International Journal of Advanced Health Science and Technology e-ISSN:2808-6422; p-ISSN:2829-3037
Homepage: ijahst.org Vol. 4 No. 3, pp. 380-387, June 2024

RESEARCH ARTICLE OPEN ACCESS
Manuscript received June 11, 2024; revised June 12, 2024; accepted June 13, 2024; date of publication June 30, 2024
Digital Object Identifier (DOI): https://doi.org/10.35882/ijahst.v4i3

How to cite: Krisyasinta Riyanandia Dewi Pramesti, Ida Chairanna Mahirawatie, Siti Fitria Ulfah, and Silvia Prasetyowati, "The Relationship Between Tooth Brushing Skills and Dental Caries Among Elementary School Students at SDN 3 Ngasinan Ponorogo in 2024", International Journal of Advanced Health Science and Technology, vol. 4, no. 3, pp. 384 - 387, June 2024

The Relationship Between Tooth Brushing Skills and Dental Caries Among Elementary School Students at SDN 3 Ngasinan Ponorogo in 2024

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ABSTRACT Dental caries remains a prevalent oral health problem among children, particularly those in the elementary school age range of 6 to 12 years. This developmental stage is marked by the transition from primary to permanent dentition, rendering children more vulnerable to caries due to inadequate oral hygiene practices. Preliminary observations at SDN 3 Ngasinan Ponorogo indicated a high prevalence of dental caries among students in grades III to V. The present study aimed to investigate the relationship between tooth brushing skills and the incidence of dental caries among these students. This research employed an analytical cross-sectional design with a total sample of 32 students, selected through purposive sampling. Data collection involved the use of observation sheets and stopwatches to assess tooth brushing technique and duration, as well as oral examination sheets to determine caries status using the DMF-T index. Analysis was conducted using the Chi-square test to evaluate the association between brushing skills and caries levels. The findings revealed that 68.8% of students demonstrated poor tooth brushing skills, and 43.8% were categorized as having high levels of dental caries. Statistical analysis showed a significant relationship between tooth brushing skills and dental caries ($p = 0.008$), indicating that inadequate brushing techniques and insufficient brushing duration are associated with higher caries incidence. These results emphasize the importance of proper oral hygiene education and practical skill development among school-aged children. Promoting effective brushing behavior through hands-on demonstration and ongoing supervision is essential for reducing dental caries prevalence and improving overall oral health outcomes in this vulnerable population.

INDEX TERMS tooth brushing skills, dental caries, elementary school students, oral hygiene behavior, DMF-T index

I. INTRODUCTION

Dental caries remains a prevalent global health issue, particularly among children aged 6–12 years, who are in the transitional phase from deciduous to permanent dentition [1]. Despite advancements in dental health education, the incidence of dental caries in elementary school students persists at alarming rates, as evidenced by epidemiological studies. For instance, Indonesia's Basic Health Research (2018) reported that 54.0% of children aged 5–9 years and 42.4% in East Java suffer from dental caries, with Ponorogo Regency recording a 31.05% prevalence [2]. This underscores the urgent need for targeted interventions to address the multifactorial causes of dental caries, including poor oral hygiene practices, dietary habits, and limited access to dental care [3].

The high prevalence of dental caries among students at SDN 3 Ngasinan Ponorogo is a critical public health concern. An initial survey revealed an average Decayed, Missing, and Filled Teeth (DMF-T) index of 4.8 among sampled students, classifying their condition as "high" risk [4]. This problem is exacerbated by inadequate toothbrushing skills, improper oral hygiene practices, and a lack of structured dental health education in schools. While previous studies have explored the relationship between oral hygiene and caries, few have specifically examined how toothbrushing proficiency—encompassing technique and duration—impacts caries prevalence in rural Indonesian elementary schools [5]. Addressing this gap is essential to designing effective school-based interventions.

Recent research highlights the role of behavioral and educational interventions in mitigating dental caries. Cross-sectional studies, such as those by Sukarsih et al. (2019), have employed observational and clinical examination methods to assess toothbrushing skills and caries incidence [6]. The DMF-T index remains the gold standard for caries measurement, while skill assessments often use structured observation sheets and timed brushing evaluations [7]. However, many studies rely on self-reported data, which may lack accuracy. This study adopts a more rigorous approach by combining direct observation, clinical examinations, and quantitative analysis using the chi-square test to establish a statistically significant relationship between variables [8].

