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Nutritional Status and Dental Caries in the Perspective of Sustainable Health Promotion

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ABSTRACT

Nutritional status and dental caries are interconnected key indicators of child health and quality of life, reflecting biological determinants. Dental caries remains prevalent among elementary school children and is influenced by nutritional status, sugar intake, and oral hygiene behavior. Nutritional status may influence caries risk by affecting tooth development, salivary composition, and dietary patterns. This study aimed to analyze the relationship between nutritional status and dental caries among children at SDN 21 Dangin Puri, Denpasar. This research used an observational cross-sectional analytical study among 70 students aged 7–12 years. Nutritional status was assessed using BMI-for-age based on WHO standards. Dental caries status was determined using the DMFT/dmft index based on WHO criteria. Results showed 51.4% of students had poor nutritional status, and 28.6% had high caries. Tests showed a significant relationship between nutritional status and caries, p-value <0.05. A significant association exists between nutritional status and dental caries among students. The School Dental Health Program should be optimized through preventive efforts integrating nutrition and policy interventions. A low-sugar diet is effective for preventing dental caries and improving children's dental health.

Keywords: nutritional status, dental caries, elementary school children, sustainable health promotion

INTRODUCTION

Nutritional status and dental caries represent two interconnected components of child health that should be addressed through a sustainable health promotion approach. Dental health is not merely the absence of disease, but an integral part of general health, quality of life, and long-term well-being. Dental caries remains one of the most prevalent

chronic diseases in children worldwide, affecting approximately 514 million children globally and contributing substantially to pain, difficulty in chewing, reduced appetite, sleep disturbances, impaired school performance, and diminished psychosocial well-being (Putriyani et al., 2024). At the same time, nutritional imbalance, both undernutrition and overnutrition, continues to be a major public health issue, particularly in developing countries where socioeconomic disparities, limited access to health services, and inadequate health literacy remain significant barriers.

Dental caries in elementary school children remains a significant public health issue because it directly impacts their quality of life, learning process, and nutritional status. Children with dental caries often experience pain, difficulty chewing, decreased appetite, and limited access to nutritious food. This can affect their growth and nutritional status in the long term. Conversely, a high-sugar, low-fiber diet, and poor oral hygiene habits also contribute to caries and imbalanced nutritional status. This two-way relationship makes caries and nutritional status interconnected and important to study in elementary school children (Muharlina et al., 2025).

Dental caries is a multifactorial disease characterized by the demineralization of dental hard tissues due to acid production from bacterial fermentation of dietary sugars. Despite being largely preventable, caries remains highly prevalent among children worldwide and contributes to pain, chewing difficulties, and reduced quality of life. Nutritional status plays a critical role in both the development of caries and general health. Poor nutrition may impair immune response, alter salivary flow, and influence dietary quality, thereby affecting caries risk. Several studies have found significant relationships between children's nutritional status and caries occurrence, though findings can be inconsistent across different populations (Herman, 2024).

Nationally, dental and oral health problems among Indonesian children remain quite high. Dental caries is one of the most common non-communicable diseases found in the school-age group. This condition not only affects oral health but also impacts children's overall health. Children with severe caries tend to experience masticatory disorders, resulting in suboptimal food intake. In the long term, this condition can lead to nutritional disorders, both undernutrition and overnutrition due to an unbalanced cariogenic diet (Agita et al., 2025).

Various studies have shown a significant relationship between nutritional status and the incidence of dental caries in elementary school children. A study at SDN 1 Dolo, Sigi Regency, found that the majority of students had good nutritional status (63.5%), and dental caries was found in 78.8% of students. Chi-square test results showed a significant relationship between nutritional status based on BMI/Age and dental caries ($p=0.032$). Another study at SD Negeri Inpres Pancur Batu also showed a significant relationship between dental caries and nutritional status. A systematic review by Pardosi et al. concluded that the majority of articles showed a significant relationship between nutritional status and the occurrence of dental caries in elementary school children; the lower the dental caries index, the better the child's nutritional status (Bangkele et al., 24).

