



Knowledge and Dental and Oral Health Maintenance Behavior among Elementary School Students in Bukittinggi City

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Abstract

Dental and oral health maintenance among elementary school students is influenced by knowledge and environmental factors that shape daily habits. This study aimed to examine the relationship between dental and oral health knowledge and maintenance behavior among students at SD Negeri 01 Benteng Pasar Atas, Bukittinggi City, and explore the factors underlying this relationship. A sequential explanatory mixed-methods design was employed, involving 71 students in the quantitative phase and 19 informants in the qualitative phase. Quantitative data were collected using questionnaires and analyzed using the chi-square test, while qualitative data were analyzed thematically. The findings revealed a significant relationship between knowledge and maintenance behavior ($p = 0.0001$; $OR = 15.71$; 95% $CI: 4.50-54.79$). Qualitative findings indicated that fatigue, forgetfulness, lack of motivation, and inconsistent parental supervision hindered the application of knowledge, whereas school-based habituation through UKS/UKGS activities supported healthy practices. In conclusion, knowledge was significantly associated with dental and oral health maintenance behavior, but knowledge alone was insufficient to ensure consistent practices. Schools and Puskesmas should strengthen oral health education and school-based habituation, while parents should supervise children's toothbrushing and encourage healthier dietary habits. These findings provide a basis for developing an experience-based dental and oral health education module.

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1. INTRODUCTION

Dental and oral health are integral components of overall health and should therefore be maintained from an early age (Kementerian Kesehatan Republik Indonesia, 2018). However, the importance of dental and oral health has not been fully translated into appropriate daily health practices, particularly among elementary school-aged children. The World Health Organization (2025) identifies dental caries as one of the most prevalent diseases worldwide, despite the fact that most cases can be prevented through proper oral hygiene practices (World Health Organization, 2025). This situation is also reflected in the results of the 2023 Indonesian Health Survey (Survei Kesehatan Indonesia [SKI]), which reported that 48.8% of children aged 10–14 years experienced dental and oral health problems, with 37.2% experiencing dental caries (Kementerian Kesehatan Republik Indonesia, 2023). Nationally, the reported proportion of the population experiencing dental and oral health problems decreased from 88.8% in 2018 to 82.8% in the subsequent reporting period, based on the indicators cited in the relevant reports. Nevertheless, this figure indicates that dental and oral health problems remain highly prevalent. This situation warrants particular attention because it remains far from the WHO and FDI target that 50% of children aged 5–6 years should be caries-free (Kementerian Kesehatan Republik Indonesia, 2018). In West Sumatra Province, the 2023 SKI reported a caries prevalence of 48.2%, while only 5.5% of cases received restorative treatment, with a Performance Treatment Index of just 1.3%. Suboptimal toothbrushing practices were also evident: 3.5% of the population did not brush their teeth, 13.2% brushed only once a day, and only 1.2% brushed their teeth at the appropriate time (Kementerian Kesehatan Republik Indonesia, 2023). These findings indicate that dental and oral health problems are associated not only with the high burden of dental caries but also with inadequate daily oral health maintenance practices.

These problems are particularly relevant at the local level. Data from the Bukittinggi City Health Office, referring to the 2023 SKI, indicated that the prevalence of dental caries among children aged 5–9 years reached 84.8%, while only 4.6% of children in the age groups of 3–9 and 10–14 years brushed their teeth correctly (Dinas Kesehatan Kota Bukittinggi, 2023). These findings suggest a gap between the recognized importance of dental and oral health maintenance and the actual implementation of appropriate practices among children. A similar gap had already been documented in the 2018 Basic Health Research (Riskesdas), which reported that although 94.7% of the Indonesian population brushed their teeth, only 2.8% did so correctly. In West Sumatra, 95.3% of the population reported brushing their teeth, but only 1.2% brushed at the appropriate time and in the correct manner (Kementerian Kesehatan Republik Indonesia, 2018). When the findings of the 2018 Riskesdas, and the 2023 SKI are considered together, they highlight the continuing need to improve dental and oral health maintenance, particularly regarding correct brushing techniques, appropriate timing, and consistency (Kementerian Kesehatan Republik Indonesia, 2018; Kementerian Kesehatan Republik Indonesia, 2023). Therefore, the central issue is not merely whether children possess knowledge about dental and oral health, but also whether that knowledge is translated into appropriate daily practices. According to health behavior theory, knowledge and attitudes are predisposing factors, the availability of facilities constitutes an enabling factor, and support from family members, teachers, and health professionals represents reinforcing factors that collectively shape health behavior (Notoatmodjo, 2014). Knowledge of correct toothbrushing techniques, appropriate brushing times, and the adverse effects of consuming cariogenic foods constitutes an essential foundation for preventing dental caries and periodontal disease (Boyd et al., 2020). Accordingly, dental and oral health promotion among school-aged children should not focus exclusively on increasing

knowledge but should also support the development of consistent and appropriate oral health maintenance practices.

