



Dental Caries Incidence Among Children at the Dental and Oral Hospital of Universitas Muhammadiyah Semarang

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Article Info	Abstract
Article History: Submitted 20 May 2025 Revised 15 December 2025 Accepted 10 February 2026 Keywords: Child Dental Caries, Dietary Habits, Oral Hygiene, Risk Factors DOI: https://doi.org/10.15294/phpj.v10i1.25226	Early childhood dental caries constitutes a major public health problem in Indonesia, with an exceptionally high disease burden. Data from the 2018 National Basic Health Research (Riskesdas) reported a caries prevalence of 81.5% among children aged 3–4 years, increasing to 92.6% among those aged 5–9 years, placing Indonesia among countries with the highest prevalence globally. This study aimed to analyze risk factors associated with dental caries in children, including sex, dietary habits, toothbrushing practices, parental education level, and history of preterm birth. A case–control study design was employed at the Dental and Oral Hospital of Universitas Muhammadiyah Semarang, involving 88 children aged 3–10 years selected through purposive sampling. The case group consisted of 44 children diagnosed with dental caries based on medical records (ICD-10: K02), while the control group comprised 44 children without dental caries (ICD-10: Z01.2). Data were collected using validated questionnaires and medical records. Respondent characteristics indicated that the case group was predominantly male, aged 6–10 years, and exhibited poor dietary and toothbrushing habits. Statistical analyses were conducted using the Chi-square test and logistic regression. The results demonstrated that poor dietary habits were the most dominant risk factor for dental caries (OR = 98.967; $p < 0.001$), followed by toothbrushing practices, which remained statistically significant in the final model. The predictive model showed that children with poor dietary habits and inadequate toothbrushing practices had a 99.37% probability of developing dental caries. These findings underscore the importance of early screening and behavioral interventions targeting dietary practices and oral hygiene among children, supported by collaborative efforts involving parents, schools, and healthcare services to reduce the prevalence of childhood dental caries.

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INTRODUCTION

Dental caries is one of the most prevalent chronic diseases affecting children worldwide, including in Indonesia. A wide range of prevalence has been reported across 29 out of 195 countries, with greater variability attributed to differences between countries rather than between continents or over time (Uribe et al., 2021). Caries occurs due to the demineralization of tooth hard tissues, driven by a complex interaction between cariogenic microorganisms, fermentable carbohydrates, and host factors. WHO data indicate that approximately 60–90% of school-aged children have experienced dental caries, making it a major concern in public oral health (Ruff & Niederman, 2018). The prevalence of Early Childhood Caries (ECC) is substantially higher in developing countries, reaching up to 70%, compared with only 1–12% in developed countries. The factors most strongly contributing to the high incidence of ECC include excessive consumption of sugary foods, vertical transmission of cariogenic bacteria from mother to child, and limited access to dental healthcare services (Skeie & Klock, 2023). If left untreated, caries can impair a child's quality of life, causing difficulties in eating, sleeping, and concentrating in school (Zaror, C., et al., 2022).

Early Childhood Caries (ECC) has gained global attention. In Indonesia, ECC prevalence among five-year-old children reaches 90%, which is significantly higher than in countries such as Nigeria (7%) (Chen et al., 2021) or Cambodia (56.6%) (Turton et al., 2019). The 2018 Indonesian Basic Health Survey (Riskesdas) reported a caries prevalence of 92.6% among children aged 5–9 years, identifying them as the age group bearing the highest disease burden (Kemenkes, 2018). The consistently high prevalence highlights the urgent need for preventive and promotional measures, especially early detection (Hasan et al., 2024).

In Southeast Asia, the prevalence of dental caries among children aged 5–6 years is reported to be 79%, with a mean caries experience (dmf-t) of 5.1, indicating that each child has, on average, 5.1 teeth affected by caries. This finding is comparable to the epidemiological survey on Early Childhood Caries (ECC) conducted in

Cambodia in 2019, which reported that 56.6% of participants had one or more carious teeth (Turton et al., 2019). Dental caries in early childhood represents a major health problem affecting children aged 0–6 years in many countries, including Indonesia.

