

Analysis of Risk Factors for Dental Caries Using the Karyogram Method in Dental Students of Prima Indonesia University in 2026

Suci Erawati*, Idamawati Nababan, Boaz Sihotang, Tesalonika Natasya Siregar

Universitas Prima Indonesia, Indonesia

Email: esuci64@gmail.com*, idamawatinababan@gmail.com, boazsihotang44@gmail.com, siregarnatasya5@gmail.com

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Abstract

Dental caries remains a significant oral health concern among young adults, including dental students, despite their exposure to preventive oral health knowledge. This study aimed to examine factors associated with caries experience and describe caries risk using a modified Cariogram approach among dental students at Universitas Prima Indonesia in 2026. An analytical observational study with a cross-sectional design was conducted from April to June 2026, involving 50 students. Data were collected through clinical examinations using the decayed, missing, and filled teeth (DMFT) index, salivary pH measurements using test strips, and dietary questionnaires. Statistical analyses were performed using SPSS version 25, with statistical significance set at $p < 0.05$. Most participants were classified as having a high risk of dental caries. Toothbrushing frequency was significantly associated with DMFT scores ($p = 0.007$), and salivary pH also demonstrated a significant association with caries experience. The plaque index was reported to be associated with caries experience, whereas sugar consumption patterns and fluoride use showed no significant associations. These findings emphasize the importance of oral hygiene behaviors and salivary conditions within a multifactorial caries risk assessment framework. The study concludes that individualized caries risk assessment may inform preventive education among dental students, although longitudinal research is needed to establish temporal relationships and validate the predictive performance of the modified Cariogram approach.



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INTRODUCTION

Dental and oral diseases are common health conditions that are widely encountered across various populations. One of the most prevalent is dental caries, which can cause not only pain but also considerable discomfort, thereby reducing an individual's productivity and quality of life (Andriyani et al., 2023). Dental caries is a condition characterized by the demineralization and destruction of hard dental tissues, particularly enamel and dentin, resulting from acids produced by bacteria within dental biofilm. The caries process may begin when fermentable carbohydrates, particularly sugars, remain on the tooth surface and are metabolized by bacteria within dental plaque, producing organic acids such as lactic acid and acetate (Almalki et al., 2024; Antonelli et al., 2024; Hikma et al., 2021). Repeated acid exposure can cause enamel demineralization, initially presenting as white spot lesions. If the process continues, the lesions may progress to cavitation and eventually appear as dark-colored defects on the tooth surface (Su et al., 2021; Yuniarti, 2024).

Dental caries is one of the most common oral health problems worldwide and remains a substantial global public health burden. The World Health Organization (WHO) reported in 2022 that more than 3.5 billion people worldwide are affected by oral diseases, with untreated dental caries being among the most prevalent conditions (World Health Organization. (2022). Global oral health status report.). Caries is also a common health problem affecting nearly all population groups in Indonesia. The 2023 Indonesian Health Survey (SKI) indicates that the prevalence of dental caries remains high at 82.8%, making it one of the most prevalent oral health problems across various age groups (T. C. Ng et al., 2024; T. C.-H. Ng et al., 2024) . Dental caries also remains a considerable oral health problem in North Sumatra Province. Based on data from the 2018 Basic Health Research (RISKESDAS), the proportion of the population in North Sumatra experiencing dental and oral health problems is relatively high. More than 40% of the population was reported to experience dental and oral health problems, with many of these cases related to dental caries. This situation indicates that dental caries remains a significant health concern in North Sumatra and requires prevention efforts through promotive and preventive approaches, particularly among young adults (Ministry of Health, 2011).

As the capital of North Sumatra Province, Medan also reflects the substantial burden of dental caries at the urban level. Data reported in oral health reports based on RISKESDAS and publications from health education institutions in Medan indicate that dental caries remains frequently encountered in the community. Several academic reports have indicated that the proportion of individuals experiencing dental caries in Medan is relatively high, particularly among school-aged and productive-age populations. The high prevalence of caries in urban areas such as Medan is thought to be associated with cariogenic food consumption patterns, inadequate oral hygiene practices, and infrequent routine dental visits. This condition emphasizes the importance of investigating dental caries risk factors among young adults as a basis for developing more effective preventive strategies (Pitts et al., 2021; Pulungan, 2026; Putri & Fadilah, 2025) .

Dental caries not only affects clinical aspects, such as dental tissue damage and pain, but also influences individuals' daily functioning and well-being. Research involving university students has demonstrated a significant relationship between the severity of dental caries and oral health-related quality of life. Students with more severe caries experience are more likely to report impaired oral function and discomfort during activities such as eating and speaking, which may be reflected in poorer scores on the 14-item Oral Health Impact Profile (OHIP-14). These findings indicate that dental caries can influence individuals' subjective perceptions of their quality of life through both functional and psychosocial dimensions (Slade, 1997).