However, several studies have reported conflicting results, finding no significant relationship between nutritional status and dental caries. These differences in results may be influenced by the nutritional content of the food, variations in research methods, sample size, population characteristics, tooth-brushing habits, cariogenic food consumption, and family socioeconomic factors (Ghasemianpour et al., 2019; Kizilcci et al., 22; Reflioni et al., 2024). Therefore, local analysis at each school remains important to describe the specific conditions of the local area, including those of students at SDN 21 Dangin Puri, Denpasar.

Denpasar City, as an urban area with high access to school snacks, presents unique challenges to the dental health and nutritional status of schoolchildren. Consumption of sweet foods, sweetened drinks, and poor tooth-brushing habits after meals and before bed can increase the risk of caries. At the same time, changes in modern dietary patterns also contribute to nutritional status issues, both undernutrition and overnutrition (Ghasemianpour et al., 2019; Harini et al., 2025; Kizilci et al., 2022). Therefore, evaluating the relationship between nutritional status and caries in students at SDN 21 Dangin Puri, Denpasar is important as a basis for developing school-based promotive and preventive interventions. This research is expected to provide a scientific overview of the relationship between nutritional status and dental caries in students at SDN 21 Dangin Puri, Denpasar. This can serve as a basis for schools, parents, and health workers in designing more effective dental health and nutrition education programs. Understanding this relationship in the local context of Denpasar is essential for developing targeted preventive strategies within school health programs.

RESEARCH METHOD

This is an observational analytical study using a cross-sectional approach. The aim was to determine the relationship between nutritional status and dental caries in students at SDN 21 Dangin Puri, Denpasar. The cross-sectional design was chosen because it allows researchers to assess nutritional status and caries levels simultaneously, making it efficient for describing the relationship between variables in an elementary school population. This approach is also widely used in epidemiological research on children's dental health because it can provide a rapid and systematic overview of prevalence and associations with risk factors. This study used a Chi-square test to determine the relationship between the two variables.

The study population was all students at SDN 21 Dangin Puri, Denpasar, who met the inclusion criteria. The sample size was 70 students, considered representative for describing the relationship between nutritional status and caries in this school population. A similar study of elementary school children also used a comparable sample size to achieve adequate power in bivariate analysis to test the relationship between nutritional status and caries (Pardosi et al., 2022). The independent variable in this study was students' nutritional status, while the dependent variable was the severity of dental caries. Nutritional status assessment was conducted using the Body Mass Index (BMI) based on the classification of the Ministry of Health of the Republic of Indonesia, by measuring

the weight and height of students. Nutritional status was classified into categories of undernutrition, normal nutrition, and overnutrition according to anthropometric standards for school children. BMI is an indicator widely used in research on children's nutritional status because it is simple, valid, and has good sensitivity in assessing growth balance at school age (Kemenkes, 2022).

The severity of caries was assessed using the DMF-T (Decay, Missing, Filling Teeth) index, which is the World Health Organization (WHO) standard for evaluating permanent tooth caries (WHO, 2026a). This index measures the number of permanent teeth with active caries (Decay), teeth missing due to caries (Missing), and teeth that have been filled (Filling). According to the WHO, the DMF-T classification is divided into very low (0.0-1.1), low (1.2-2.6), moderate (2.7-4.4), high (4.5-6.5), and very high (>6.6). Use The DMF-T index provides high validity in assessing the dental health status of schoolchildren and allows for global comparisons between studies (WHO, 2026b). The research instruments used included anthropometric tools in the form of a scale and a microtoise for height measurement, as well as a dental clinical examination form for recording the DMF-T index. The examinations were conducted directly on students using intraoral examination procedures using basic dental diagnostic tools in accordance with field examination standards. The examinations were conducted while adhering to the principles of hygiene, safety, and research ethics.

