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Association Between Dental Health Knowledge and Dental Caries Among Students with Visual Impairments Using a Braille Questionnaire: A Cross-Sectional Study at SMPLB-A YPAB Surabaya

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ABSTRACT Visual impairment can restrict access to health information and make independent oral-hygiene practices more difficult, potentially increasing the burden of dental caries among school-aged children. However, evidence regarding the association between oral health knowledge and dental caries among visually impaired students remains limited, particularly in Indonesian special-school settings. This study aimed to determine the relationship between oral health knowledge and dental caries among visually impaired students at SMPLB-A YPAB Surabaya in 2024. An analytical observational study with a cross-sectional design was conducted among 30 visually impaired students selected using total sampling. Oral health knowledge was assessed using a 20-item Braille questionnaire covering toothbrushing practices, diet, dental visits, and oral-health consequences, while dental caries was clinically assessed using the Decayed, Missing, and Filled Teeth (DMF-T) index. Data were analyzed using univariate analysis and Spearman's rank correlation test with a significance level of 0.05. Most respondents demonstrated an adequate level of oral health knowledge (56.7%), while the mean DMF-T score was 12.4, indicating a high caries burden. The Spearman analysis showed a statistically significant but weak positive correlation between oral health knowledge and DMF-T score ($r = 0.391$; $p = 0.033$). Thus, although knowledge and caries status were statistically associated, the positive direction of the correlation should not be interpreted as evidence that greater knowledge reduces dental caries. The findings indicate that oral health knowledge is related to dental caries status in this population, but knowledge alone may not explain the high caries burden. Comprehensive preventive strategies incorporating accessible oral-health education, toothbrushing support, dietary guidance, family and teacher involvement, and regular dental care should therefore be considered for visually impaired students.

INDEX TERMS Oral Health Knowledge, Dental Caries, Visual Impairment, DMF-T, Braille Questionnaire.

I. INTRODUCTION

Oral health is an important component of general health and quality of life, while dental caries remains one of the most prevalent oral diseases affecting children and adolescents worldwide [1]–[3]. The burden is particularly relevant among children with disabilities, who may experience additional difficulties in performing routine oral-hygiene practices and obtaining appropriate dental care [4]–[6]. Children with visual impairment face specific challenges because conventional health information and oral-hygiene demonstrations are predominantly visual. Difficulties in identifying plaque accumulation, early dental changes, and the correctness of toothbrushing techniques may limit independent oral-health management [7], [8]. Recent evidence indicates that children and adolescents with visual impairment generally exhibit

poorer oral-health outcomes, including dental caries and inadequate oral hygiene, although the magnitude of the association varies across settings [9], [10]. A systematic review of South Asian studies further reported dental-caries prevalence ranging from 40% to 98.5% among visually impaired children, emphasizing the continuing oral-health burden in this population [11].

Oral-health knowledge is an important component of health literacy because it can influence how individuals understand preventive practices and respond to oral-health risks. Research among adolescents has demonstrated associations between oral-health literacy and dental-caries experience, while family and socioeconomic factors may also shape these outcomes [12], [13]. Evidence from school-based interventions suggests that improving oral-health knowledge

can support healthier oral-hygiene behaviors and prevent deterioration of oral-hygiene status; however, improvements in knowledge or short-term hygiene indicators do not necessarily translate directly into reductions in dental caries [14]. This distinction is important because caries is multifactorial and may also be influenced by diet, toothbrushing behavior, family support, access to dental services, and other environmental determinants [15], [16].

The state of the art for visually impaired children has increasingly emphasized accessible oral-health education through Braille, audio, tactile models, and combinations of these approaches. Systematic reviews have reported beneficial effects of adapted educational approaches on oral-hygiene knowledge and clinical hygiene indicators [17]–[19]. Comparative studies have also examined Braille, nonvisual digital access, and audio-tactile performance, demonstrating that accessible formats can improve knowledge and oral-hygiene outcomes [20], [21]. Nevertheless, recent umbrella-level evidence indicates that the certainty of the evidence remains limited, with substantial overlap among primary studies and insufficient evidence concerning dental-caries outcomes specifically [22]. In addition, much of the available literature evaluates educational interventions rather than directly examining the relationship between measured oral-health knowledge and clinically assessed caries experience in visually impaired students. Evidence from individual schools in Indonesia is also relatively limited. Therefore, a context-specific assessment is needed to clarify whether oral-health knowledge is statistically associated with dental-caries status in this population.