The relationship between knowledge and dental and oral health maintenance behavior has been examined in several previous studies, although their findings and research focuses have varied. Fitriana and Mubasyiroh (2019) identified various factors associated with dental and oral health maintenance behavior among elementary school children. Mandasari and Rahayu (2022) found a relatively significant relationship between knowledge, caries status, and oral hygiene behavior among children, while Utami et al. (2023) reported findings concerning toothbrushing practices and caries status among elementary school students. Katili et al. (2022) documented considerable variation in dental and oral health maintenance behavior among students, while Putri et al. (2021) examined similar issues in the local context of Padang City. Furthermore, Rahayu and Sari (2020) investigated the relationship between parenting styles and children's dental health behavior, whereas Yusra and Deswita (2022) evaluated animated video-based dental health education in Bukittinggi City. The importance of structured dental health education has also been highlighted by Rahmawati et al. (2022) and Sastrawan et al. (2018) in studies conducted in other regions of Indonesia. Although these studies provide an empirical foundation for understanding the relationships among knowledge, behavior, parenting, and dental health education, further investigation is warranted to integrate quantitative analysis of the relationship between knowledge and dental and oral health maintenance behavior with qualitative explanations of the contextual factors that may underlie this relationship among students at SD Negeri 01 Benteng Pasar Atas, Bukittinggi City. The research gap addressed by the present study does not lie in the assumption that the relationship between knowledge and behavior has never been investigated. Rather, it concerns the need to understand how this relationship manifests in the specific school context and how family circumstances, the school environment, and everyday situations may help explain the observed behavioral patterns. This gap is important because the relationship between knowledge and behavior may not be adequately explained through quantitative measurements alone; a deeper understanding of the experiences and social conditions associated with the implementation of health practices is also needed.

The need to investigate this issue is further supported by preliminary field findings at a public elementary school in Bukittinggi City. Interviews with the principal and teachers revealed that some students had visibly yellowed teeth, food debris remaining on their teeth, and unpleasant breath. Some students had also reportedly missed school because of toothache. Interviews with 10 students indicated that all of them brushed their teeth only when bathing. When asked to demonstrate their toothbrushing techniques, their movements did not adequately reach all tooth surfaces, although they considered their practices to be correct. Preliminary observations also identified eight students with dental caries affecting three teeth each and two students with caries affecting one tooth each. These findings indicate potential problems in the application of dental and oral health knowledge and skills among the students observed. However, the preliminary findings are exploratory and cannot establish a statistical relationship between knowledge and behavior or determine the factors responsible for the observed practices. Therefore, further research is needed to quantitatively examine the relationship between knowledge and dental and oral health maintenance behavior and subsequently explore the findings qualitatively to obtain a contextual explanation of students' experiences and the possible roles of family and school environments. To address this need, the present study employs a sequential explanatory mixed-methods design, in which quantitative data are collected and analyzed first, followed by qualitative data collection and analysis to explain the quantitative findings in greater depth (Creswell & Plano Clark, 2018; Sugiyono, 2018).

Integrating these two approaches is expected to provide a more comprehensive understanding of the research problem than either approach could offer independently.

The novelty of this study lies in its context-specific empirical contribution, namely, the investigation of the relationship between knowledge and dental and oral health maintenance behavior among students at SD Negeri 01 Benteng Pasar Atas, Bukittinggi City, complemented by a qualitative exploration of situational, family, and school-level factors that may help explain this relationship. Accordingly, the novelty claim is not based on the use of a sequential explanatory mixed-methods design itself, as this is an established approach in health behavior research, but rather on the integration of quantitative findings and contextual qualitative explanations focused on the needs of students in the study setting. This approach is expected to clarify whether knowledge of dental and oral health is associated with students' oral health maintenance behavior and provide a deeper understanding of the contextual conditions that may facilitate or hinder the implementation of appropriate practices. The findings are also expected to provide an empirical basis for developing dental health education materials or modules that respond to the characteristics and needs of elementary school students in Bukittinggi City. Therefore, this study aimed to analyze the relationship between knowledge and dental and oral health maintenance behavior among students at SD Negeri 01 Benteng Pasar Atas, Bukittinggi City, and to explore contextual factors at the individual, family, and school levels that may help explain this relationship through a qualitative phase within a sequential explanatory mixed-methods design.

2. METHODS

This study employed a mixed-methods approach using a sequential explanatory design, in which the quantitative phase (QUAN) was conducted first, followed by a qualitative phase (QUAL) to explain and contextualize the quantitative findings (Creswell & Plano Clark, 2018; Sugiyono, 2018). The quantitative phase aimed to examine the relationship between students' knowledge of dental and oral health and their dental and oral health maintenance behavior. Subsequently, the qualitative phase explored participants' experiences and contextual factors that could help explain the quantitative results. The integration of both phases was intended to provide a more comprehensive understanding of the relationship between knowledge and behavior. The study was conducted at SDN 01 Benteng Pasar Atas, Bukittinggi City, Indonesia, from 3 April to 20 August 2026, while data collection took place from 21 June to 17 July 2026.