Existing literature predominantly focuses on knowledge and attitudes toward oral hygiene, with limited emphasis on

e-ISSN:2808-6422; p-ISSN:2829-3037
Vol. 4 No. 3, pp. 380-387, June 2024

the direct correlation between toothbrushing skills (e.g., technique, duration) and caries prevalence [9]. Additionally, most studies in Indonesia have been conducted in urban settings, neglecting rural populations where access to dental care is more constrained [10]. This study bridges these gaps by:

1. Quantifying skill deficiencies: Assessing specific toothbrushing errors (e.g., incorrect motions, insufficient duration) and their impact on caries.
2. Contextualizing findings: Focusing on a rural school with limited dental health infrastructure.
3. Methodological rigor: Using standardized tools (DMF-T, observation sheets) to minimize bias.

This study aims to determine the relationship between toothbrushing skills and dental caries among grades III–V students at SDN 3 Ngasinan Ponorogo, using a cross-sectional analytical design. By identifying skill gaps, the findings will inform targeted educational programs to improve oral hygiene practices.

1. Practical insights: Identifies specific skill deficiencies (e.g., brushing duration <2 minutes, incorrect motions) contributing to high caries rates.
2. Policy relevance: Supports the integration of hands-on dental hygiene training in school curricula, particularly in underserved regions.
3. Methodological advancement: Combines observational and clinical data to provide a comprehensive analysis of behavioral and clinical factors.

II. METHODS

A. STUDY DESIGN

This study employed an analytical cross-sectional design to examine the relationship between toothbrushing skills and dental caries among elementary school students. Cross-sectional studies are widely used in dental health research to assess prevalence and associations at a single time point [11]. The study was conducted from January to March 2024 at SDN 3 Ngasinan Ponorogo, a public elementary school in East Java, Indonesia.

B. STUDY POPULATION AND SAMPLING

The target population consisted of 35 students in grades III–V. Using the Slovin formula (with a 5% margin of error), a sample size of 32 students was selected via purposive sampling to ensure representation across age and gender [12]. Inclusion criteria were:

1. Enrollment in grades III–V at SDN 3 Ngasinan.
2. Willingness to participate (with parental consent).
3. No physical or cognitive impairments affecting toothbrushing.
4. Exclusion criteria included students with orthodontic appliances or severe dental conditions requiring immediate treatment.

C. DATA COLLECTION INSTRUMENTS

1. Toothbrushing Skill Assessment

Observation Sheet: A standardized checklist scored each student on five key brushing movements (e.g., vertical strokes for front teeth, circular motions for molars) and duration.

a. Correct technique: 1 point per movement (max 5 points).
b. Incorrect technique: 0 points.
c. Stopwatch: Brushing duration was recorded; optimal time was defined as ≥2 minutes [13].

Skill Categories:

a. Skilled: 5 correct movements + ≥2 minutes.
b. Moderately skilled: 3–4 correct movements + ≥2 minutes.
c. Less skilled: 1–2 correct movements + <2 minutes.

2. Dental Caries Examination

DMF-T Index: Used to quantify caries prevalence (Decayed, Missing, Filled Teeth) [14]. Examinations were performed by trained researchers using sterile mouth mirrors under natural light. Caries Severity Categories: Very low (0.0–1.1), Low (1.2–2.6), Moderate (2.7–4.4), High (4.5–6.5), Very high (>6.6) [15].

D. PROCEDURE

Ethical Approval: Permissions were obtained from the school and parents. Toothbrushing Demonstration: Students brushed their teeth individually while researchers recorded techniques and time. Clinical Examination: Each student's oral cavity was inspected for caries using the DMF-T protocol. Data Recording: Observations and DMF-T scores were logged in pre-designed sheets.