In Indonesia, dental caries ranks as the most common chronic disease among young children. Nevertheless, many parents still perceive caries as a trivial issue (Kusuma et al., 2023). ECC is not merely a dental problem; it negatively affects children's growth, development, and overall oral health-related quality of life (Thirunavukkarasu & Alaqidi, 2024). Therefore, early prevention strategies and accessible diagnostic methods are critically needed (Y. Zhang et al., 2020).

Dental caries experienced from an early age can lead to various adverse outcomes, affecting not only the function of teeth as masticatory organs but also resulting in swollen gingival tissues and a decline in children's ability to perform daily activities (Bramantoro et al., 2024). Due to pain and discomfort, affected children tend to experience a loss of appetite, which may subsequently lead to malnutrition and contribute to learning difficulties as a result of reduced concentration, and may even impair cognitive development (Mardiati et al., 2017).

Numerous studies have linked pediatric dental caries to several risk factors, including gender, tooth brushing habits, consumption of sugary foods, and parental education level (Purwaningsih & Sirat, 2016). However, the findings are often inconsistent, particularly regarding brushing habits, which are influenced by both frequency and technique (Jalante et al., 2020). Additionally, the role of premature birth in caries development remains underexplored, although it may impact dental development and enamel resistance.

In Central Java, the prevalence of dental problems remains high at 56%, yet only 50.4% of elementary school students who require treatment have received dental care (Dinkes Jateng, 2022). This gap underscores the importance of early prevention programs such as the School Dental Health Program (UKGS). The presence of biofilms from Cbp⁺ *Streptococcus mutans* and *Candida albicans* has also been

implicated in recurrent caries, emphasizing the need for targeted prevention strategies (Garcia, et al., 2021). In Semarang City, the prevalence of dental caries among children aged 5–9 years increased from 25.4% in 2013 to 56% in 2023 (Sholekhah et al., 2023).

A preliminary study conducted at the Dental and Oral Hospital of Universitas Muhammadiyah Semarang (RSGM Unimus) from 2022 to 2024 recorded 4,816 pediatric caries cases, ranking it among the top ten most commonly treated conditions. With an average of 116 pediatric visits per month in 2024, RSGM Unimus bears the highest caries burden among children in Semarang. These findings underscore the urgency of mapping local risk factors and designing data-driven interventions.

This study aims to analyze the associations between gender, dietary habits, tooth brushing practices, parental education level, and premature birth with dental caries incidence in children at RSGM Unimus. Through an analytical approach and an epidemiologically relevant population, this study seeks to inform the development of more effective, evidence-based, and sustainable promotive and preventive strategies.

METHOD

This research employed an analytical observational design using a case-control approach to evaluate the relationship between several risk factors and the incidence of dental caries among children aged 3–10 years. The study was conducted at the Dental and Oral Hospital of Universitas Muhammadiyah Semarang (RSGM Unimus), located in the Tembalang subdistrict of Semarang, from October 2024 to January 2025.

The study population consisted of two groups: the case group included children diagnosed with dental caries based on medical records (ICD-10 code: K02), while the control group included children without caries diagnoses (ICD-10 code: Z01.2). A purposive sampling technique was employed, considering specific characteristics relevant to the study objectives. Each group comprised 44 respondents, with an additional 10% added to account for potential data loss or dropouts. Inclusion and exclusion

criteria were established to ensure appropriate subject characteristics aligned with the study design.

The independent variables in this study were gender, parental education level, children's dietary habits, tooth brushing practices, and history of premature birth. The dependent variable was the presence of dental caries. The primary data collection instrument was a questionnaire, which had undergone validity and reliability testing. Item validity was tested using Pearson correlation, with all items demonstrating satisfactory validity ($p < 0.05$), yielding correlation coefficients ranging from 0.567 to 0.902. Reliability testing using Cronbach's Alpha produced a coefficient of 0.825, indicating high internal consistency of the instrument. In addition to primary data, secondary data from medical records were used to support the analysis.

The data analysis process involved three main stages. First, univariate analysis was conducted to describe the demographic characteristics and distribution of the variables. Second, bivariate analysis was used to examine the associations between independent and dependent variables through Chi-Square tests or Fisher's Exact tests when assumptions were not met. Third, multivariate analysis using logistic regression was performed to identify the most dominant factors contributing to caries incidence. This study received ethical clearance from the institutional ethics committee, and data collection procedures adhered to ethical standards, including obtaining informed consent from parents or guardians prior to participation.

