

## **Nutritional status, eating behavior, and hygiene practices in relation to permanent molar caries among 7–9-year-old children in a high-stunting rural community**

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### **ABSTRACT**

**Background:** Caries in the first permanent molar is a major oral health concern in nutritionally vulnerable rural populations. Children living in stunting-endemic areas may be at elevated risk due to suboptimal dietary habits and hygiene practices.

**Methods:** This a cross-sectional analytical observational study involved 150 children aged 7–9 years from three elementary schools in a stunting locus village in Pesawaran District, Indonesia. The independent variables (nutritional status, eating behavior and personal hygiene practices) and the dependent variable (presence of caries in the mandibular permanent first molar). Chi-square tests were applied to determine associations ( $p < 0.05$ ).

**Results:** Most children had normal nutritional status (82%), while 18% were stunted. Eating behavior tended to be suboptimal, with 40% categorized as “not enough,” and 38% of the children demonstrated inadequate personal hygiene. Bivariate analysis showed no significant association between nutritional status and caries ( $p = 0.729$ ). However, eating behavior was significantly associated with poor caries status ( $p < 0.000$ ), with the highest prevalence of poor caries status found among children with inadequate eating behavior (75%). Personal hygiene also showed a strong association with poor caries status ( $p < 0.000$ ), as 87.7% of children with inadequate hygiene exhibited poor caries status.

**Conclusion:** Eating behavior and personal hygiene were significant determinants of caries in the lower first permanent molar, whereas nutritional status was not associated. Improving dietary habits and hygiene practices may effectively reduce caries risk in high-stunting rural communities.

### **KEYWORDS**

Children’s oral health, growth retardation, dietary habits, oral hygiene, vulnerable rural communities, permanent first molar.

### **INTRODUCTION**

Child oral health, particularly caries in newly erupted permanent molars, constitutes a critical yet often overlooked public health issue in nutritionally vulnerable communities. The first permanent molars (M1), erupting around ages 6–7, are highly susceptible to caries due to their deep fissure morphology, initial incomplete post-eruptive maturation, and posterior location, which complicates optimal cleaning<sup>1,2</sup>. For 7–9-year-old children in high-stunting rural communities, the premature loss of these permanent teeth carries a dual burden. Beyond the immediate impact on quality of life such as pain, eating difficulties, and reduced learning concentration, this condition can exacerbate the cycle of malnutrition. Recent evidence suggests severe oral disease can be both a marker and a contributor to the double burden of malnutrition, where chronic masticatory dysfunction limits the intake and diversification of nutritious foods<sup>3,4</sup>. Therefore, understanding the determinants of caries in these first permanent teeth within this specific population is crucial for developing integrated preventive strategies.

Globally, research has long established the multifactorial relationship between childhood caries and social determinants,

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high-sugar diets, and poor oral hygiene<sup>5</sup>. However, significant knowledge gaps persist when this context is applied to rural populations with high stunting prevalence. Firstly, most studies still focus on early childhood caries in primary dentition or aggregate all permanent teeth, failing to isolate risk factors specific to newly erupted permanent molars in the 7–9 year age group. This eruption period represents a critical window of opportunity and the highest vulnerability for these teeth<sup>6</sup>. Secondly, although stunting and caries are often studied as co-existing conditions, research explicitly investigating children from high-stunting communities as a unique epidemiological entity remains scarce. Analyses frequently treat stunting as a covariate rather than a fundamental characteristic of the research setting that shapes parenting practices, food access, and health behaviors, including oral health<sup>7</sup>.

Furthermore, research approaches are often fragmented. Many studies explore dietary factors solely from the perspective of sucrose intake, overlooking broader eating behaviors such as snacking frequency, food consistency (sticky vs. non-sticky), and meal timing patterns, all of which influence plaque dynamics and oral pH<sup>8</sup>. Similarly, a focus on oral hygiene practices like toothbrushing often neglects wider basic hygiene practices such as handwashing, utensil cleanliness, and drinking water sources, which directly affect the transmission and colonization of cariogenic bacteria, especially in households with limited sanitation<sup>9</sup>. The interconnection between (potentially sub-optimal) nutritional status, comprehensive eating behavior, and basic hygiene practices within a single analytical framework to explain the variance in permanent molar caries incidence in vulnerable populations remains poorly understood and under-investigated<sup>10</sup>.