This study aimed to determine the relationship between oral-health knowledge and dental caries among visually impaired students at SMPLB-A YPAB Surabaya in 2024. The study makes three contributions. First, it provides empirical evidence from a visually impaired student population in an Indonesian special-school setting. Second, it combines an accessible Braille-based knowledge assessment with clinical measurement using the DMF-T index. Third, it provides a quantitative basis for designing more comprehensive oral-health promotion strategies that recognize knowledge as one component within a broader network of behavioral, familial, and healthcare-access factors. The remainder of this article presents the research method, results, discussion of the findings in relation to previous evidence, and conclusions and recommendations for practice and future research.

II. METHOD

A. STUDY DESIGN

This study employed an analytical observational design with a cross-sectional approach to examine the association between oral health knowledge and dental caries among visually impaired students. The study was non-experimental because no treatment, educational intervention, or manipulation of the study variables was administered. Data on oral health knowledge and dental caries status were collected during the same study period, allowing the relationship between the variables to be assessed at a single point in time. A cross-sectional design is appropriate for describing health conditions

and examining associations between exposure-related characteristics and health outcomes within a defined population [23]. The study was conducted at SMPLB-A YPAB Surabaya, located on Jl. Gebang Putih No. 5, Sukolilo District, Surabaya, East Java, Indonesia. Data collection was performed in 2024.

B. POPULATION, PARTICIPANTS, AND SAMPLING

The target population comprised visually impaired students enrolled at SMPLB-A YPAB Surabaya. The accessible population consisted of all students with visual impairment who were enrolled at the school during the study period. A total of 30 students participated in the study. Total sampling was applied; therefore, all students who met the predetermined eligibility criteria and were available during data collection were included as respondents. No randomization, allocation into experimental groups, or control group was used because the study was observational and intended to assess the naturally occurring relationship between oral health knowledge and dental caries. The use of a defined school-based population and explicit participant selection is consistent with recommended reporting for cross-sectional observational research [24].

C. STUDY VARIABLES AND OPERATIONAL DEFINITIONS

The independent variable was oral health knowledge, whereas the dependent variable was dental caries status. Oral health knowledge was operationally defined as the respondent's understanding of fundamental oral-health practices, including toothbrushing frequency and technique, toothbrushing duration, toothbrush selection, foods associated with dental health, routine dental examinations, and consequences of inadequate oral hygiene. Knowledge was assessed using a structured Braille questionnaire. The dependent variable, dental caries status, was operationally defined as the cumulative number of decayed, missing due to caries, and filled permanent teeth, expressed as the DMF-T index. DMF-T is an established epidemiological indicator used to describe dental caries experience in permanent dentition [25]. Recent studies involving visually impaired children have likewise used clinical dental examination and DMFT/DMF-T measures to quantify caries experience [26].

D. RESEARCH INSTRUMENTS

Two principal instruments were used. First, oral health knowledge was measured using a 20-item questionnaire presented in Braille. The questionnaire addressed practical aspects of oral-health maintenance, including toothbrushing frequency, appropriate toothbrushing timing and technique, toothbrush characteristics, dietary factors, interdental cleaning, dental visits, and the consequences of inadequate oral hygiene. Each correct response received a score of 1, whereas an incorrect response received a score of 0. The total score was converted into a percentage and categorized as good (76–100%), adequate (56–75%), or insufficient (<56%). The use of Braille-based educational and assessment materials is consistent with previous research indicating that conventional

visually oriented oral-health education may be unsuitable for children with visual impairment [27], while accessible approaches such as Braille, audio, and tactile methods have been investigated as alternative approaches [28].

Second, dental caries was assessed through direct intraoral examination using the DMF-T index. The examination used basic dental diagnostic instruments consisting of a mouth mirror, dental probe, forceps, and adequate illumination. The numbers of decayed (D), missing due to caries (M), and filled (F) permanent teeth were recorded and summed to obtain each participant's DMF-T score. Standardized clinical examination and DMFT assessment have been applied in previous cross-sectional studies of visually impaired children [26].