RESULTS AND DISCUSSIONS

The results of the univariate analysis concerning the frequency distribution of respondents are presented in Table 1. The results of the univariate analysis revealed a clear pattern: the case group was predominantly composed of male children (34.1%) aged 6–10 years (39.8%) who exhibited poor dietary habits (47.7%) and inadequate oral hygiene or toothbrushing practices (43.2%). In contrast, the control group demonstrated an opposite pattern, with a predominance of females

Table 1. Respondent Characteristics

Variable	Category	Frequency	
		Case	Control
Gender	Male	30	8
	Female	14	36
	Total	44	44
Parental Education	Basic (Elementary, Junior High School)	3	19
	Intermediate (Senior High School/ Vocational)	12	16
	Higher (Diploma, Undergraduate, Specialist, Doctorate)	29	9
	Total	44	44
	Total	44	44
Child's Age	1 – 5 Years	9	33
	6 – 10 Years	35	11
	Total	44	44
Child's Dietary Habits	Poor	42	3
	Good	2	41
	Total	44	44
Tooth Brushing Habits	Poor	38	1
	Good	6	43
	Total	44	44
History of Premature Birth	Premature	31	25
	Normal	13	19
	Total	44	44
Dental Caries Status	Caries (1–6)	44	0
	Non-caries	0	44
	Total	44	44

Source: Primary Data

(40.9%) aged 1–5 years (37.5%) who reported good dietary habits (46.6%) and appropriate toothbrushing practices (48.9%). An interesting finding was that 33.0% of parents in the case group had a high level of education, compared with only 10.2% in the control group. Furthermore, 35.2% of children in the caries group had a history of preterm birth, while preterm birth was also the most prevalent condition in the control group (28.4%). These findings indicate that despite a high parental educational background, poor oral health practices remain the dominant contributing factor, supported by additional risk factors such

as school-age status and prematurity. Overall, these results underscore the importance of targeted preventive interventions, particularly among school-aged boys, with a strong emphasis on establishing good oral hygiene practices regardless of parental educational level.

The results of the bivariate analysis examining the association between risk factors and dental caries are presented in Table 2. The analysis demonstrated significant associations between several risk factors and the occurrence of dental caries in children. Male children had a 9.6-fold higher risk of developing dental caries compared with female children (OR = 9.643; $p < 0.001$). Parental education level was also significantly associated with caries occurrence, whereby children of parents with primary education had a 10.4-fold higher risk of dental caries compared with those whose parents had higher education (OR = 10.387; $p < 0.001$), and a 7.5-fold higher risk compared with those with secondary education (OR = 7.519; $p < 0.001$). In contrast, the difference between higher and secondary education levels was not statistically significant ($p = 0.360$). Behavioral factors exerted the strongest influence, with poor dietary habits increasing the risk of dental caries by 287 times (OR = 287; $p < 0.001$) and inadequate toothbrushing practices increasing the risk by 272.3 times (OR = 272.3; $p < 0.001$). Conversely, a history of preterm birth was not significantly associated with the occurrence of dental caries in children ($p = 0.184$).

The chi-square analysis demonstrated a statistically significant association ($p < 0.001$) between sex and dental caries, with an odds ratio (OR) of 9.643. This indicates that male children have a 9.643-fold higher risk of developing dental caries compared with female children. These findings are consistent with the study by Ali et al (2024) which reported that the proportion of male students with dental caries (74.4%) was higher than that of female students (71%). Although their study did not find a statistically significant association between gender and caries incidence (p -value = 0.551), it suggests that gender may influence caries risk, even if not always significantly. This is further supported by Kusuma & Taiyeb (2020) who also found a higher prevalence of caries among male students

compared to females, despite the statistical insignificance of the difference (p -value = 0.446) furthermore, a study by Moca et al (2024) reported that female children tend to demonstrate better oral hygiene practices.