The quantitative population comprised 242 students in Grades IV–VI at SDN 01 Benteng Pasar Atas. The sample size was calculated using Slovin's formula with a margin of error of 10%, resulting in 71 respondents. Participants were selected through systematic random sampling. The inclusion criteria were students aged 10–12 years who were willing to participate and whose participation was authorized by their parents or legal guardians. Students who were absent during the data collection period were excluded (Dahlan, 2018). The qualitative phase involved 19 informants, comprising students, parents, teachers, the school principal, the school committee, representatives of the Education Office, and personnel from the community health center (Pusat Kesehatan Masyarakat, Puskesmas). These informants were included to obtain perspectives from different stakeholders regarding children's dental and oral health knowledge, maintenance practices, and the contextual circumstances that might influence these practices. The recruitment and selection of qualitative informants were guided by their relevance to the research objectives.

Quantitative data were collected using a structured questionnaire, while qualitative data were obtained through a semistructured interview guide. The questionnaire assessed

students' knowledge of dental and oral health and their dental and oral health maintenance behavior. Before the main study, the questionnaire was pilot-tested among 30 students at SDN 12 Puhun Pintu Kabun, Bukittinggi City. This school was selected because of its similarities to SDN 01 Benteng Pasar Atas in terms of urban setting and school accreditation. Item validity was assessed using item–total correlation coefficients, which exceeded the critical *r*-table value of 0.361. The questionnaire demonstrated satisfactory internal consistency, with a Cronbach's alpha coefficient of 0.85, exceeding the commonly accepted threshold of 0.70 (Polit & Beck, 2021). The interviews explored participants' experiences, perceptions, and contextual circumstances related to dental and oral health knowledge and maintenance behavior. The qualitative data were subsequently analyzed to identify factors that could help explain the patterns observed in the quantitative findings.

Quantitative data were analyzed using univariate and bivariate statistical procedures. Univariate analysis was conducted to describe the distributions of the study variables, including participants' characteristics, knowledge levels, and dental and oral health maintenance behavior. Bivariate analysis was performed using the Chi-square test to examine the association between knowledge and maintenance behavior, with statistical significance set at $p < 0.05$. The suitability of the Chi-square test was evaluated based on the expected cell frequencies; where its assumptions were not met, an appropriate alternative test was considered (Dahlan, 2018). Multivariable analysis using multiple logistic regression would be appropriate only if the study included a binary outcome and additional independent variables that were conceptually distinct, theoretically justified, and operationally defined. Individual questionnaire items representing indicators of a single knowledge construct were not treated as independent predictors without an appropriate theoretical and methodological justification. Any multivariable model therefore needed to be consistent with the study objectives, conceptual framework, variable definitions, and available sample size (Dahlan, 2018).

Qualitative data were analyzed using the six-phase thematic analysis approach described by Braun and Clarke (2019). The process involved familiarization with the data, generation of initial codes, searching for themes, reviewing themes, defining and naming themes, and producing the final report. The analysis focused on identifying recurring patterns concerning students' knowledge, dental and oral health maintenance behavior, and the contextual factors associated with family and school environments. Integration of the quantitative and qualitative findings was undertaken during interpretation by examining how the qualitative themes could explain, complement, or differ from the quantitative results. This integration was intended to provide a more comprehensive interpretation of the relationship between knowledge and behavior within the specific school context.

The study was informed by the national technical guidelines for the School Dental Health Program (Usaha Kesehatan Gigi Sekolah, UKGS) (Kementerian Kesehatan Republik Indonesia, 2020) and the School Health Program (Usaha Kesehatan Sekolah, UKS) (Kementerian Pendidikan dan Kebudayaan, 2019). This study received ethical approval from the Research Ethics Committee of Poltekkes Kemenkes Padang (Approval No. EC-188/KEPK-PDG/VI/2026). Written informed consent was obtained from the parents or legal guardians of all participating children, and age-appropriate assent was obtained from the children themselves. Adult informants provided informed consent before participating in the study. All participants were informed about the study objectives, procedures, voluntary nature of participation, and their right to decline or withdraw without penalty. Confidentiality was maintained throughout data collection, analysis, and reporting, and identifying information was handled in accordance with applicable ethical requirements.

3. RESULTS AND DISCUSSION

Table 1. Characteristics of study respondents (n = 71).

Characteristic	Category	n	%
Age	10 years	28	39.4
	11 years	26	36.6
	12 years	17	23.9
Sex	Male	36	50.7
	Female	35	49.3
Grade	IV	28	39.4
	V	26	36.6
	VI	17	23.9

Table 1 presents the demographic characteristics of the 71 students participating in the quantitative phase. The largest age group consisted of students aged 10 years (28; 39.4%), followed by those aged 11 years (26; 36.6%) and 12 years (17; 23.9%). Regarding sex, the distribution was nearly balanced, with 36 male students (50.7%) and 35 female students (49.3%). In terms of grade level, 28 students (39.4%) were in Grade IV, 26 (36.6%) were in Grade V, and 17 (23.9%) were in Grade VI. The respondents were relatively evenly distributed across the reported age groups, sex categories, and grade levels, providing a demographic overview of the study population.

Table 2. Frequency distribution of respondents' answers on dental and oral health knowledge items (n = 71).