E. DATA COLLECTION PROCEDURE

Data collection was conducted after permission had been obtained from the school. The study procedures were explained to prospective participants and, where applicable, to their parents or legal guardians. Informed consent was obtained before data collection. Each respondent completed the Braille oral-health knowledge questionnaire independently. When assistance was required because of reading or accessibility difficulties, the researcher provided procedural assistance without explaining, suggesting, or modifying the answer so that the respondent's response remained independent. After completion of the questionnaire, each respondent underwent an intraoral examination to determine dental caries status using the DMF-T index. Questionnaire responses and clinical examination findings were subsequently checked, coded, and entered into the study dataset.

F. DATA MANAGEMENT AND STATISTICAL ANALYSIS

Data were analyzed using univariate and bivariate procedures. Univariate analysis was used to describe participant characteristics, oral health knowledge categories, individual questionnaire responses, and DMF-T findings using frequencies, percentages, and mean values as appropriate. Bivariate analysis was conducted to determine the association between oral health knowledge and dental caries status. Because the analysis involved an ordinal/score-based knowledge variable and a DMF-T measure, Spearman's rank correlation test was used to assess the direction and strength of the association. Spearman's correlation coefficient ranges from -1 to $+1$, with the sign representing the direction and the absolute magnitude representing the strength of the association [29]. Statistical significance was determined using a two-sided significance level of $\alpha = 0.05$. A p-value below 0.05 was interpreted as evidence of a statistically significant association. The statistical analysis was designed to identify association rather than establish a causal relationship, consistent with the cross-sectional nature of the study [23].

G. ETHICAL CONSIDERATIONS

The study was conducted after obtaining institutional permission from SMPLB-A YPAB Surabaya. The study procedures, objectives, and examination processes were explained to the participants and their parents or guardians

before participation. Informed consent was obtained before questionnaire administration and clinical examination. Participant information was treated confidentially and used solely for research purposes. The study documentation included an ethical approval letter in accordance with the research requirements of the institution. No intervention was administered, and participation did not involve randomization or assignment to treatment groups. The methodological approach also considered the specific accessibility requirements of visually impaired participants, particularly through the use of Braille-based assessment materials. Previous systematic reviews have emphasized the importance of adapting oral-health education and assessment procedures to the sensory requirements of visually impaired children [27], [28].

III. RESULTS

The data collection results are presented in tabular form, derived from measurements of dental health knowledge and dental caries rates among 30 visually impaired students at SMPLB-A YPAB Surabaya in 2024.

TABLE 1
Frequency Distribution of Characteristics of Visually Impaired Students at SMPLB-A YPAB Surabaya in 2024

No.	Respondent Characteristics	Frequency	Percentage (%)
1.	Frequency Distribution by Gender		
	Male	19	63.3
	Female	11	36.7
2.	Age Frequency Distribution		
	9–11	7	24
	12–14	10	34
	15–17	10	34
	18–20	3	8
3.	Class Frequency Distribution		
	Elementary	10	33.3
	Junior High School	15	50
	High School	5	16.7

According to the data in [TABLE 1](#), it was found that the majority of respondents were male, totaling 19 students (63.3%); the majority were aged 12–17, totaling 20 students (68%); and the majority had a junior high school education, totaling 15 students (50%).

TABLE 2
Distribution of Respondents' Knowledge Scores in 2024

No	Knowledge Level	Frequency	Percentage (%)
1	Good	13	43.3
2	Fair	17	56.7
3	Insufficient	0	0
	Total	30	100

According to [TABLE 2](#), the results of the questionnaire distribution regarding oral health, which was completed by respondents, show that 17 students (56.7%) fall into the "adequate" category.

According to [TABLE 3](#), respondents with a sufficient level of knowledge about dental health had an average of 75%

correct answers, while 13 respondents (43.3%) had a good level of knowledge.