Table 2. Association Between Risk Factors and Dental Caries in Children: Gender, Parental Education Level, Dietary Habits, Tooth Brushing Habits, and Premature Birth

Variable	Category	<i>p</i> -value	OR
Gender	Male	0.000	9.643
	Female		
Parental Education and Caries Status (Higher vs Basic)	Higher	0.000	10.387
	Basic		
Parental Education and Caries Status (Higher vs Intermediate)	Higher	0.360	1.524
	Intermediate		
Parental Education and Caries Status (Intermediate vs Basic)	Intermediate	0.000	7.519
	Basic		
Child's Dietary Habits	Poor	0.000	287
	Good		
Tooth Brushing Habits	Poor	0.000	272.3
	Good		
History of Premature Birth	Premature	0.184	1.812
	Normal		

Source: Primary Data

However, these findings contrast with those reported by Napitupulu (2023) who found that female children had a higher risk of developing dental caries compared to males. This was attributed to the fact that girls typically experience earlier tooth eruption than boys, resulting in prolonged exposure of their teeth to cariogenic risk factors such as dental plaque and sugary foods.

Furthermore, research by de Jesus, et al (2020) indicated that the composition of dental plaque microbiota and gender may serve as

significant determinants in the pathogenesis of Severe Early Childhood Caries (S-ECC). These factors should therefore be considered in the development of comprehensive caries risk assessment tools.

The differences in the findings of this study may be explained by several factors, including variations in sample characteristics, environmental conditions, and respondents' lifestyle behaviors. For instance, faster tooth eruption in female children may render their teeth more susceptible to caries, particularly if not accompanied by adequate toothbrushing practices and a healthy diet. Conversely, male children may be more vulnerable to dental caries due to behavioral factors, such as lower attention to oral and dental hygiene.

In addition, hormonal factors may also influence the risk of dental caries in female children. Hormonal changes, particularly during puberty, can affect oral and dental health conditions, including salivary flow and oral pH, which may ultimately increase the risk of caries. However, hormonal factors were not directly measured in this study; therefore, further research is required to confirm their potential effects.

The analysis of the relationship between parental education level and dental caries also identified this variable as an important factor. Table 2 presents a comparative analysis between higher education and both basic and intermediate education levels in relation to children's caries status.

A significant association was observed between higher and primary education levels, as well as between secondary and primary education levels. However, no significant difference was observed between higher and intermediate education levels. These findings are consistent with those of Wahyuningsih., et al (2024) who reported a significant correlation between parental education and caries incidence, noting that children with less-educated parents were at greater risk of developing dental caries. However, this contrasts with findings by Amalia et al (2024) who reported no significant association between parental education level and the incidence of dental caries among students at SDN Johar Baru 29, Central Jakarta.

The discrepancies in research findings may

be attributed to several factors, including variations in sample characteristics, environmental influences, and respondents' lifestyle habits. According to Atmadjati et al (2023) limited parental involvement often due to time constraints may reduce the opportunity for parents to provide guidance and supervision to their children as well as the study by Al-Haj Ali et al (2021) emphasized that working mothers who are busy with their professional responsibilities should also be encouraged to assist or ensure that their children brush their teeth in the morning before going to work and at night before the children go to sleep.

Furthermore, the analysis identified dietary habits as the strongest predictor of dental caries. The Chi-square test yielded a p-value of 0.000, indicating a highly significant statistical association between dietary habits and caries status. Odds ratio (OR) of 287 indicates that poor dietary habits are associated with a substantially higher risk of developing dental caries compared with children who have good dietary habits. These findings are consistent with the study by Bernabé, et al (2020) which identified cariogenic foods as a primary cause of dental caries. Their research demonstrated that the early introduction of sugar-sweetened beverages significantly increases the risk of severe caries in children. Accordingly, they recommend avoiding added sugars in toddlers' diets and promoting healthy eating patterns from an early age.

The consumption of carbonated beverages and sugary snacks contributes substantially to Early Childhood Caries (ECC) (Thang Le et al., 2021). This finding is further supported by a study conducted by Saprudin et al (2023) which reported that children with high cariogenic dietary habits had a ninefold higher risk of developing Early Childhood Caries (ECC) compared with those with low cariogenic dietary habits.

Changes in dietary patterns, including reducing sugar intake and increasing food variety, are recommended as preventive strategies (Dhull et al., 2024). A study conducted by Ipek & Tuncer (2024) in Turkey highlighted the importance of oral health education and early interventions as integral components of preventive strategies.