In addition to studies involving university students, the relationship between dental caries and quality of life has also been identified in research conducted among students at other universities. Findings have demonstrated that individuals with greater caries experience are more likely to perceive negative effects on their quality of life, including disruptions to daily activities and reduced perceptions of personal well-being. These findings illustrate that dental caries imposes not only a clinical burden but also adverse effects on subjective well-being, making it an important public health issue that requires comprehensive management. The impact of dental caries on productivity and quality of life. Indonesian Journal of Dental Health.)

Effective prevention of dental caries requires the early identification of risk factors that contribute to disease development. The Cariogram model is a comprehensive caries risk assessment tool designed to simultaneously evaluate multiple determinants of dental caries, including diet, plaque levels, cariogenic bacteria, fluoride exposure, and salivary characteristics. The model subsequently visualizes these factors in a pie chart representing the estimated chance of avoiding new caries. This approach enables dentists and public health researchers to classify individuals according to their caries risk profiles and provide more targeted preventive interventions, such as dietary counseling, improved oral hygiene practices, and appropriate fluoride exposure for high-risk individuals, before carious lesions progress to substantial dental tissue destruction. Evidence from the clinical literature also suggests that the Cariogram can support individualized preventive planning by integrating clinical, behavioral, and microbiological factors associated with future caries development (Zandoná et al., 2025).

In addition to its role in evaluating individual caries risk profiles, the Cariogram has been applied in various clinical settings and population-based studies to facilitate the early identification of caries risk and the development of appropriate preventive programs. By integrating multiple risk parameters into a single model, the Cariogram not only estimates an individual's likelihood of developing dental caries but also provides insight into the factors that contribute most substantially to the overall risk profile. This reinforces the importance of personalized risk-based prevention, whereby interventions are not applied generically but are tailored to each individual's specific risk factors. Therefore, caries risk assessment using the Cariogram may provide a useful basis for planning more effective and efficient preventive measures to reduce the burden of dental caries at both the individual and population levels.

Efforts to prevent dental caries require a risk assessment approach capable of identifying factors that contribute to disease development from an early stage. One approach that can be used is the Cariogram, a caries risk assessment model that integrates various factors related to oral health, including dietary habits, oral hygiene, salivary conditions, fluoride exposure, and previous caries experience. Through this approach, each student is expected to obtain an overview of their individual caries risk profile, thereby facilitating early identification and the development of preventive strategies tailored to their specific risk factors (Ratthall, D., Hänsel Petersson, G. (2005). Cariogram – a multifactorial risk assessment model for dental caries. Community Dentistry and Oral Epidemiology. (Cariogram Model)). Based on the aforementioned considerations, the present study aims to investigate dental caries risk factors and describe caries risk profiles among FKKGK students using the Cariogram method.

METHOD

This study employed an analytical observational approach with a cross-sectional design to analyze factors associated with dental caries risk using a modified Cariogram approach among students of the Faculty of Dentistry, Universitas Prima Indonesia (UNPRI). The study was conducted at the Faculty of Dentistry, UNPRI, from April to June 2026. The study population consisted of 120 dentistry students from the 2024–2025 cohort. The sample size was determined using the Slovin formula with a 5% margin of error, resulting in a minimum sample of 50 participants. Participants were selected according to the predetermined eligibility criteria.

The inclusion criteria were active dentistry students from the 2024–2025 cohort at UNPRI who provided written informed consent, had permanent teeth available for assessment of caries experience using the Decayed, Missing, and Filled Teeth (DMFT) index, provided saliva samples for pH measurement, and completed the questionnaire required for caries risk assessment. The dependent variable was the level of dental caries risk assessed using the modified Cariogram approach, whereas the independent variables included caries experience measured using the DMFT index, salivary pH, and cariogenic dietary patterns. Clinical examinations and data collection were performed using standardized dental examination instruments, DMFT assessment forms, salivary pH test strips, saliva collection containers, and structured dietary questionnaires.

Caries experience was assessed clinically using the DMFT index, and the findings were recorded on standardized examination forms. Salivary pH was measured from collected saliva samples using pH test strips according to the manufacturer's instructions. Dietary patterns were assessed using a structured questionnaire covering the frequency, type, and timing of cariogenic food and beverage consumption. The collected clinical, salivary, and dietary data were subsequently analyzed using SPSS version 25.0. Statistical significance was established at $p < 0.05$.

RESULTS AND DISCUSSION

Dental caries is a multifactorial disease that is influenced by the balance between risk factors and protective factors in the oral cavity. The Cariogram approach is used to assess the risk of caries by combining several aspects, such as caries experience, cariogenic food consumption habits, saliva conditions, oral hygiene, and fluoride use. Based on the results of the study, the majority of students of the Faculty of Dentistry, Universitas Prima Indonesia are included in the category of high caries risk. This condition shows that the knowledge possessed by respondents related to dental and oral health has not been fully applied in daily behavior, so there are still factors that have the potential to increase the risk of caries (T. C. Ng et al., 2023).