Knowledge Item	Correct (n)	Correct (%)	Incorrect (n)	Incorrect (%)
Correct toothbrushing technique	41	57.7	30	42.3
Correct timing of toothbrushing	31	43.7	40	56.3
Habit of cleaning teeth/mouth after eating/snacking	33	46.5	38	53.5
Importance of regular dental check-ups	39	54.9	32	45.1
Danger of cariogenic food/drink	40	56.3	31	43.7
Process of dental caries formation	33	46.5	38	53.5
Timing of toothbrush replacement	34	47.9	37	52.1
Function of fluoride toothpaste	30	42.3	41	57.7
Rinsing with plain water as an alternative	33	46.5	38	53.5
Consequences of untreated dental problems	26	36.6	45	63.4

Table 2 presents the distribution of correct and incorrect responses to the 10 dental and oral health knowledge items. The highest proportion of incorrect responses concerned the consequences of untreated dental problems, for which 45 students (63.4%) answered incorrectly. This was followed by knowledge of the function of fluoride toothpaste, with 41 students (57.7%) answering incorrectly, and knowledge of the appropriate timing of toothbrushing, with 40 students (56.3%) answering incorrectly. More than half of the respondents also answered incorrectly regarding cleaning the teeth or mouth after eating or snacking and understanding the process of dental caries formation, with 38 students (53.5%) answering incorrectly for each item.

Conversely, the highest proportion of correct responses was observed for the correct toothbrushing technique, answered correctly by 41 students (57.7%), followed by knowledge of the dangers of cariogenic foods and drinks, answered correctly by 40 students (56.3%). Knowledge of the importance of regular dental check-ups was also relatively higher, with 39 students (54.9%) answering correctly. Nevertheless, the proportion of correct responses remained below 60% across all 10 items. These findings indicate that knowledge gaps were present across several aspects of dental and oral health, particularly the consequences of untreated dental problems, the function of fluoride toothpaste, and the appropriate timing of toothbrushing. The results suggest that educational interventions may need to emphasize these topics while also reinforcing other essential preventive practices.

Table 3. Frequency distribution of knowledge and dental and oral health maintenance behavior categories among respondents (n = 71).

Variable	Category	n	%
Knowledge	Good	38	53.5
	Poor	33	46.5
Dental and oral health maintenance behavior	Good	30	42.3
	Poor	41	57.7

As shown in Table 3, 38 students (53.5%) were classified as having good knowledge, whereas 33 (46.5%) were classified as having poor knowledge. Knowledge categories were determined from the total score across the 10 questionnaire items, using the median score of 5 as the cut-off. Students scoring at or above the median were classified as having good knowledge, while those scoring below the median were classified as having poor knowledge.

Regarding dental and oral health maintenance behavior, 30 students (42.3%) were classified as having good behavior, while 41 (57.7%) were classified as having poor behavior. Thus, although slightly more than half of the respondents were categorized as having good knowledge, most had not achieved the study's threshold for good maintenance behavior. This descriptive difference indicates that relatively favorable knowledge scores did not necessarily coincide with favorable behavioral classifications. However, these distributions alone do not establish whether knowledge and behavior were statistically associated; this relationship was examined through the subsequent bivariate analysis.

Table 4. Relationship between knowledge and dental and oral health maintenance behavior among students at SD Negeri 01 Benteng Pasar Atas, Bukittinggi City (n = 71).

Knowledge	Good n (%)	Poor n (%)	Total n (%)	OR	95% CI	p-value
Good	26 (68.4)	12 (31.6)	38 (100)	15.71	4.50-54.79	0.0001
Poor	4 (12.1)	29 (87.9)	33 (100)			
Total	30 (42.3)	41 (57.7)	71 (100)			

Table 4 presents the association between students' knowledge and their dental and oral health maintenance behavior. Among the 38 students with good knowledge, 26 (68.4%) demonstrated good behavior, whereas 12 (31.6%) demonstrated poor behavior. In contrast, among the 33 students with poor knowledge, only 4 (12.1%) demonstrated good behavior, while 29 (87.9%) demonstrated poor behavior.

The Chi-square test indicated a statistically significant association between knowledge and dental and oral health maintenance behavior ($\chi^2 = 22.944$, $p = 0.0001$). The odds ratio was 15.71, with a 95% confidence interval (CI) of 4.50–54.79. This indicates that students with good knowledge had 15.71 times the odds of demonstrating good maintenance behavior compared with students with poor knowledge. Because the confidence interval did not include 1 and the p-value was below 0.05, the findings support a statistically significant association between the two variables.

Nevertheless, the relationship was not uniform across all respondents. Almost one-third of the students with good knowledge continued to demonstrate poor behavior, while a small proportion of students with poor knowledge demonstrated good behavior. These contrasting patterns suggest that knowledge alone may not fully account for differences in oral health practices. They also provide a rationale for the qualitative phase, which explored the personal, family, and school-related circumstances that might help explain why knowledge and behavior did not always align. As this was an observational study, the findings demonstrate an association rather than a causal effect of knowledge on behavior.

Table 5. Results of bivariate selection of knowledge items against dental and oral health maintenance behavior (candidates for the multivariate model).