The analysis of the toothbrushing habits variable yielded a p-value of < 0.001 , indicating a highly statistically significant association between the two variables. Children with poor toothbrushing habits had a 272.3-fold higher risk of developing dental caries compared with those who practiced good toothbrushing habits. This finding is consistent with the randomized controlled trial conducted by Paszynska (2021) which innovatively demonstrated that the regular use of toothpaste containing microcrystalline hydroxyapatite in children is equally effective as fluoride toothpaste in preventing enamel caries in primary dentition.

According to Prayoga et al (2024), optimal oral hygiene, including proper and correct tooth cleaning, is essential for removing dental plaque and food debris that can lead to caries. Regular toothbrushing performed with the correct technique can effectively eliminate plaque and prevent the accumulation of bacteria that damage tooth enamel. This is further supported by a study conducted by Wahyuni et al (2023), which emphasized the importance of brushing teeth twice daily using proper techniques to prevent oral and dental diseases.

The findings of this study are further supported by research conducted by Mariati et al (2024), which found that the majority of respondents were unaware of the appropriate time to replace their toothbrushes. The American Dental Association (ADA) and the British Oral Health Foundation recommend replacing toothbrushes every three months to prevent the growth of pathogenic microorganisms that may adversely affect oral health. This highlights that not only the frequency and technique of toothbrushing are important, but also the maintenance of oral hygiene tools, such as toothbrushes.

These results are also supported by Boustedt., et al (2020) who found that brushing less than twice daily and difficulties in maintaining brushing routines during early preschool years were significant determinants of the high caries prevalence observed in five year old children. Therefore, healthcare professionals must provide focused attention and continuous support to parents in improving and optimizing

their children's tooth brushing behaviors during this critical developmental period.

The analysis of the association between premature birth and dental caries status showed no significant relationship, with a p-value of 0.184. A study by Diastutik et al (2024) suggested that premature birth may affect enamel quality; however, the impact is likely indirect and warrants further investigation.

Other studies have found no association between breastfeeding and Early Childhood Caries (ECC). Given the substantial benefits of breastfeeding and the low prevalence of prolonged breastfeeding, restriction of breastfeeding is not recommended. Instead, effective prevention of ECC requires limiting added sugars in children's diets (Devenish et al., 2020). Furthermore, the combination of microbiome-related factors, dental plaque, and breastfeeding practices plays an important role in the risk of Early Childhood Caries (ECC) (Irfan et al., 2023).

Variables eligible for inclusion in the

multivariate analysis were independent variables with a p-value <0.05 in the bivariate analysis; therefore, the variables comparing higher versus secondary parental education and history of preterm birth were not included in the multivariate analysis. The variables with p<0.05 that were entered into the multivariate analysis were sex, parental education level, children's dietary habits, and toothbrushing practices.

The multivariate analysis using logistic regression generated a predictive model for the occurrence of dental caries. In the final model, the logistic regression results identified the most dominant variables influencing the occurrence of dental caries among children at the Dental and Oral Hospital of Universitas Muhammadiyah Semarang. The variables included in the final model were those re-tested after removing variables that were not statistically significant in the previous logistic regression analysis. Consequently, only children's dietary habits and toothbrushing practices were retained in the final model, as presented in Table 3.

Table 3. Multivariate Analysis

	Variable	B	S.E.	Wald	df	Sig.	Exp (B)	95% C.I. for Exp (B)	
								Lower	Upper
Step 1	Child's Dietary Habits	4.595	1.206	14.507	1	0.000	98.967	9.303	1052.821
	Tooth Brushing Habits	4.430	1.421	9.715	1	0.002	83.957	5.178	1361.164
	Constant	5.184	-7.092	-3.958	1.056	14.047	1	0.000	0.019

Source: Primary Data

The results of the multivariate logistic regression analysis using the Backward LR method indicated that only children's dietary habits and toothbrushing practices remained statistically significant predictors of dental caries occurrence, with significance values of 0.000 and 0.002, respectively (< 0.05). Children with poor dietary habits had an approximately 98.97-fold higher risk of developing dental caries compared with those with good dietary habits, while children with poor toothbrushing practices had an approximately 83.96-fold higher risk compared with those who practiced good toothbrushing. These findings confirm that

dietary behavior and oral hygiene practices are the most dominant risk factors in predicting dental caries in children. Therefore, preventive interventions should focus on establishing healthy eating patterns and improving proper toothbrushing habits from an early age.