Based on the results of the Chi-Square test, the frequency of brushing teeth had a significant relationship with the DMFT value ($p=0.007$). These results show that regular toothbrushing habits play an important role in reducing the experience of caries in respondents. Brushing teeth at least twice a day is one of the main preventive measures to remove plaque and food residues attached to the surface of the teeth. If plaque is not cleaned optimally, cariogenic bacteria such as *Streptococcus mutans* will ferment carbohydrates into acids resulting in a decrease in plaque pH and triggering the enamel demineralization process which ultimately increases the risk of caries lesions.

The results of this study are in line with the research of Ng et al. (2024) who stated that the habit of maintaining oral hygiene is one of the main components in caries risk assessment because it is able to reduce the accumulation of biofilm thereby reducing the activity of cariogenic bacteria. Research by (Pagnussatti et al., 2024) also reported that biofilm accumulation is closely related to the development of caries because biofilm is a place for colonization of acid-producing bacteria that cause demineralization of hard tissue of teeth.

Clinically, these findings show that education to students is not enough to only emphasize the frequency of brushing teeth, but also needs to pay attention to correct brushing

techniques, optimal brushing time, and periodic evaluation of oral hygiene to obtain the maximum caries prevention effect.

Consumption of sugary foods and beverages is one of the risk factors for caries because the process of sugar fermentation by plaque bacteria produces acids that can lower the pH of the oral cavity and cause enamel demineralization. Although in this study, sugar consumption patterns did not show a significant relationship with DMFT values, frequent sugar consumption can still increase the risk of caries if not balanced with good oral hygiene habits (Akinsolu et al., 2024).

Factors oral hygiene being one of the important components in caries risk as it relates to plaque accumulation and karyogenic bacterial activity. The results showed that the frequency of brushing teeth and plaque index were related to DMFT, whereas fluoride use did not show a significant relationship, although it still played a role in helping enamel remineralization (Pagnussatti et al., 2023).

Biological factors such as salivary pH play an important role in maintaining a balance between the demineralization and remineralization processes of teeth. In this study, saliva pH showed a significant relationship with DMFT values, which showed that saliva conditions contributed to the respondents' caries experience. The results of the Kariogram analysis also showed that most of the respondents were in the high caries risk category, which illustrates the interaction of various risk factors such as caries experience (DMFT), salivary conditions, karyogenic food consumption patterns, oral cavity hygiene, and other protective factors. These findings are in line with the research (Alamoudi et al., 2022) which states that saliva characteristics have an important role in the development and assessment of caries risk, as well as research T. C.-H. Ng et al., (2023) which explains that a comprehensive caries risk assessment needs to consider various risk factors and protective factors through a multifactorial approach. In addition, research Pagnussatti et al., (2023) It shows that the condition of the biofilm and the balance of oral cavity microorganisms are related to the development of caries. Therefore, caries risk assessment cannot be based on a single factor alone, but must consider the interaction between biological, behavioral, and protective factors as conceptualized in the Kariogram method.

In this study, the relationship analysis was carried out using the DMFT value as an indicator of caries experience, while the Kariogram method was used to provide a comprehensive picture of caries risk. The use of the two approaches complements each other because DMFT describes the experience of caries that has occurred, while the Kariogram estimates the chances of future caries based on a combination of biological, behavioral, and protective factors. Thus, the results of this study not only identify factors related to the experience of caries, but also provide a more comprehensive picture of the respondents' caries risk level.

CONCLUSION

This study found that most participating dental students at Universitas Prima Indonesia were classified as having a high risk of dental caries based on the modified Cariogram approach. Toothbrushing frequency and salivary pH were significantly associated with caries experience, as measured using the DMFT index, while the plaque index was also associated

with DMFT scores. In contrast, sugar consumption patterns and fluoride use showed no statistically significant associations with DMFT scores in this sample. These findings highlight the importance of behavioral and biological factors in caries risk assessment and support the integration of individualized risk profiles into preventive oral health education for dental students. However, the cross-sectional design precluded causal inference; therefore, the findings should be interpreted within the context and characteristics of the study sample.

Future research should involve larger and more representative samples from multiple institutions and employ longitudinal designs to determine whether baseline caries risk profiles predict the development of new carious lesions. Standardized assessments of dietary habits, plaque accumulation, fluoride exposure, salivary flow rate, and buffering capacity would strengthen the evaluation of interacting risk and protective factors. Further studies should also validate the modified Cariogram approach against the complete Cariogram model and evaluate its predictive performance based on subsequent caries outcomes. Multivariable analyses could be employed to control for potential confounding factors, while intervention studies could determine whether individualized oral hygiene education, dietary counseling, and preventive dental care improve oral health behaviors and reduce caries incidence among dental students

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CONFLICT OF INTEREST

The authors' contributions in this study are divided equally, where all authors contribute equally in terms of preparing ideas, analyzing data, and writing scripts.

AUTHOR CONTRIBUTION

The authors' contributions in this study are divided equally, where all authors contribute equally in terms of preparing ideas, analyzing data, and writing scripts.

GENERATIVE ARTIFICIAL INTELLIGENCE USAGE STATEMENT

The author states that this study uses artificial intelligence (AI), whose use is limited only for the purpose of grammar improvement and language checking.

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