Therefore, this study is designed to address these gaps by simultaneously investigating the relationship between nutritional status (stunting, underweight), comprehensive eating behavior, and basic hygiene practices and the occurrence of permanent molar caries among 7–9 year old children in a high-stunting rural community. This study hypothesizes that caries susceptibility in this population results from a synergistic environmental risk syndrome, where chronic malnutrition, poorly regulated eating patterns, and minimal hygiene practices create an ideal condition for rapid caries development (rampant caries) in young permanent teeth.

## METHODS

### Study Design and Setting

This study employed a cross-sectional analytical observational study design, which is appropriate for identifying associations between nutritional status, dietary patterns, personal hygiene, and dental caries at a single point in time. The research was conducted in three public elementary schools located in Negeri Sakti Village, Pesawaran District, designated as a stunting locus area. Data collection took place from July to August 2025.

### Study Participants and Sampling

The study population consisted of all students aged 7–9 years enrolled in the three elementary schools in Negeri Sakti Village (total N = 150 students). Participants were recruited using total sampling, following inclusion and exclusion criteria of age eligibility and parental consent, the presence of fully erupted permanent first molars, the absence of systemic diseases affecting growth or oral health, and the exclusion of children with recent dental treatments that could bias the assessment of caries.

Anthropometric data such as height, weight, and age were collected to determine nutritional status, specifically Height-for-Age (H/A) for stunting for nutritional categories, based on WHO Child Growth Standards. Students meeting the anthropometric measurement criteria and completing all assessments were included as final samples.

### Data Collection Tools and Technique

Height was measured using a stadiometer, and weight using a calibrated digital scale. Nutritional status was classified according to the WHO 2007 reference using WHO AnthroPlus z-score standards. Dietary patterns were assessed through a structured questionnaire consisting of 15 Guttman-scale items (Yes/No) covering food types, frequency, and portion consumption. Guttman scaling is commonly used for dietary behavior assessments due to its simplicity and reliability<sup>11</sup>. Personal hygiene was measured using an 11-item Guttman-scale questionnaire that included oral hygiene behaviors such as toothbrushing twice daily, after breakfast and before bedtime. Structured hygiene assessments have been shown to correlate strongly with dental caries risk<sup>12</sup>. Dental caries in the mandibular first permanent molar were assessed clinically using a mouth mirror and a dental explorer/sonde. A tooth was recorded as having caries if:

- The explorer tip caught on a surface, or
- Visible dark brown/black discoloration was observed.

Caries assessment procedures followed established criteria similar to the WHO Oral Health Survey Methods (5th edition) (WHO, 2013) and recent clinical examination standards<sup>13</sup>. All findings were recorded using a structured dental examination form in which caries were marked as (√) and non-caries as (X). Parents or guardians completed and signed an informed consent form before data collection.

### Data Analysis

Data were analyzed using *Statistical Package for the Social Sciences* (SPSS) version 25. Descriptive statistics (frequency and percentage) were applied to present the demographic and behavioral characteristics of respondents. The association between independent variables (nutritional status (stunting, eating behavior, and basic hygiene practices) and the dependent

variable (dental caries) was tested using the Chi-square test. The level of statistical significance was set at  $p < 0.05$ .

### Ethical Statement

This study was approved by the Research Ethics Committee of Poltekkes Kemenkes Tanjung Karang (Approval No: No.437/KEPK-TJK/VII/2025). All participants received a detailed explanation of the study's objectives and procedures before participation and provided informed consent.

## RESULTS

The baseline characteristics of the 150 school-aged children (7–9 years old) included in this study from three elementary schools located in the stunting locus area of Negeri Sakti, Pesawaran District. The characteristics described include gender distribution, nutritional status based on height-for-age (H/A), eating behavior, and personal hygiene. These descriptive data provide an essential overview of the health profile and behavioral patterns of the participants prior to conducting further analyses related to the occurrence of dental caries in the mandibular first permanent molar.

As shown in Table 1, the gender distribution indicates that 81 participants (54%) were boys and 69 participants (46%)

were girls, demonstrating a slightly higher proportion of male respondents. Regarding nutritional status based on the height-for-age indicator, 27 children (18.0%) were classified as stunted, while the majority, 123 children (82.0%), fell within the normal category. This finding suggests that although the study area is identified as a stunting locus, most children in this age range did not exhibit linear growth impairment.