TABLE 3

Frequency Distribution of Respondents' Questionnaire Answers, 2024

No	Question	Correct Answers		Incorrect Answer	
		n	%	n	%
1	What is the term for damage to the hard tissues of the teeth?	11	36.7	19	63.3
2	What are the signs of tooth decay?	16	53.3	14	46.7
3	What causes cavities?	30	100	0	0
4	What does it feel like to have a cavity?	30	100	0	0
5	What foods cause cavities?	30	100	0	0
6	What foods are good for your teeth?	22	73.3	8	26.7
7	How many times a day do you brush your teeth?	25	83.3	5	16.7
8	When is the best time to brush your teeth?	29	96.7	1	3.3
9	How do you brush your front teeth?	7	23.3	23	76.7
10	Should you also clean your tongue when brushing your teeth?	18	60	12	40
11	What is the treatment for cavities?	30	100	0	0
12	Can eating fruits and vegetables be good for your teeth?	25	83.3	5	16.7
13	What is the ideal shape of toothbrush bristles for brushing your teeth?	30	100	0	0
14	What tools and materials are needed for brushing your teeth?	30	100	0	0
15	What is used to clean between teeth?	15	50	15	50
16	How often do you get a dental checkup at your local health clinic?	21	70	9	30
17	Which fruit has a high water content?	25	83.3	5	16.7
18	What are the benefits of maintaining good oral health?	28	93.3	2	6.7
19	Is it okay to eat sweet foods like chocolate?	17	56.7	13	43.3
20	What happens if you don't brush your teeth regularly and like to eat sweets?	15	50	15	50
Average		454	75.6	146	24.3
Category		Fair			

According to TABLE 4, it was found that the majority of respondents had dental caries (decay) affecting a total of 349

teeth (93.56%) with an average DMF-T of 12.4, which falls into the high category.

TABLE 4

Frequency Distribution of Dental Caries in 2024

DMF-T	Frequency	Percentage (%)
D (Decay)	349	93.56
M (Missing)	4	1.07
F (Filling)	20	5.36
Total	373	100
Average	12.4	
Category	High	

TABLE 5

Analysis of Oral Health Knowledge and Dental Caries Among Students at SMPLB-A YPAB Surabaya in 2024

Research Variables		n	r	p value
Dental health knowledge among visually impaired students at SMPLB-A YPAB Surabaya		30	+ 0.391	0.033
Dental Caries in Visually Impaired Students at SMPLB-A YPAB Surabaya		30		

According to TABLE 5, the results of the Spearman correlation test a p-value (0.033) < α (0.05) with a correlation coefficient (r) of +0.391, H1 is accepted and H0 is rejected. It can therefore be concluded that there is a relationship between knowledge of oral health and dental caries among visually impaired students at SMPLB-A YPAB Surabaya.

Based on the processed data, the correlation coefficient is 0.391. This indicates that the strength of the relationship between knowledge of oral health and the incidence of dental caries among visually impaired students is weak. The coefficient is positive, at +0.391, indicating a positive correlation between the two variables. This suggests that as health knowledge among visually impaired students increases, the DMF-T index for dental caries among visually impaired children improves.

IV. DISCUSSION

A. INTERPRETATION OF ORAL HEALTH KNOWLEDGE AND DENTAL CARIES STATUS

The findings indicate that oral health knowledge among students with visual impairments at SMPLB-A YPAB Surabaya was generally adequate. Of the 30 participants, 17 students (56.7%) were categorized as having adequate knowledge, while 13 students (43.3%) demonstrated good knowledge. No participant was classified as having insufficient knowledge. This distribution suggests that most students had acquired a basic understanding of oral health practices, including toothbrushing frequency and technique, toothbrush selection, dietary considerations, dental visits, and the consequences of inadequate oral hygiene. However, the relatively adequate level of knowledge did not correspond to a low burden of dental caries. The mean DMF-T score was 12.4, which was categorized as high. The DMF-T composition

was predominantly represented by decayed teeth, accounting for 349 teeth (93.56%), whereas missing and filled teeth accounted for only 4 (1.07%) and 20 (5.36%), respectively. The predominance of the decayed component indicates that untreated dental caries constituted the major component of the observed caries experience.

These findings are consistent with recent evidence demonstrating that oral health among young people with visual impairment may remain compromised despite access to oral health information. Křížová et al. reported higher plaque levels among visually impaired youth than among sighted peers and showed that repeated individualized oral hygiene training was associated with gradual improvement in plaque scores [31]. Their findings indicate that maintaining oral hygiene among individuals with visual impairment may require repeated practical instruction rather than information provision alone. Similarly, Kannappan et al. reported a substantial prevalence of dental caries among visually impaired schoolchildren in Chennai, emphasizing the continuing vulnerability of this population to oral disease [32]. The present findings therefore support the broader observation that visual impairment may create practical barriers to translating oral health knowledge into consistent preventive practices.