The study was conducted at SDN 21 Dangin Puri, Denpasar, Bali, based on preliminary survey results indicating a high incidence of dental caries and variations in student nutritional status, ranging from underweight to overweight. The study was conducted after obtaining permission from the school and obtaining research ethics approval. Data analysis was performed using univariate and bivariate methods. Univariate analysis was used to describe the frequency distribution of students' nutritional status and caries levels. Bivariate analysis was then conducted using the Chi-square test to determine the relationship between nutritional status and dental caries. This test was chosen because both variables are categorical and aims to assess the proportional relationship between groups. Results were declared statistically significant if the p-value < 0.05. This research approach is expected to provide a comprehensive scientific picture of the relationship between nutritional status and dental health in elementary school children, so that it can be the basis for school-based, family-based, and primary health care-based promotive and preventive interventions.

RESULTS AND DISCUSSION

This study shows that 58.5% of elementary school students have malnutrition and are very thin (Table 1), and 50.4% have caries in the high and very high DMF-T categories (Table 2). Based on direct interviews with students at SDN 21 Dangin Puri Denpasar, this is due to students' lack of knowledge about dental and oral health, such as how to brush their teeth correctly and appropriately, as well as inappropriate food intake and eating patterns, so that most students are in the high caries and poor nutritional status categories (Nuraini et al., 2026). These results are in line with research conducted by Ramdhania et

al. (2022), where the high caries category in elementary school children with a low BMI category. Poor nutritional status can increase caries because it is caused by saliva composition and salivary secretion disorders. Salivary gland hypofunction has been reported to be caused by lack of nutrition. According to research by Chan et al. (2023) Diet, nutrition, and dental health are interconnected. Proper nutrition and healthy eating habits promote oral health, and healthy, functioning teeth support nutrient intake.

Table 1. Distribution of Respondents Based on Nutritional Status

Nutritional Status	Frequency (n)	Percentag (%)
Malnutrition	36	51,4
Normal Nutrition	15	21,4
Overweight	7	10,0
Obesity I	7	10,0
Obesity II	5	7,1
Total	70	100

Source: Data processed, 2026

The distribution of nutritional status shows that more than half of students are classified as malnutrition (51.4%)(Table 1). This finding indicates that nutritional problems among elementary school children remain quite high and have the potential to impact systemic and oral health (WHO, 2025b). Poor nutritional status can lead to impaired tooth enamel formation, decreased saliva quality, and decreased local resistance to cariogenic bacterial colonization. These conditions contribute to the occurrence of more severe dental caries in elementary school children (Kizilci et al., 2022; Ramdhania et al., 2022). There are students with a very high risk of dental caries and underweight nutritional status. It is hoped that the School Dental Health Program (UKGS) will be optimized through promotional and preventive efforts (Ramdhania et al, 2022).

Nutritional status is an expression of the body's state of nutritional balance. Tooth composition varies from person to person. This is due to various factors, including age, gender, occupation, and daily nutritional intake. Nutrient intake from food consumed must meet the body's needs. Food consumption significantly influences a person's nutritional status. Good nutritional status occurs when the body receives sufficient nutritional intake to support physical growth (including dental health), brain and intelligence development, work productivity, and optimal resistance to infection (Agung et al. 2023).

Table 2. Distribution of Respondents Based on DMF-T

DMF-T Category	Frequency (n)	Percentage (%)
Very Low	10	14,3
Low	13	18,6
Medium	18	25,7
High	20	28,6
Very High	9	12,8
Total	70	100

Source: Data processed, 2026

The results of the DMF-T distribution show that the highest caries category was found in the high DMF-T group, with 20 students (28.6%) (Table 2). This condition indicates that nearly one-third of students have experienced quite severe caries. This high caries rate can be caused by high consumption of cariogenic foods, poor tooth-brushing habits, lack of dental health education, and suboptimal nutritional status. Severe caries can cause pain when eating, masticatory disorders, and decreased appetite, which ultimately worsens a child's nutritional status.

The distribution of respondents in this study showed that the majority of respondents fell into the moderate to high DMF-T category, indicating that dental caries remains a significant health problem. This finding aligns with global reports stating that dental caries is one of the most common chronic diseases in children and adolescents, and is even the most prevalent health condition globally. The Global Burden of Disease 2025 study reported that the burden of dental caries continues to increase, particularly in school-age groups, with the main risk factors being excessive sugar consumption, poor oral hygiene, low fluoride exposure, and limited access to dental health services (Ganochir et al., 2026).