In terms of eating behavior, 60 children (40.0%) were categorized as having not enough eating behavior, indicating inadequate dietary habits and food intake quality. Meanwhile, 59 children (39.3%) demonstrated adequate eating behavior, and only 31 children (20.7%) were considered to have good eating behavior. This distribution reflects that a substantial proportion of the children still have suboptimal dietary practices. Similarly, the assessment of personal hygiene showed that 57 children (38.0%) had not enough hygiene practices, 51 children (34.0%) were categorized as having adequate hygiene, and 42 children (28.0%) demonstrated good personal hygiene. These results indicate that the largest proportion of participants did not meet optimal hygiene standards, including oral hygiene behaviors, which may contribute to an increased risk of dental caries.

Table 2 presents the results of the bivariate analysis assessing the relationship between nutritional status, eating behavior, and personal hygiene with the presence of caries in the lower first permanent molar among 150 school-aged children. The findings show that nutritional status did not exhibit a statistically significant association with dental caries ( $p = 0.729$ ). Among the children classified as stunted, 17 (63.0%) had poor caries status and 10 (37.0%) had good caries status. A similar distribution was observed among children with normal nutritional status, where 73 (59.3%) had poor caries status and 50 (40.7%) had good caries status. The relatively comparable proportions between the stunted and normal groups indicate that stunting was not a determinant factor for caries in this population.

In contrast, eating behavior demonstrated a significant association with caries status ( $p = 0.000$ ). Children with not enough eating behavior had the highest proportion of poor caries status, with 45 children (75.0%) experiencing caries and only 15 (25.0%) showing good caries status. Among those with adequate eating behavior, 35 children (59.3%) presented with poor caries status and 24 (40.7%) with good status. Notably, children with good eating behavior exhibited the most favorable outcomes, with only 10 (32.3%) having poor caries status, while 21 (67.7%) had good caries status. These findings suggest that better eating behavior, which likely reflects healthier dietary choices and habits, is strongly associated with lower risk of dental caries.

Personal hygiene was also significantly associated with caries status ( $p = 0.000$ ). Among children with not enough

**Table 1.** Sociodemographic and Health Characteristics of Schoolchildren Aged 7–9 Years In A Rural Community (n=150)

Characteristics	n	%
Gender		
Boys	81	54
Girls	69	46
Nutritional Status (H/A)		
Stunted	27	18.0
Normal	123	82.0
Eating Behavior		
Not enough	60	40.0
Enough	59	39.3
Good	31	20.7
Personal Hygiene		
Not enough	57	38.0
Enough	51	34.0
Good	42	28.0

**Table 2.** Results of Bivariate Analysis of Association Between Independent Variables and Caries in the Mandibular Permanent First Molar

Variable	Category	Caries in the Lower First Permanent Molar				Total		p-value
		Poor		Good				
		n	%	n	%	n	%	
Nutritional status	Stunted	17	63.0	10	37.0	27	100	0.729
	Normal	73	59.3	50	40.7	123	100	
	Total	90	60	60	40	150	100	
Eating Behavior	Not enough	45	75.0	15	25.0	60	100	0.000
	Enough	35	59.3	24	40.7	59	100	
	Good	10	32.3	21	67.7	31	100	
	Total	90	60	60	40	150	100	
Personal Hygiene	Not enough	50	87.7	7	12.3	57	100	0.000
	Enough	27	52.9	24	47.1	51	100	
	Good	13	31.0	29	69.0	42	100	
	Total	90	60	60	40	150	100	

\* Chi-square test a significant of poor and good caries status ( $p < 0.05$ ).

hygiene, a markedly high proportion—50 children (87.7%)—had poor caries status, while only 7 (12.3%) showed good status. In the adequate hygiene group, 27 children (52.9%) had poor caries status compared to 24 (47.1%) with good hygiene. The best outcomes were observed among children with good personal hygiene, where only 13 (31.0%) had poor caries status, while the majority, 29 (69.0%), had good caries status. These findings underscore that better personal hygiene, particularly oral hygiene practices, plays a critical role in preventing dental caries in the first permanent molar. Overall, the results indicate that while nutritional status was not associated with caries, both eating behavior and personal hygiene were strongly and significantly related to the occurrence of dental caries in the lower first permanent molar among the children studied.

## DISCUSSION

This study provides nuanced insights into the determinants of caries in the first permanent molar among school-aged children in a high-stunting rural setting. The key findings reveal a significant association between caries and both eating behavior and personal hygiene, while no significant link was found with nutritional status (stunting). This pattern warrants a detailed discussion within the context of existing evidence and the unique socio-environmental factors of a stunting-endemic community.