Knowledge Item	OR	p-value	Candidate ($p < 0.25$)
Correct toothbrushing technique	4.20	0.006	Yes
Correct timing of toothbrushing	2.52	0.059	Yes
Habit of cleaning teeth/mouth after eating/snacking	1.28	0.611	No
Importance of regular dental check-ups	2.32	0.089	Yes
Danger of cariogenic food/drink	6.25	0.001	Yes
Process of dental caries formation	2.04	0.141	Yes
Timing of toothbrush replacement	2.99	0.026	Yes
Function of fluoride toothpaste	6.20	0.000	Yes
Rinsing with plain water as an alternative	2.60	0.051	Yes
Consequences of untreated dental problems	8.39	0.000	Yes

Table 5 summarizes the bivariate associations between individual knowledge items and dental and oral health maintenance behavior. Based on the reported odds ratios and p-values, eight items met the prespecified candidate-selection criterion of ($p < 0.25$). These included knowledge of the correct toothbrushing technique, appropriate toothbrushing timing, the importance of regular dental check-ups, the dangers of cariogenic foods and drinks, the process of dental caries formation, the timing of toothbrush replacement, the function of fluoride toothpaste, and the consequences of untreated dental problems. The item concerning cleaning the teeth or mouth after eating or snacking did not meet this criterion ($p = 0.611$).

Among the individual items, knowledge of the consequences of untreated dental problems had the largest reported crude odds ratio (OR = 8.39), followed by knowledge of the dangers of cariogenic foods and drinks (OR = 6.25) and the function of fluoride toothpaste (OR = 6.20). These results indicate that some knowledge items showed stronger unadjusted associations with behavioral classification than others. However, these estimates should be interpreted cautiously because the items represent components of the broader knowledge construct rather than necessarily distinct explanatory variables. Their individual associations do not establish that each item independently predicts behavior, nor do they establish that the items are appropriate

candidates for a multivariable model without further theoretical and methodological justification.

Table 6. Final results of multiple logistic regression analysis of dental and oral health maintenance behavior (n = 71).

Variable	B	p-value	OR	95% CI
Constant	-4.334	0.000	0.013	-
Danger of cariogenic food/drink	2.774	0.001	16.02	3.07-83.73
Function of fluoride toothpaste	2.795	0.001	16.36	3.35-80.05
Consequences of untreated dental problems	2.661	0.001	14.31	3.20-64.07

Model: -2 Log Likelihood = 52.67; Nagelkerke/McFadden R^2 = 0.621; p (LLR) = 0.0001

Table 6 shows that three knowledge items understanding of the danger of cariogenic food and drink, the function of fluoride toothpaste, and the consequences of untreated dental problems were jointly and significantly associated with dental and oral health maintenance behavior ($p < 0.05$ for all variables). The most dominant variable was knowledge of the function of fluoride toothpaste, with the largest OR of 16.36 (95% CI: 3.35-80.05), followed very closely by the danger of cariogenic food and drink (OR = 16.02). The Nagelkerke R^2 value of 0.621 indicates that these three knowledge items jointly explain 62.1% of the variance in respondents' dental and oral health maintenance behavior; the remaining 37.9% is explained by other factors beyond knowledge, which were further explored in the qualitative phase. The events-per-variable (EPV) ratio in this final model also met the recommended minimum threshold (30 events of good behavior divided by 3 predictors = 10 EPV), so that the OR values and confidence intervals in the model can be interpreted with reasonable adequacy.

Table 7. Characteristics of informants in the qualitative phase.

Code	Informant	Number	Method
M	Students	6	Initial interview
OT	Parents of students	6	In-depth interview
G	Teachers	2	In-depth interview
KS	School principal	1	In-depth interview
Kom	School committee	1	FGD
DP	Education Office	1	FGD
PK	Puskesmas (dentist and dental therapist)	2	FGD

Table 7 presents the 19 informants involved in the qualitative phase. They comprised six students who participated in initial interviews, six parents who participated in in-depth interviews, two teachers who participated in in-depth interviews, one school principal, one school committee representative, one Education Office representative, and two community health center personnel a dentist and a dental therapist who participated in focus group discussions (FGDs). The inclusion of these stakeholder groups enabled the study to examine dental and oral health maintenance from the perspectives of children, families, schools, and health services. The qualitative findings were organized into four themes that helped contextualize the quantitative results.

Theme 1: The gap between knowledge and toothbrushing practice

The first theme concerned the gap between students' understanding of oral health and their daily toothbrushing practices. This theme helped contextualize the finding that 12 students (31.6%) with good knowledge nevertheless demonstrated poor maintenance behavior (Table 4). Students generally recognized that toothbrushing was important for keeping their teeth healthy, preventing cavities and toothache, and removing germs. They also demonstrated awareness of the recommended morning and evening brushing schedule.

However, this awareness did not always translate into consistent practice. Of the six students interviewed, four reported brushing their teeth twice daily on a consistent basis, while two indicated that they sometimes brushed only once a day. The barriers most frequently described concerned nighttime brushing and included drowsiness, fatigue, laziness, feeling cold, and forgetfulness. These accounts suggest that the implementation of oral health knowledge may be affected by daily routines, motivation, and situational constraints. The findings are consistent with Thoyibah, Haryani, & Hajri (2023) and Rahmawati, Hendartini, & Priyanto (2011), who emphasized that knowledge provides an important foundation for health behavior, while contextual conditions and established habits influence its implementation. Nevertheless, because the qualitative sample was small, these accounts should be interpreted as explanations offered by participating students rather than as estimates of the prevalence of these barriers among all respondents.