Biologically, high DMF-T scores are closely related to the frequency of cariogenic food consumption, particularly sweet, sticky, and high-sucrose foods frequently consumed by school-age children. These fermentable carbohydrates serve as the primary substrate for cariogenic bacteria such as Streptococcus mutans, which produce acids that cause tooth enamel demineralization. Research by Yenti et al. (2023) showed a significant association between the frequency of cariogenic food consumption and the DMF-T index in 12-year-old children, with a p-value of 0.016, confirming that dietary patterns significantly contribute to caries experience.

Table 3. Chi-Square Test of the Relationship between Nutritional Status and Dental Caries

Variable	p-value	Description
Nutritional Status vs Dental Caries (DMF-T)	0,012	Significant

Source: Data processed, 2026

Based on the results of the research that has been carried out, it was found that there is a relationship between nutritional status and the severity of caries in students at SDN 21 Dangin Puri, Denpasar. The results of statistical analysis showed a significant relationship between nutritional status and caries in elementary school students (Table 3). Several studies have shown that children with poor nutritional status tend to have higher rates of caries. Malnutrition is known to affect the structure of hard dental tissue, salivary function, and the local immune system in the oral cavity. Deficiencies in protein and micronutrients such as calcium, phosphorus, vitamin A, vitamin D, and fluoride can disrupt the amelogenesis and mineralization processes of tooth enamel, making the enamel more brittle, easily demineralized, and more susceptible to colonization by cariogenic bacteria such as Streptococcus mutans. Furthermore, children with chronic malnutrition often experience decreased salivary gland function and reduced salivary flow, which leads to a decrease in the buffering, self-cleansing, and natural antimicrobial protection of the oral cavity against caries (WHO, 2025a; WHO, 2026c). The relationship between nutritional status and dental caries is bidirectional and biologically plausible. Children with poor nutritional status, especially undernutrition, often experience deficiencies in essential nutrients such as protein, calcium, phosphorus, vitamin A, vitamin D, and fluoride, all of which are crucial for enamel formation, salivary gland function, and immune defense in the oral cavity. Inadequate mineralization of enamel increases susceptibility to demineralization and bacterial colonization, particularly by cariogenic microorganisms such as Streptococcus mutans. Reduced salivary flow and buffering capacity further compromise the protective mechanisms of the oral environment, accelerating the caries process (Dipalma et al., 2026). The mechanisms linking nutrition and caries may involve dietary sugar exposure, enamel mineralization affected by nutrient deficiencies, and compromised immune responses. Children with poor nutritional status may have increased exposure to high-carbohydrate diets or lower intake of protective nutrients such as calcium and fluoride. Moreover, socioeconomic and behavioral factors should be considered in interpreting these associations.

The WHO defines malnutrition as a deficiency or imbalance in the intake of essential nutrients that play a vital role in the formation of enzymes, hormones, and other biological substances necessary for the growth and development of the body, including teeth and oral tissues. Micronutrient deficiencies during the growth period can inhibit the development of hard dental tissue and increase susceptibility to oral diseases (WHO, 2025a). A review study by Kirthiga et al. (2019) explains that childhood malnutrition is associated with impaired enamel maturation, enamel hypoplasia, changes in saliva composition, and an increased risk of early caries in both primary and permanent teeth.

This condition makes the tooth surface more susceptible to penetration by acids produced by cariogenic bacterial fermentation, accelerating the caries process. Other studies also show that vitamin D and calcium deficiencies are associated with increased caries prevalence due to impaired enamel remineralization and local oral defenses (Agung et al., 2023). From a nutritional status perspective, high DMF-T levels may also be associated with malnutrition. Children with poor nutritional status tend to experience impaired enamel mineralization, decreased salivary function, and low oral mucosal resistance, making them more susceptible to caries. Conversely, severe caries can cause pain when chewing, decreased appetite, and impaired nutritional intake, ultimately worsening a child's nutritional status. Recent research has shown a significant association between nutritional status and DMFT scores, with children with adequate nutrition having better oral health than those with chronic malnutrition (Jethi et al., 2024).