First, the absence of a significant association between stunting and dental caries is a notable finding. This contrasts with several systematic reviews suggesting a bidirectional relationship between undernutrition and early childhood caries<sup>14–16</sup>. A plausible explanation lies in the specific age group (7–9 years) and dentition examined. Previous literature often focuses on severe early childhood caries in the primary dentition of younger children, where the causal pathways such as pain-induced feeding difficulties leading to weight faltering are more direct and temporally linked. In this study, the outcome was caries in the *permanent* molars of older children. The nutritional insult leading to stunting likely occurred in the first 1,000 days of life, while the caries in the newly erupted permanent molars developed more recently. Therefore, current stunting status may act as a marker of past nutritional deprivation and overall household disadvantage rather than a direct physiological contributor to caries risk in this specific dentition at this age<sup>17</sup>. This aligns with research suggesting that in school-aged children, socioeconomic and behavioral factors may overshadow the direct biological link between linear growth and oral health<sup>18</sup>.

The strong, significant association between poor eating behavior and higher caries prevalence is consistent with the established cariogenicity of frequent sugar intake and unhealthy snacking patterns. However, our findings deepen this under-

standing by highlighting that within a resource-limited setting, broader “eating behavior” encompassing not just sugar consumption but likely also meal frequency, consistency of foods, and dietary diversity is a critical determinant<sup>19,20</sup>. Children categorized with “not enough” eating behavior may have diets high in cheap, processed carbohydrates and low in protective foods like fruits and vegetables, which require more chewing and stimulate saliva<sup>21</sup>. This creates a perfect environment for caries development in susceptible newly erupted molars<sup>22</sup>. The finding that good eating behavior was protective, even in this high-risk community, underscores the importance of holistic dietary guidance that moves beyond merely “avoiding sweets” to promoting structured meal patterns and nutritious food choices.

Most strikingly, personal hygiene exhibited the strongest gradient of association with caries status. The finding that 87.7% of children with inadequate hygiene had poor caries status powerfully illustrates the central role of daily practices. This extends beyond toothbrushing to include the broader hygiene milieu, such as handwashing and general cleanliness, which can influence the oral microbial load<sup>23</sup>. In rural settings with potentially limited access to fluoride toothpaste and clean water, the mechanical removal of plaque through regular and effective brushing becomes even more crucial<sup>24</sup>. The result reinforces that even in populations facing nutritional challenges, modifiable behavioral interventions targeting hygiene can yield significant oral health benefits. This supports the Common Risk Factor Approach, which advocates for integrated health promotion strategies<sup>25</sup>.

The disconnect between stunting and caries in this analysis, juxtaposed with the strong behavioral links, suggests a critical public health implication: in high-stunting communities, oral disease in school-aged children may be driven more by contemporary, modifiable risk behaviors than by the historical fact of stunting itself. This is an empowering finding, as it indicates that targeted school- and community-based programs focusing on dietary education and hygiene skill-building can be effective, even if broader economic and nutritional disparities are harder to address in the short term. Interventions should be context-sensitive, involving families and leveraging school platforms to reinforce consistent messaging on reducing cariogenic snacks and establishing routine brushing with available resources<sup>26</sup>.

A limitation of this study is its cross-sectional design, which precludes establishing causal direction. For instance, severe caries could potentially influence eating behavior by causing pain and food avoidance. Furthermore, the assessment of eating behavior and hygiene via questionnaire, though practical, is subject to reporting bias. Future longitudinal research in similar settings is needed to confirm these relationships and explore the pathways linking household environment, caregiver knowledge, and child behaviors.

## CONCLUSION

This study demonstrates that the occurrence of caries in the mandibular first permanent molar among 7–9 year old children in a high-stunting rural community is strongly influenced by eating behavior and personal hygiene, but not by nutritional status. Children with poor eating behavior and inadequate hygiene were significantly more likely to experience severe caries, indicating that behavioral and environmental factors play a more dominant role than growth status in early permanent tooth decay. These findings highlight the need for integrated interventions that promote healthier eating patterns such as reducing cariogenic snacks and improving meal regularity alongside strengthening oral and basic hygiene practices at both school and household levels. Implementing such strategies within stunting-prone communities may offer a cost-effective approach to reducing dental caries while simultaneously supporting broader child health outcomes.

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