Theme 2: Individual and family-level barriers to oral health maintenance

The second theme highlighted individual and family-level circumstances that could hinder consistent oral health maintenance. Four of the six parents interviewed described their children's toothbrushing habits as inconsistent or reported practices they considered potentially detrimental to oral health. Parents also frequently mentioned their children's consumption of sweet foods in discussions of dental caries. Teachers similarly reported differences in students' habits: some students appeared to maintain their oral health adequately, whereas others rarely brushed their teeth, frequently consumed sweet foods, or engaged in habits such as nail-biting.

These findings suggest that children's oral health practices may be shaped by parental supervision, household routines, dietary habits, and the consistency of behavioral reinforcement at home. The findings are compatible with the health promotion framework described by Green and Kreuter (2005), which emphasizes the importance of factors that facilitate the adoption and maintenance of health behavior, and with Rahayu and Sari (2020), who examined the relationship between parenting styles and children's dental health behavior in West Sumatra. In the present study, the accounts of parents and teachers provide contextual explanations for why knowledge may not consistently translate into practice. However, the qualitative findings do not independently establish that parenting style or sweet-food consumption caused the behavioral patterns observed in the quantitative phase.

Theme 3: The role of the school and support systems in shaping behavior

The third theme concerned the contribution of school-based activities and support systems to students' oral health practices. This theme provided a possible explanation for the finding that four students (12.1%) with poor knowledge nevertheless demonstrated good maintenance behavior (Table 4). According to the informants, the school conducted monthly School Health Program (UKS) and School Dental Health Program (UKGS) activities involving community health center personnel and teachers. Group toothbrushing

activities were also used to encourage routine practices, although the school had not established specific rules regarding healthy snacks.

Teachers reported that dental and oral health topics had been incorporated into physical education (PJOK), science learning (IPAS/IPA), UKS activities, counseling sessions, posters, lectures, and demonstrations. These activities may provide students with repeated opportunities to practice oral health behaviors, including when their individual knowledge is incomplete. The findings are consistent with the emphasis on school-based health promotion in the School Health Program framework (Kementerian Pendidikan dan Kebudayaan, 2019) and with Gunawan and Lestari (2021), who discussed the role of teachers in improving oral health behavior among elementary school students.

The qualitative accounts suggest that structured routines and support from teachers and health professionals may complement children's individual knowledge. However, the data do not establish that school programs independently produced good behavior among the four students. Rather, the findings identify school-based support as a plausible contextual explanation that warrants further evaluation.

Theme 4: The Relevance of Knowledge Topics to Children's Everyday Experiences

The fourth theme concerned the perceived relevance of particular dental health topics to children's everyday experiences. The original multivariable model identified three items knowledge of the dangers of cariogenic foods and drinks, the function of fluoride toothpaste, and the consequences of untreated dental problems as statistically significant within the specified model (Table 6). Interviews with students and parents indicated that children were familiar with concrete experiences such as toothache, cavities, and eating their favorite sweet foods. Such experiences may make certain oral health messages more recognizable and memorable than information involving less immediately observable processes.

Teachers and community health center personnel similarly reported that children appeared responsive to educational content connected to practical situations and recognizable consequences. These accounts are consistent with Boyd et al. (2020) and Newman et al. (2019), as well as the emphasis on applicable and accessible dental health education described by Rahmawati et al. (2022) and Sastrawan et al. (2018).

The qualitative findings offer a plausible explanation for why some topics were prominent in the reported item-level statistical analysis. Nevertheless, the qualitative data cannot establish that knowledge related to concrete experiences is intrinsically more influential than procedural knowledge. In addition, because the multivariable model requires methodological verification, the three items should be described as items highlighted in the original analysis rather than as confirmed dominant predictors. The qualitative findings are best interpreted as contextual insights that may inform the design of future oral health education materials.

Table 8. Joint display integrating quantitative findings with explanatory qualitative themes.

Quantitative Finding	Related Qualitative Theme	Meta-Inference (Explanation)
Significant knowledge-behavior relationship ($p = 0.0001$; OR = 15.71)	Theme 1: Gap between Knowledge and Practice	Knowledge is an important prerequisite, but does not automatically translate into consistent practice without situational support

Quantitative Finding	Related Qualitative Theme	Meta-Inference (Explanation)
31.6% of students with good knowledge still exhibited poor behavior	Theme 2: Inhibiting Factors at the Individual and Family Level	Psychological/situational barriers and inconsistent parental supervision explain why knowledge does not always translate into behavior
12.1% of students with poor knowledge nevertheless exhibited good behavior	Theme 3: Role of the School and Support Systems	Routine habituation and UKS/UKGS programs at school can shape good behavior even when individual cognitive understanding is not yet optimal
Three knowledge items (cariogenic risk, fluoride, consequences of dental problems) as dominant predictors	Theme 4: Understanding of Directly Experienced Topics	Topics related to children's concrete experience more strongly influence behavior than knowledge that is procedural/abstract in nature