Based on the results of the analysis, the final model demonstrated that dietary habits and toothbrushing practices are the primary predictors of dental caries occurrence in children. This model was designed to assist healthcare professionals in the early identification of children with high-risk dietary patterns, thereby enabling timely interventions such as nutritional

education and dietary modification to prevent the development of dental caries. The model generated a logit equation that was subsequently converted into a probability estimate, indicating that the combination of these risk factors yields a 99.37% probability of dental caries occurrence. This finding underscores the critical importance of interventions targeting dietary behaviors and oral hygiene practices in children, particularly among high-risk groups. Overall, these results highlight the robustness of the model in identifying high-risk individuals based on behavioral factors and emphasize the need for predictive screening and preventive interventions focused on improving dietary patterns and toothbrushing habits from an early age.

Based on the multivariate analysis, only children's dietary habits and toothbrushing practices were identified as the primary risk factors influencing the occurrence of dental caries. This finding indicates that, although the bivariate analysis demonstrated significant associations between sex, parental education level (high vs. low), and parental education level (secondary vs. low) with dental caries, these associations became non-significant when behavioral variables such as dietary patterns and oral hygiene practices were included in the model. In summary, the multivariate analysis highlights that dietary habits and toothbrushing practices are the most dominant and relevant factors in predicting the occurrence of dental caries in this pediatric population.

These findings underscore the critical need for early screening programs focused on dietary behavior and oral hygiene education. This aligns with the findings of Rahatina et al (2023) which demonstrated that educational interventions and direct actions are highly effective in reducing caries incidence. Moreover, access to dental health services and active parental involvement are key factors in supporting the development of positive oral health behaviors in children.

Other studies, such as that conducted by Miftakhun et al (2016), have found that knowledge of oral health is also a contributing factor to the occurrence of dental caries among preschool children. In contrast, research by Sowwam & Pramita Ran Lestari, (2023) demonstrated that toothbrushing habits are a

significant factor influencing the incidence of dental caries among elementary school children. These differences suggest that risk factors for dental caries may vary depending on the context and characteristics of the population studied. Therefore, prevention strategies based on education, behavioral management, and care procedures tailored to children's sensitivity are required (Adeghe et al., 2024).

In addition, a study by Amalia et al (2024) identified residential distance to healthcare facilities as a dominant factor influencing the occurrence of dental caries. Communities residing closer to healthcare facilities tend to have better access to dental services, which can consequently reduce the risk of dental caries. This finding indicates that environmental factors and access to healthcare services also play an important role in determining children's dental caries status. Furthermore, preventive dental visits and additional training in oral health practices are recommended to reduce the prevalence of Early Childhood Caries (ECC) (M. Zhang et al., 2020). Moreover, a study conducted by Patel et al (2025) emphasized the importance of comprehensive preventive strategies encompassing public education, interprofessional collaboration, and improved access to dental healthcare services.

Through a holistic approach involving collaboration among parents, healthcare providers, and educational institutions, the prevalence of dental caries in children can be significantly reduced, thereby improving their overall quality of life.

CONCLUSION

The study results indicate that dietary habits and toothbrushing practices are the most dominant risk factors for the occurrence of dental caries in children. Bivariate analysis identified significant associations between dental caries and sex, parental education level, dietary habits, and toothbrushing practices; however, in the multivariate analysis, only dietary habits and toothbrushing practices remained independently associated with dental caries. Children with poor dietary habits had an almost 99-fold higher risk of developing dental caries, while poor

toothbrushing practices increased the risk by more than 80 times compared with children who exhibited good habits. The effects of sex and parental education level lost statistical significance after controlling for behavioral variables, whereas a history of preterm birth showed no significant association with the occurrence of dental caries. The final predictive model demonstrated that the combination of poor dietary habits and inadequate toothbrushing practices yielded a 99.37% probability of dental caries occurrence, underscoring the central role of behavioral factors in determining dental caries status among children.

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