The adequate level of knowledge observed in the present study may be associated with students' exposure to educational activities within the school environment. Nevertheless, knowledge represents only one component of oral health behavior. Among students with visual impairment, the implementation of knowledge may be affected by accessibility of educational materials, ability to perform toothbrushing correctly, motor skills, parental or teacher supervision, dietary habits, and access to dental services. Chua et al. reported that conventional oral health education approaches may be inappropriate for children and adolescents with visual impairment because many conventional techniques depend heavily on visual demonstration. Their systematic review found insufficient evidence to identify a single educational method as definitively superior, while combination approaches could provide comparable or potentially better outcomes [33]. Maulanti and Nurmala similarly identified Braille, audio, tactile, verbal, and audio-tactile approaches as alternative educational media and reported potential benefits from combining different sensory modalities [34].

This evidence is particularly relevant to the present study because the use of a Braille questionnaire provides an accessible mechanism for assessing knowledge but does not directly measure whether students are able to translate that knowledge into effective daily oral hygiene practices. Recent evidence indicates that adapted oral health education should incorporate sensory modalities that are accessible to visually impaired individuals. Bhor et al. found that newer oral health education approaches could improve short-term plaque and gingival outcomes among visually impaired children, although the available studies were generally limited in their duration [35]. Therefore, the relatively adequate knowledge observed in the present study should be understood as an

important educational outcome but not as a sufficient indicator of effective oral health behavior.

B. INTERPRETATION OF THE ASSOCIATION BETWEEN KNOWLEDGE AND DENTAL CARIES

The Spearman correlation analysis demonstrated a statistically significant association between oral health knowledge and dental caries, with a correlation coefficient of $r = +0.391$ and $p = 0.033$. The magnitude of the coefficient indicates a weak association. Importantly, the positive direction of the coefficient requires careful interpretation. Because a higher DMF-T value represents greater cumulative dental caries experience, the present finding cannot be interpreted as evidence that greater oral health knowledge reduces dental caries. Instead, the result indicates that the two variables were statistically associated in the study population, with a positive direction of association. The finding should therefore be interpreted as an association rather than as evidence of causality.

Several factors may explain why a positive association was observed. First, DMF-T is a cumulative measure of dental caries experience and includes decayed, missing, and filled teeth. Consequently, the current level of oral health knowledge may not correspond directly to the conditions and behaviors that contributed to caries development over previous years. Students may have acquired additional oral health knowledge after experiencing dental problems, receiving health education, or interacting with parents, teachers, or dental professionals. In such circumstances, higher knowledge could coexist with a high cumulative DMF-T score without implying that knowledge caused the disease burden.

Second, the present study did not simultaneously measure several behavioral and environmental determinants of dental caries. Factors such as toothbrushing performance, dietary sugar consumption, fluoride exposure, frequency of dental attendance, parental assistance, and accessibility of dental services may influence caries independently of knowledge. The original study recommendations similarly identify toothbrushing behavior, dietary habits, family support, and utilization of health services as important variables for further investigation.

The present finding should also be considered in relation to recent oral health education research. Deshpande et al. reported that several educational approaches, including Braille and audio-tactile performance, could improve oral hygiene outcomes among visually impaired young individuals [36]. However, such intervention evidence differs conceptually from the present cross-sectional analysis because improvement in oral hygiene following an intervention cannot be equated with a cross-sectional relationship between knowledge and cumulative DMF-T. Similarly, Sardana et al. concluded that combinations of oral health education approaches may improve oral hygiene among people with visual impairment, but evidence concerning their effects on dental caries remained inconclusive [37]. These findings reinforce the importance of distinguishing knowledge outcomes, behavioral outcomes, oral hygiene outcomes, and

cumulative disease outcomes when interpreting oral health research.