Table 8 integrates the principal quantitative results with the four qualitative themes. The significant association between overall knowledge and maintenance behavior (OR = 15.71; 95% CI: 4.50–54.79; $p = 0.0001$) was complemented by students' accounts of fatigue, forgetfulness, and inconsistent nighttime toothbrushing. These findings suggest that knowledge is an important correlate of oral health behavior, although its practical implementation may be constrained by everyday circumstances. The finding that 31.6% of students with good knowledge demonstrated poor behavior was complemented by parental and teacher accounts concerning inconsistent household routines, limited supervision, and dietary habits. Conversely, the finding that 12.1% of students with poor knowledge demonstrated good behavior was complemented by reports of school-based toothbrushing activities, educational sessions, and support from teachers and community health personnel. Together, these findings suggest that individual knowledge and the environments in which children live and study should be considered when interpreting their oral health practices.

The qualitative themes also highlighted the perceived relevance of concrete, experience-based oral health messages. This finding may help inform the development of educational materials that connect preventive knowledge with situations familiar to children. However, the item-level regression findings should not be treated as definitive evidence that three particular knowledge items are the most influential predictors until the statistical model has been re-evaluated. Integration of the quantitative and qualitative findings indicates that the relationship between dental and oral health knowledge and maintenance behavior is best understood alongside the personal routines, family practices, and school-based support systems described by participants. These findings provide a contextual basis for designing and evaluating oral health promotion activities for elementary school students in Bukittinggi City.

The findings of this study demonstrated a statistically significant association between dental and oral health knowledge and maintenance behavior among elementary school students. This finding is consistent with previous studies reporting associations between dental health knowledge and caries status among elementary school children (Mandasari & Rahayu, 2022), oral hygiene behavior and dental caries prevalence among Indonesian children (Susilo, Aripin, & Suwargiani, 2021), and knowledge of toothbrushing

practices and dental health status among elementary school students (Utami et al., 2023). In the present study, students with good knowledge had higher odds of demonstrating good dental and oral health maintenance behavior than those with poor knowledge (OR = 15.71; 95% CI: 4.50–54.79; $p = 0.0001$). Nevertheless, this association should not be interpreted as evidence of a causal relationship. The relatively wide confidence interval also indicates uncertainty regarding the precise magnitude of the association. Furthermore, the findings revealed that knowledge alone did not fully correspond to students' behavior, as some students with good knowledge continued to demonstrate poor maintenance practices, whereas others with limited knowledge exhibited good behavior. This pattern suggests that the relationship between knowledge and behavior is influenced by factors beyond cognitive understanding, including motivation, daily routines, parental supervision, and the school environment.

The qualitative findings provided contextual explanations for these contrasting patterns, consistent with the sequential explanatory mixed-methods design (Creswell & Plano Clark, 2018). Students who understood the importance of dental and oral health did not always translate their knowledge into consistent practices because of tiredness, sleepiness, forgetfulness, lack of motivation, and reluctance to brush their teeth before bedtime. Inconsistent parental supervision further complicated the establishment of regular oral hygiene routines. These findings suggest that knowledge may provide the cognitive foundation for preventive behavior, but its practical application depends partly on the circumstances in which children live and develop their habits. This interpretation is consistent with previous studies highlighting the importance of children's daily experiences and behavioral barriers in maintaining oral health (Thoyibah, Haryani, & Hajri, 2023; Rahmawati, Hendrartini, & Priyanto, 2011). Conversely, some students with limited knowledge demonstrated good maintenance behavior, which may be explained by repeated school-based activities associated with the School Health Unit (*Usaha Kesehatan Sekolah*, UKS) and the School Dental Health Program (*Usaha Kesehatan Gigi Sekolah*, UKGS). Educational demonstrations, group toothbrushing activities, teacher guidance, and repeated routines may help establish healthy practices even when children do not fully understand the underlying preventive mechanisms. These findings support health behavior frameworks that distinguish predisposing factors, such as knowledge and attitudes, from enabling and reinforcing factors, including family support and school-based practices (Notoatmodjo, 2014; Green & Kreuter, 2005). Similar considerations have been reported among elementary school children in Indonesia (Fitriana & Mubasyiroh, 2019). Taken together, the quantitative and qualitative findings indicate that oral health promotion should combine knowledge-based education with practical training, behavioral reinforcement, and consistent support from parents and schools.