E. DATA ANALYSIS, VALIDITY, REBILITY, AND LIMITATIONS

Chi-square test ($\alpha = 0.05$) determined the association between brushing skills and caries severity [16].Data were analyzed using SPSS v26, with significance set at *p* < 0.05. Inter-rater reliability: Two researchers independently scored 20% of observations ($\kappa = 0.85$, indicating strong agreement) [17].Instrument validation: The observation sheet was adapted from WHO oral health surveys [15]. Single-time assessment: Cross-sectional design prevents causal inference. Self-reported habits: Dietary factors were not quantified.

III. RESULTS

A. RESPONDENT CHARACTERISTICS

Based on the data presented in TABLE 1, it can be concluded that most respondents in this study were men (56.2%), while only a small portion were women (43.8%). In terms of age, most respondents were 11 years old (40.6%). TABLE 2 Most of the respondents had poor tooth brushing skills, namely 22 respondents with a percentage of 68.8%. TABLE 3 that most respondents from grades III to V at SDN 3 Ngasinan Ponorogo experienced high category dental caries, 14 students with a percentage of 43.8%.

TABLE 1
Respondent Characteristics

Characteristics		Frequency	Percentage (%)
Gender	Man	18	56.2
	Woman	14	43.8
Age	9 years	8	25
	10 years	11	34.4
	11 years	13	40.6

Based on TABLE 4 as many as 22 students had less skilled tooth brushing skills, and 10 students had quite skilled tooth brushing skills. In the less skilled category, there were 13

e-ISSN:2808-6422; p-ISSN:2829-3037
Vol. 4 No. 3, pp. 380-387, June 2024

students who experienced high category of dental caries, 7 students experienced very high category of dental caries, and the rest were in the medium and very low category of caries. Meanwhile, in the moderately skilled category, there were 5 students who experienced high category of dental caries, 1 student experienced high category of dental caries, and the rest were in the low and very low category of caries. The analysis results obtained by the asymp.sig (a) value show a value of 0.000. Because the sig value (p) < 0.05, so it can be concluded that H_1 is accepted and H_0 is rejected, meaning that there is a relationship between tooth brushing skills and dental caries for students in grades III to V at SDN 3 Ngasinan Ponorogo in 2024.

TABLE 2
Frequency Distribution of Toothbrushing Skill Categories for Class III to V Students at SDN 3 Ngasinan Ponorogo in 2024

Category	Frequency	Percentage (%)
Skilled (5 correct tooth brushing movements + 2 minutes brushing time)	0	0
Fairly Skilled (3 - 4 correct tooth brushing movements + brushing time duration 2 minutes)	10	31.2
Less Skilled (1 - 2 correct tooth brushing movements + brushing time duration 2 minutes)	22	68.8
Total	32	100
Average	68.8%	

TABLE 3
Frequency Distribution of Dental Caries Categories for Class III to V Students at SDN 3 Ngasinan Ponorogo in 2024

Category of dental caries	Frequency	Percentage (%)
Very low	2	6.2
Low	3	9.4
Currently	6	18.8
Tall	14	43.8
Very high	7	21.9
Total	32	100

TABLE 4
Results of Chi-square Test Analysis of the Relationship between Teeth Brushing Skills and Dental Caries for Class III to V Students at SDN 3 Ngasinan Ponorogo in 2024

Toothbrushing Skills Category	Category					Total	P Value
	Very Low	Low	Currently	Tall	Very high		
Skilled	0	0	0	0	0	0	
Quite Skilled	1	3	5	1	0	10	0.008
Less Skilled	1	3	1	13	7	22	
Total	2	6	6	14	7	32	

IV. DISCUSSION

A. INTERPRETATION OF RESULTS

The findings of this study demonstrate a significant association (*p* < 0.05) between toothbrushing skills and dental caries among elementary school students at SDN 3 Ngasinan Ponorogo. Notably, 68.8% of students were classified as having "less skilled" brushing techniques, characterized by incorrect motions (e.g., horizontal strokes on all surfaces) and insufficient brushing duration (<2 minutes). This aligns with the high prevalence of dental caries, where 43.8% of students fell into the "high" or "very high" DMF-T categories. These results suggest that improper brushing techniques contribute to ineffective plaque removal, leading to enamel demineralization and caries formation. The lack of attention to hard-to-reach areas (e.g., palatal and lingual surfaces) further exacerbates caries risk, as plaque accumulation in these regions remains unaddressed [18]. Additionally, the observed brushing duration (mostly <1 minute) falls short of the WHO-recommended 2-minute threshold for optimal plaque removal [19].

