

Dental Erosion and Its Association with Intrinsic and Extrinsic Factors in Marine Science Students

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ABSTRACT

Background: Dental erosion is a pathological form of tooth wear resulting from the chemical dissolution of dental hard tissues by acids, independent of bacterial activity. Its prevalence varies across populations, with university students exhibiting relatively high rates, potentially due to specific risk factors.

Purpose: This study aimed to analyze the association between intrinsic factors (Gastroesophageal Reflux Disease/GERD) and extrinsic factors (dietary habits, oral care practices, and swimming habits) with the occurrence of dental erosion among Marine Science students at Universitas Sriwijaya.

Methods: A descriptive-analytical study with a cross-sectional design was conducted involving 60 participants recruited through purposive sampling. Data were collected through oral clinical examinations and self-administered questionnaires assessing GERD, dietary habits, oral care practices, and swimming habits. Statistical analyses were performed using the Chi-square test and Fisher's exact test.

Results: The prevalence of dental erosion among participants was 80%. A significant association was observed between GERD and dental erosion ($p < 0.05$), whereas extrinsic factors demonstrated no statistically significant relationship ($p > 0.05$).

Conclusion: GERD, as an intrinsic factor, is significantly associated with the occurrence of dental erosion among Marine Science students.

Keywords: Dental erosion, intrinsic factors, extrinsic factors, Marine Science students

INTRODUCTION

Dental erosion is the progressive loss of tooth hard tissue due to acid exposure without bacterial involvement.¹ This condition is characterized by smooth and glossy tooth erosion, caused by intrinsic factors, such as gastric acid reflux into the oral cavity in cases of Gastroesophageal Reflux Disease and eating disorders, as well as extrinsic factors (consumption of acidic foods and beverages with a $pH < 5.5$, acidic medications, and exposure to improperly maintained swimming pool water.^{1,2}

Dental erosion is notably prevalent among university students. In Jakarta, 97% of students were reported to have dental erosion, with 51% involving dentin. University students

are particularly vulnerable due to the high academic demands during their adaptation phase, which can induce stress and gastrointestinal disturbances.³ More than half of students living away from home report stress from excessive academic workload, a condition linked to unhealthy dietary patterns and an increased risk GERD.^{4,5}

The main etiological factor for dental erosion in dietary patterns is characterized by frequent consumption of acidic foods and beverages. The erosive potential of these substances is largely attributed to their chemical properties and composition, which can reduce salivary pH to below the critical threshold of 5.5. The intake of commercially packaged fruit juices has been reported to induce erosion of primary anterior teeth, primarily due to their high citric acid content.⁶ Preventive oral health measures, such as regular toothbrushing twice daily, may mitigate the risk of dental erosion. Nevertheless, the use of certain mouth rinses, particularly those with low pH values, may further contribute to the progression of erosive lesions. Acidic mouthwashes can erode tooth enamel, especially in areas with receding gums or exposed dentin.⁷

The subjects of this study were undergraduate students of Marine Science at Sriwijaya University. In accordance with the academic curriculum, the subjects participated in routine weekly diving practice.⁸ Swimming activities pose an additional risk factor for dental erosion. Previous studies have reported that swimmers are twice as likely to have tooth erosion compared to non-swimmers.^{9,10} This phenomenon is associated with exposure to swimming pool water that has an acidic pH, resulting from suboptimal chlorination control. The recommended standard for swimming pool water pH ranges from 7,2 to 7,8, however, deviations toward lower (acidic) values may occur, leading to enamel demineralization.^{11,12} The swimming activities of the study participants were conducted at Bala Putra Dewa Swimming Pool in Palembang. Measurement of the pool water pH demonstrated values between 6.8 and 7.0, this indicates that the pH of the swimming pool water does not fulfill the recommended standards.

Considering the absence of similar studies within the context of Sriwijaya University and the presence of specific risk factors among Marine Science students, this study aims to characterize the prevalence of dental erosion in this population and to analyze the influence of intrinsic factors (gastroesophageal reflux disease), as well as extrinsic factors (dietary habits, oral hygiene practices, and swimming activities) on the occurrence of dental erosion.