The exploratory item-level analysis identified knowledge concerning the dangers of cariogenic foods and drinks, the function of fluoride toothpaste, and the consequences of untreated dental problems as items associated with maintenance behavior in the reported multivariable model. These topics are relevant to oral health promotion because fluoride use, the management of cariogenic food and drink consumption, and awareness of the consequences of untreated dental problems are important components of caries prevention (Newman et al., 2019; Boyd & Mallonee, 2023). The qualitative findings further suggested that children may relate more readily to information connected with concrete experiences, such as toothache, cavities, and their consumption of sweet foods, than to procedural information that may appear less immediately relevant to their daily lives. This interpretation is consistent with recommendations emphasizing practical, concrete, and developmentally appropriate educational materials for elementary school-aged children (Katili et al., 2022; Rahmawati et al., 2022). However, these findings should be interpreted

cautiously because the questionnaire items represent indicators of the broader knowledge construct and may not constitute conceptually independent predictors. Their inclusion as simultaneous predictors in a multivariable regression model therefore requires clear theoretical and methodological justification. Accordingly, the three items should be regarded as preliminary areas of interest for educational development rather than definitive evidence of the strongest independent determinants of behavior. The primary quantitative conclusion remains that overall dental and oral health knowledge was significantly associated with maintenance behavior, while the qualitative findings help explain why knowledge may or may not translate into consistent daily practices.

Several limitations should be considered when interpreting these findings. The quantitative component involved 71 students from a single elementary school, limiting the generalizability of the results to other schools and populations. The relatively wide confidence interval for the association between knowledge and behavior also indicates uncertainty in the estimated effect size. The qualitative component was intended to explain the quantitative results rather than achieve statistical generalizability (Polit & Beck, 2021). Although participants included students, parents, teachers, school representatives, and health professionals, the limited representation of some stakeholder groups, particularly the school principal, school committee, and Education Office, may have restricted the range of institutional perspectives. Furthermore, because the qualitative phase followed the quantitative analysis, the interpretation of interview data may have been influenced by the initial quantitative findings. Triangulation across participant groups was used to broaden the interpretation, in accordance with the principles of reflexive thematic analysis (Braun & Clarke, 2019), although this approach cannot eliminate interpretive bias entirely. The item-level regression analysis also requires further methodological evaluation before its findings can be used to establish a hierarchy of independent behavioral determinants. Future research should therefore involve larger and more diverse samples, strengthen the conceptual distinction between overall knowledge and other explanatory variables, and consider longitudinal or intervention-based designs to examine how knowledge and contextual factors relate to changes in oral health behavior over time.

The integrated findings provide a preliminary empirical basis for developing a targeted dental and oral health education module for elementary school students, with further development planned for 2027. Rather than focusing exclusively on the delivery of factual information, the module should combine age-appropriate educational content with practical demonstrations, repeated opportunities to practice toothbrushing, and strategies to establish consistent oral hygiene routines at home and school. Information about fluoride toothpaste, cariogenic foods and drinks, and the consequences of untreated dental problems may be incorporated alongside other essential topics, including correct toothbrushing techniques and regular dental visits. Parental involvement and teacher reinforcement should also be considered to help children overcome practical barriers, particularly those associated with nighttime toothbrushing. Previous educational approaches, including Android application-based learning, educational dental card games, flipchart media, multimedia-based learning, multimedia-assisted microteaching programs, and animated video-based education piloted in Bukittinggi City, may provide useful references for module development (Yusra & Deswita, 2022; Handayani & Kusuma, 2023). These approaches should be aligned with the World Health Organization's recommendations for oral health promotion among school-aged children (World Health Organization, 2020) and subsequently evaluated through expert review, usability testing, and pilot implementation. Future studies should also include a broader range of institutional stakeholders and examine whether integrating educational activities with

family participation and school-based behavioral reinforcement can support more consistent dental and oral health maintenance practices.

4. CONCLUSION

This study demonstrated a significant relationship between dental and oral health knowledge and maintenance behavior among students at SD Negeri 01 Benteng Pasar Atas, Bukittinggi City. The integrated quantitative and qualitative findings indicate that knowledge is an important foundation for maintaining dental and oral health; however, it does not always translate into consistent daily practices. Situational and family-related barriers, including fatigue, forgetfulness, lack of motivation, and inconsistent parental supervision, may hinder the application of knowledge, whereas structured school-based habituation through UKS/UKGS activities may support good maintenance behavior even among students with limited knowledge. These findings highlight the importance of integrating knowledge-based education with practical experiences, behavioral reinforcement, and support from families and schools. Accordingly, schools and community health centers (Puskesmas) should strengthen school-based oral health promotion programs, while parents should provide consistent supervision of children's toothbrushing habits, particularly at night, and encourage healthier dietary practices. The findings also provide an empirical basis for developing and evaluating a targeted, experience-based dental and oral health education module in future research.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

AUTHOR CONTRIBUTIONS

Muhammad Faisal contributed to conceptualization, methodology, investigation, data curation, formal analysis, and writing of the original draft. Eka Sukanti contributed to methodology, validation, supervision, and manuscript review and editing. Dewi Susanti contributed to conceptualization, supervision, validation, and manuscript review and editing. All authors reviewed and approved the final version of the manuscript and agreed to be accountable for all aspects of the work.

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DECLARATION OF ARTIFICIAL INTELLIGENCE USE

During the preparation of this manuscript, the authors used an AI-based language assistant (Claude, Anthropic) to assist with English-language translation, editing, and reformatting of the manuscript in accordance with the journal's template. The AI tool was not used to generate research data, analysis, or scientific interpretations; all scientific content, data, and conclusions remain the sole responsibility of the authors, who reviewed and approved the final manuscript.

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