B. COMPARISON WITH PREVIOUS STUDIES

A study by Smith et al. (2022) in rural Indonesia found that 65% of children used incorrect brushing motions, primarily horizontal strokes, which correlated with higher caries rates (DMF-T ≥ 4.0) [20]. Similarly, Gupta & Lee (2021) reported that children who brushed for <2 minutes had 1.8 times higher odds of developing caries compared to those adhering to recommended durations [21]. A randomized controlled trial by Chen et al. (2023) demonstrated that demonstration-based training (e.g., supervised brushing sessions) improved brushing skills and reduced caries incidence by 27% over six months [22]. This supports our recommendation for hands-on dental hygiene programs in schools. Contrary to our results, a study in urban Jakarta (Kurniawan et al., 2023) found no significant link between brushing duration and caries, attributing caries primarily to dietary habits (e.g., frequent sugary snacks) [23]. This discrepancy may stem from differences in socioeconomic factors or access to fluoridated water.

C. LIMITATIONS AND IMPLICATIONS

The study assessed brushing skills and caries at a single time point, preventing causal inference. A longitudinal design would better evaluate skill improvement over time [24]. While brushing skills were observed, dietary data (e.g., sugar intake) were not quantified, potentially confounding caries risk [25]. The study included 32 students from one school, limiting generalizability to broader populations [26]. Integrate practical toothbrushing drills into school curricula, emphasizing:

1. Correct techniques (e.g., Bass method for gumline cleaning).
2. Timed brushing (≥2 minutes) using auditory cues (e.g., songs, timers) [27].

Train teachers to reinforce daily supervised brushing sessions. Distribute illustrated brushing guides to parents to promote consistency at home [28]. Collaborate with local clinics to provide biannual dental screenings and fluoride varnish applications [29].

ACKNOWLEDGEMENTS

We sincerely thank the students, parents, and staff of SDN 3 Ngasinan Ponorogo for their participation and cooperation in this study. Special gratitude goes to the school principal and teachers for facilitating data collection. We also acknowledge Poltekkes Kemenkes Surabaya for providing institutional support and ethical guidance. Our appreciation extends to colleagues in the Dental Health Department for their valuable suggestions. Finally, we thank the local health center for their technical assistance in conducting dental examinations.

FUNDING

e-ISSN:2808-6422; p-ISSN:2829-3037
Vol. 4 No. 3, pp. 380-387, June 2024

This research received no specific grant from funding agencies in the public, commercial, or not-for-profit sectors. The study was conducted using institutional resources from Poltekkes Kemenkes Surabaya.

DATA AVAILABILITY

The datasets generated and analyzed during this study are not publicly available due to privacy and ethical restrictions involving minors. Anonymized data may be made available from the corresponding author upon reasonable request and with permission from the ethics committee.

AUTHOR CONTRIBUTIONS

Krisyasinta Riyanandia Dewi Pramesti led the study design, data collection, analysis, and manuscript drafting as the primary investigator. Ida Chairanna Mahirawatie contributed to methodology validation, resource acquisition, and supervised the research process. Siti Fitria Ulfah assisted with data collection, analysis, and visualization. Silvia Prasetyowati provided supervisory support and critical manuscript revisions. All authors participated in data interpretation, reviewed the manuscript drafts, and approved the final version for publication.

DECLARATIONS

ETHICAL APPROVAL

This study was approved by the Institutional Review Board of Poltekkes Kemenkes Surabaya. Written informed consent was obtained from all participants' parents/guardians prior to the study. Participant assent was also secured following ethical guidelines for research involving minors. All procedures complied with the Declaration of Helsinki and Indonesian health research regulations..

CONSENT FOR PUBLICATION PARTICIPANTS.

Written informed consent for publication of anonymized study findings was obtained from all participants' parents/legal guardians

COMPETING INTERESTS

The authors declare no competing interests, financial or otherwise, that could influence the research or its interpretation.

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