METHODS

This study was conducted as a descriptive-analytic approach with a cross-sectional design. The study population comprised 104 first-year Marine Science students of Sriwijaya University. Research subjects were selected through purposive sampling using the Slovin formula with a 10% margin of error, resulting in a total of 60 participants. Inclusion criteria consisted of active students aged 18–20 years who agreed to participate, while exclusion criteria included students unable to attend, those with salivary pH <6.8, and those presenting with anterior dental caries.

The variables assessed included intrinsic factors (GERD) and extrinsic factors (dietary habits, oral care, swimming activity, and dental erosion). Data were collected through clinical examinations using a mouth mirror to identify dental erosion and salivary pH measurement with pH paper. Questionnaires consisted of the GERDQ to assess GERD symptoms (scores ≥ 8 indicating probable GERD), dietary habits (frequency of acidic food and beverage consumption), oral care practices (frequency of toothbrushing and mouthwash use), and swimming activity (frequency and duration).^{2,13,14}

Questionnaire validity and reliability were tested on 30 subjects (Cronbach's Alpha >0.60), and inter-observer calibration on 20 clinical photographs used Cohen's Kappa. Study procedures included instructions for participants to brush their teeth and refrain from eating for 1 hour prior, rinsing with 1% povidone-iodine, collection of unstimulated saliva (for pH measurement), oral clinical examination, oral documentation, and completion of an online questionnaire. Data were analyzed using SPSS v.27 with Chi-square and Fisher's exact test, and significance value was set at $p < 0.05$.

RESULTS

The study was conducted on 60 Marine Science students at Universitas Sriwijaya who met the inclusion and exclusion criteria. The validity and reliability tests of the questionnaire indicated that all items were valid (r -calculated $\geq r$ -table) and reliable (Cronbach's Alpha ≥ 0.60). The frequency distribution of participants by sex and age is presented in Table 1.

Table 1. Frequency Distribution of Participants by Sex and Age

| Variable | Frequency (N) | Percentage (%) |
|--------------------|---------------|----------------|
| Sex | | |
| - Male | 32 | 53.3 |
| - Female | 28 | 46.7 |
| Age (years) | | |
| - 18 | 24 | 40.0 |
| - 19 | 25 | 41.7 |

| Variable | Frequency (N) | Percentage (%) |
|--------------|---------------|----------------|
| - | 20 | 11 |
| Total | 60 | 100 |

The frequency distribution of participants by sex and age showed that the majority of participants were male and predominantly 19 years old. The frequency distribution of participants according to dental erosion, salivary pH, as well as the assessed intrinsic and extrinsic factors is presented in Table 2.

Table 2. Frequency Distribution of Participants Based on Dental Erosion, Salivary pH, and Intrinsic and Extrinsic Factors

| Variable | Frequency (N) | Percentage (%) |
|---|---------------|----------------|
| Dental Erosion | | |
| Erosion | 48 | 80.0 |
| No erosion | 12 | 20.0 |
| Salivary pH | | |
| 6.8 | 17 | 28.3 |
| 7.0 | 13 | 21.7 |
| 7.2 | 10 | 16.7 |
| 7.4 | 5 | 8.3 |
| 7.6 | 15 | 25.0 |
| Gastroesophageal Reflux Disease (GERD) | | |
| Yes | 15 | 25.0 |
| No | 45 | 75.0 |
| Dietary Habits | | |
| <i>Citrus fruit consumption</i> | | |
| 0 times/week | 19 | 31.7 |
| 1-3 times/week | 35 | 58.3 |
| 4-7 times/week | 6 | 10.0 |
| <i>Apple consumption</i> | | |
| 0 times/week | 30 | 50.0 |
| 1-3 times/week | 26 | 43.3 |
| 4-7 times/week | 4 | 6.7 |
| <i>Coffee consumption</i> | | |
| 0 times/week | 18 | 30.0 |
| 1-3 times/week | 29 | 48.3 |
| 4-7 times/week | 13 | 21.7 |
| <i>Citrus tea consumption</i> | | |
| 0 times/week | 37 | 61.7 |
| 1-3 times/week | 21 | 35.0 |
| 4-7 times/week | 2 | 3.3 |
| <i>Carbonated drink consumption</i> | | |
| 0 times/week | 28 | 46.7 |
| 1-3 times/week | 21 | 35.0 |
| 4-7 times/week | 11 | 18.3 |
| Oral Care Practices | | |
| <i>Toothbrushing frequency</i> | | |
| < 2 times/day | 15 | 25.0 |
| ≥ 2 times/day | 45 | 75.0 |

