index. This result is consistent with extensive evidence linking free sugar intake and cariogenic foods to an increased risk of caries in children. Studies by Liena et al. (2020) and Mayasari (2021) reported that cariogenic dietary patterns particularly the consumption of soft drinks and candies are significantly associated with higher caries prevalence and caries index scores. Similarly, Arsad et al. (2022) found that excessive frequency of cariogenic food consumption increases the risk of dental caries in children. Therefore, education on healthy dietary patterns and limiting the intake of sugary foods and beverages is a crucial component of sustainable caries prevention strategies.

Cariogenic food and beverage consumption behavior has been shown to be significantly associated with the occurrence of dental caries in children. The intake of free sugars, sweet foods and beverages, and sticky snacks containing refined sugars such as candies, chocolate, and donuts provides a substrate for oral bacteria to produce acids, thereby accelerating enamel demineralization. This finding aligns with the study by Afrinis et al. (2021), which reported a significant relationship between sweet food consumption and dental caries incidence ($p = 0.000$; $p < 0.05$). Children with habitual sweet food consumption were more likely to experience dental caries, whereas most children who did not consume sweet foods were free from caries.

The results of this study conducted in five public elementary schools in Tolinggula District, North Gorontalo Regency, revealed a highly significant association between toothbrushing frequency and the severity of dental caries among children aged 6–7 years (p -value = 0.000). Statistically, this indicates that differences in caries occurrence between children with insufficient and adequate toothbrushing frequency are not due to chance but represent a true effect of brushing behavior. Data analysis showed that children with inadequate toothbrushing frequency had a substantially higher proportion of very high caries severity (51.3%) compared to those who brushed their teeth adequately (2.7%). Conversely, low and very low caries categories were more prevalent among children with adequate brushing habits. These findings indicate that toothbrushing frequency is a key determinant in preventing plaque accumulation and reducing the risk of dental caries in children. This study demonstrates that toothbrushing frequency is significantly associated with dental caries occurrence in children aged 6–7 years, as measured by the def-t index. Children who brushed their teeth twice daily or more tended to have lower def-t scores than those who brushed less than twice per day. This finding is consistent with previous literature identifying brushing frequency as an important behavioral factor in caries prevention during early childhood (Khan et al., 2024; Putri et al., 2023).

Biologically, toothbrushing reduces plaque accumulation and the availability of substrates for cariogenic bacteria, thereby decreasing acid production and the risk of enamel demineralization in primary teeth. Higher brushing frequency particularly when combined with the use of fluoride toothpaste and proper brushing techniques extends the protective period against postprandial acid attacks. Therefore, both the frequency and quality of toothbrushing (including duration, technique, and fluoride toothpaste use) jointly contribute to reducing caries incidence (Putri et al., 2023; Brusius et al., 2023). The increased risk of dental caries among respondents with inadequate toothbrushing frequency can be explained by prolonged accumulation of plaque and sugar-containing food residues on tooth surfaces. This provides oral bacteria with more time to produce enamel-damaging acids. Additionally, failure to brush teeth before bedtime allows plaque to persist for several hours without sufficient salivary flow, thereby accelerating demineralization. This finding is consistent with the study by Laiya et al. (2023), which identified toothbrushing frequency as the most dominant risk factor associated with dental caries in school-aged children.

Theoretically, these findings align with Andersen's Behavioral Model, which posits that health behaviors—including toothbrushing habits are influenced by predisposing factors such as knowledge, parental education, and environmental support (Andersen, 2018). Accordingly, children who receive proper toothbrushing education from parents, teachers, or school dental health programs are more likely to develop better brushing techniques and experience a lower risk of caries. Saliva plays a critical physiological role in maintaining oral ecosystem balance. Salivary pH determines the ability of saliva to neutralize acids, inhibit the growth of cariogenic bacteria, and facilitate remineralization. When salivary pH falls below 5.5, enamel demineralization begins, rendering children with acidic saliva more susceptible to dental caries (Featherstone, 2020). The data support this theory, as no children with highly acidic salivary pH were classified in the very low caries category, while no children with normal salivary pH exhibited very high caries severity.

According to the Stephan Curve theory, the consumption of sugary foods causes a rapid decline in salivary pH within minutes, and if saliva is unable to restore pH to neutral levels, demineralization continues (Bowen, 2013). Children with acidic salivary pH exhibit reduced buffering capacity, significantly increasing caries risk. These findings also correspond with Andersen's Behavioral Model, which suggests that physiological conditions including salivary pH are influenced by predisposing factors such as dietary patterns, oral hygiene behaviors, and daily lifestyle habits. Children who frequently consume cariogenic foods, brush their teeth infrequently, or have low salivary flow tend to have more acidic salivary pH and accelerated caries development (Andersen, 2018).

The higher risk of dental caries among respondents with slightly acidic salivary pH can be attributed to gradual mineral loss from the enamel, making it more vulnerable to attacks by cariogenic bacteria such as *Streptococcus mutans* and *Lactobacillus*. A mildly acidic environment also accelerates bacterial fermentation of sugars into acids, further lowering pH and hastening demineralization. If this acidic condition persists due to frequent sugar intake, poor oral hygiene, or low salivary flow the risk of caries lesion formation increases significantly (Jupriyanto et al., 2023).

CONCLUSION

Based on the study findings, cariogenic food and beverage consumption behavior, toothbrushing frequency, and salivary pH were all significantly associated with the occurrence of dental caries, each with a p-value of 0.000. Further analysis revealed that salivary pH was the most dominant factor associated with dental caries occurrence ($p = 0.000$). These findings underscore the importance of proper toothbrushing behavior and optimal salivary pH in reducing the risk of dental caries. Cariogenic dietary behavior and toothbrushing frequency are key factors associated with dental caries among children aged 6–7 years. Therefore, comprehensive promotive and preventive efforts involving parents, schools, and healthcare professionals are required to reduce caries prevalence in this age group. Schools are encouraged to support caries prevention initiatives by implementing healthy canteen policies that limit the sale of cariogenic foods and beverages. In addition, schools may collaborate with primary healthcare centers or dental health professionals to implement School Dental Health Programs, including oral health education, routine dental examinations, and supervised toothbrushing activities. Healthcare professionals, particularly dentists and dental nurses, are expected to strengthen promotive and preventive activities through oral health education for children and parents, as well as early detection of dental caries in school-aged children. Preventive services such as fluoride application and nutritional counseling should also be optimized to reduce the risk of dental caries.

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