Thus, the relationship between nutritional status and caries is both biological and functional. Poor nutritional status increases the risk of caries, while severe caries can cause pain when eating, reduce appetite, and ultimately worsen a child's nutritional status. This bidirectional relationship makes nutritional status evaluation crucial in efforts to prevent dental caries in elementary school children. Conversely, untreated dental caries can worsen nutritional status through pain, difficulty chewing, and food avoidance, particularly of fibrous, protein-rich, and nutrient-dense foods. Children with severe caries often shift to softer, carbohydrate-rich diets, which are often more cariogenic but nutrient-poor. This creates a vicious cycle in which malnutrition triggers caries, while caries further exacerbates malnutrition. Recent studies have shown that children with high DMFT/deft scores are more likely to be underweight and have stunted growth (Putriyani et al., 2024).

A 2026 systematic review in BMC Oral Health further emphasized that a balanced, low-sugar diet is one of the most effective strategies for preventing dental caries and improving the sustainability of dental health throughout elementary school (Dipalma et al., 2026). However, the association is not always linear, as socioeconomic status, parental education, oral hygiene practices, sugar consumption patterns, and healthcare access significantly influence both nutritional status and oral health outcomes. In Indonesia, studies on preschool children have demonstrated that severe early childhood caries is highly prevalent, while stunting and undernutrition are also influenced by broader determinants such as household income and parental education. This indicates that sustainable interventions must move beyond individual behavior and address structural determinants of health (Badruddin et al., 2021).

From the perspective of sustainable health promotion, addressing nutritional status and dental caries requires an integrated, life-course approach that combines preventive, promotive, and community-based strategies. Schools, families, primary healthcare facilities, and local governments should collaborate to promote healthy eating behaviors, reduce excessive sugar consumption, strengthen oral hygiene education, ensure fluoride exposure, and provide regular dental screenings. Health promotion should not be episodic, but continuous and culturally adaptive, emphasizing empowerment rather than

merely treatment. Community participation and intersectoral collaboration are essential to ensure that oral health promotion becomes part of broader sustainable development goals, particularly those related to child health, education, and inequality reduction. Sustainable health promotion also aligns with the principle that prevention is more cost-effective than restorative care. Early interventions targeting nutritional adequacy and oral hygiene can reduce long-term healthcare expenditures, improve school attendance, and enhance children's developmental potential. Thus, the synergy between nutritional status and oral health should be viewed not only as a clinical concern but also as a strategic public health investment for future generations.

CONCLUSION

This study shows a statistically significant association between nutritional status and dental caries in elementary school children at SDN 21 Dangin Puri, Denpasar. Schools should integrate nutrition counseling with dental health education and preventive services. Nutritional status and dental caries are closely interconnected conditions that reflect broader social and biological determinants of children's dental health. A sustainable health promotion framework suggests that the School Dental Health Program (UKGS) should be optimized through promotional and preventive efforts that integrate nutrition and policy-level interventions. Low-sugar diet is one of the most effective strategies for preventing dental caries and improving the sustainability of dental health throughout children.

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Declaration Statement

The authors declare that no external funding was received for this research. The data supporting the findings of this study were obtained from anthropometric measurements and dental caries examinations using the DMF-T index among 70 students of SDN 21 Dangin Puri, Denpasar, as well as from relevant published literature cited in the manuscript. Due to ethical and confidentiality considerations involving child participants, the raw individual-level data are not publicly available; however, anonymized or aggregated data may be made available by the corresponding author upon reasonable request. This study involved human participants and was conducted after obtaining permission from the school and research ethics approval from the relevant institutional authority prior to data collection. The authors declare that they have no

financial or non-financial competing interests that could have influenced the conduct, analysis, interpretation, or reporting of this research.

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