| Variable | Frequency (N) | Percentage (%) |
|---------------------------|---------------|----------------|
| <i>Mouthwash use</i> | | |
| Yes | 21 | 35.0 |
| No | 39 | 65.0 |
| Swimming Habits | | |
| <i>Swimming frequency</i> | | |
| 1-2 times/week | 54 | 90.0 |
| ≥ 3 times/week | 6 | 10.0 |
| <i>Swimming duration</i> | | |
| 4-6 hours | 53 | 88.3 |
| ≥ 7 hours | 7 | 11.7 |

Most participants experienced dental erosion (80%), while only 20% showed no signs of erosion. The distribution of unstimulated salivary pH indicated that all participants met the inclusion criteria. Based on the GERDQ score 25% of participants were identified as having GERD symptoms. Dietary habits showed that the majority of participants consumed citrus fruits 1-3 times per week, did not consume apples, consumed coffee 1-3 times per week, rarely consumed citrus tea, and did not consume carbonated beverages. Oral care practices indicated that most participants brushed their teeth at least twice daily and did not use mouthwash. Regarding swimming habits, 90% of participants reported swimming 1-2 times per week with a duration of 4-6 hours per session. The results of Fisher's exact test assessing the association between the intrinsic factor (GERD), and the occurrence of dental erosion are presented in Table 3.

Table 3. Association between Intrinsic Factor and Dental Erosion

| Intrinsic Factor | Dental Erosion | | <i>p</i> -value |
|--|----------------|----|-----------------|
| | Yes | No | |
| Gastroesophageal Reflux Disease (GERD) | | | |
| Yes | 15 | 0 | 0.027* |
| No | 33 | 12 | |

* *p* value was based on Fisher's exact test with $p < 0.05$ considered significant.

The significance value obtained was 0.027 ($p < 0.05$), indicating a statistically significant association between GERD and dental erosion. The results of the Chi-square test assessing the association between extrinsic factors and the occurrence of dental erosion are presented in Table 4.

Tabel 4. Association between Extrinsic Factors and Dental Erosion

| Extrinsic Factor | Dental Erosion | | <i>p</i> -value ^a |
|-------------------------------------|----------------|----|------------------------------|
| | Yes | No | |
| Dietary Habits | | | |
| <i>Citrus fruit consumption</i> | | | |
| - 0 times/week | 15 | 4 | 0,239 |
| - 1-3 times/week | 27 | 8 | |
| - 4-7 times/week | 6 | 0 | |
| <i>Apple consumption</i> | | | |
| - 0 times/week | 24 | 6 | 0,966 |
| - 1-3 times/week | 21 | 5 | |
| - 4-7 times/week | 3 | 1 | |
| <i>Coffee consumption</i> | | | |
| - 0 times/week | 14 | 4 | 0,392 |
| - 1-3 times/week | 22 | 7 | |
| - 4-7 times/week | 12 | 1 | |
| <i>Citrus tea consumption</i> | | | |
| - 0 times/week | 28 | 9 | 0,413 |
| - 1-3 times/week | 18 | 3 | |
| - 4-7 times/week | 2 | 0 | |
| <i>Carbonated drink consumption</i> | | | |
| - 0 times/week | 21 | 7 | 0,495 |
| - 1-3 times/week | 17 | 4 | |
| - 4-7 times/week | 10 | 1 | |
| Oral Care Practices | | | |
| <i>Toothbrushing frequency</i> | | | |
| - < 2 times/day | 11 | 4 | 0,472 |
| - ≥ 2 times/day | 37 | 8 | |
| <i>Mouthwash use</i> | | | |
| - Yes | 17 | 4 | 1,000 |
| - No | 31 | 8 | |
| Swimming Habits | | | |
| <i>Swimming frequency</i> | | | |
| - 1-2 times/week | 44 | 10 | 0,590 |
| - ≥ 3 times/week | 4 | 2 | |
| <i>Swimming duration</i> | | | |
| - 4-6 hours | 42 | 11 | 1,000 |
| - ≥ 7 hours | 6 | 1 | |

^a *p* value were based on chi-square test (dietary habits) and Fisher's exact test (oral care practices and swimming habits) with *p* < 0.05 considered significant.

All significance values were greater than 0.05 (*p* > 0,05), indicating that no statistically significant association was found between extrinsic factors, such as dietary habits, oral care, and swimming, with dental erosion.

DISCUSSION

The prevalence of dental erosion among Marine Science students was relatively high at 80%. This finding is consistent with the study by Septalita (2022), which reported that 97% of university students in Jakarta experienced dental erosion.³ University students represent a population at increased risk of dental erosion, as they are in a transitional life stage

characterized by multiple adaptation challenges, heavy academic workloads, and lifestyle changes that may trigger stress and gastrointestinal disturbances.³

The significant association observed between GERD and dental erosion is in line with the findings of Rajab et al. (2023) and Jordão et al. (2020), who reported that individuals with GERD have lower salivary pH and a 2-4-fold higher risk of dental erosion.^{15,16} Repeated exposure of the oral cavity to gastric acid reflux with a pH below the critical threshold (5.5) leads to degradation of the acquired dental pellicle and direct contact of hydrochloric acid with enamel surfaces, initiating hydroxyapatite demineralization. Maxillary teeth are often the first to be affected due to their direct exposure to gastric contents during reflux episodes.^{17,18}

The absence of a significant association between dietary habits and dental erosion is consistent with studies by Jha et al. (2024) and Septalita (2022). This suggests that dental erosion is influenced not only by the frequency of acidic food consumption but also by consumption patterns and duration of acid-tooth contact.^{3,19} O'Toole et al. (2017) demonstrated that the duration of acid exposure is more critical than the frequency of intake in contributing to erosion risk.²⁰ Furthermore, the buffering capacity of saliva plays an important role in neutralizing pH and preventing enamel demineralization through oral clearance.^{20,21}

Oral care practices were not significantly associated with dental erosion, which is consistent with the findings of Septalita (2022). Toothbrushing is more strongly linked to dental abrasion, particularly when improper techniques or abrasive toothpastes are used. Similarly, the use of mouthwash showed no significant relationship, although certain mouthrinses with low pH may contribute to demineralization if used inappropriately.^{7,22}

Swimming habits also did not show a significant association with dental erosion, which contrasts with the study by Almira (2019) on competitive swimmers.²³ This difference may be explained by the lower swimming intensity in the present study, where participants swam only 1-2 times per week for diving practice, compared to more than four times per week in competitive athletes. Although the swimming pool water at Bala Putra Dewa was mildly acidic (pH 6.8-7.0), the relatively low exposure frequency and short duration were insufficient to induce significant erosive effects.

This study had several limitations. First, GERD status was assessed solely through self-reported questionnaires without clinical confirmation, which may have reduced the accuracy of GERD diagnosis. Second, the relatively small sample size (n = 60) may not fully represent the broader student population. Future research with larger sample sizes, clinical

verification of GERD, and the inclusion of additional risk factors is recommended to provide a deeper understanding of dental erosion among university students.

CONCLUSION

This study revealed a high prevalence of dental erosion among Marine Science students at Universitas Sriwijaya, reaching 80%. The main finding indicated that the intrinsic factor, Gastroesophageal Reflux Disease (GERD), had a significant influence on the occurrence of dental erosion in the study population. In contrast, extrinsic factors, including dietary habits, oral care practices, and swimming habits, showed no significant association with dental erosion. These findings highlight that medical conditions such as GERD constitute an important risk factor that requires particular attention in the prevention and management of dental erosion among students.

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