The results also highlight a possible gap between knowledge acquisition and behavioral implementation. Although more than half of the participants had adequate knowledge, the high mean DMF-T and particularly the very large decayed component indicate that substantial untreated disease remained. This pattern suggests that oral health promotion in visually impaired students should not rely exclusively on the delivery of information. Instead, educational programs should incorporate repeated skill-based practice, tactile or audio-tactile demonstrations, supervision, reinforcement, and accessible preventive dental services. Kumaraguru et al. reported that audio-tactile performance can improve selected oral hygiene outcomes compared with conventional approaches, although heterogeneity among the included studies requires cautious interpretation [38]. Thus, Braille remains valuable as an accessible communication and assessment medium, but it should preferably be integrated into a broader multimodal oral health strategy.

C. LIMITATIONS, IMPLICATIONS, AND FUTURE RESEARCH

Several limitations should be considered when interpreting the findings. First, the study involved only 30 students from a single special school and used total sampling. Although this approach enabled the researchers to include all available students at the study site, the small single-site sample limits the generalizability of the findings to visually impaired students in other schools or regions. Second, the cross-sectional design measured oral health knowledge and dental caries experience during the same study period. Consequently, temporal relationships cannot be established and causal conclusions cannot be drawn. In particular, the positive correlation should not be interpreted as evidence that higher knowledge causes greater dental caries experience.

Third, the study concentrated on oral health knowledge and DMF-T and did not quantitatively assess several potentially important determinants of caries, including toothbrushing technique, dietary intake, fluoride exposure, parental assistance, frequency of dental attendance, and accessibility of oral health services. Fourth, although the use of a Braille questionnaire increased accessibility for participants with visual impairment, questionnaire performance does not necessarily reflect practical oral hygiene skills. A student may correctly identify recommended practices but experience difficulty applying those practices independently. Fifth, DMF-T describes cumulative caries experience but does not identify the behavioral or environmental mechanisms responsible for the observed disease burden. These limitations should be considered when comparing the present results with intervention studies that evaluate changes in plaque or oral hygiene indices over time.

Despite these limitations, the findings have practical implications for oral health promotion in special education settings. The coexistence of adequate knowledge and a high mean DMF-T of 12.4 indicates that oral health programs should extend beyond information delivery toward accessible,

repeated, and skill-oriented interventions. Schools could implement regular Braille-based oral health education, tactile toothbrushing demonstrations, and routine monitoring by teachers. Parents could reinforce these practices at home through supervision of toothbrushing, support for healthier dietary choices, and encouragement of regular dental visits. Dental professionals should also consider communication strategies and preventive services that accommodate the sensory needs of visually impaired students. Recent evidence supports the use of multimodal and repeated approaches rather than reliance on a single educational medium [31], [33]–[38].

Future research should involve larger samples recruited from multiple special schools to improve external validity. Longitudinal studies are particularly important because they can distinguish newly acquired oral health knowledge from cumulative dental caries experience and determine whether changes in knowledge are followed by changes in oral hygiene behavior and disease outcomes. Future studies should also incorporate variables such as toothbrushing frequency and technique, dietary sugar exposure, fluoride use, family support, dental service utilization, and objective oral hygiene indices. Intervention studies could compare Braille-based education alone with combined Braille, audio, tactile, and audio-tactile performance approaches. Such research would provide stronger evidence regarding how accessible oral health education can be translated into sustained preventive behavior and improved oral health outcomes among students with visual impairment.

V. CONCLUSION

This study aimed to determine the association between oral health knowledge and dental caries among students with visual impairments at SMPLB-A YPAB Surabaya in 2024 using a Braille-based oral health questionnaire and clinical assessment of dental caries. The findings demonstrated that the oral health knowledge of the 30 participants was generally adequate, with 17 students (56.7%) classified in the adequate category and 13 students (43.3%) classified in the good category, while none were categorized as having insufficient knowledge. In contrast, the dental caries experience remained high, with a mean DMF-T score of 12.4. The DMF-T value was predominantly contributed by decayed teeth, with 349 decayed teeth (93.56%), compared with 4 missing teeth (1.07%) and 20 filled teeth (5.36%), indicating that untreated caries represented the largest component of the observed disease burden. The Spearman rank correlation analysis identified a statistically significant association between oral health knowledge and dental caries experience ($r = +0.391$; $p = 0.033$), with a weak correlation. However, because the correlation coefficient was positive and DMF-T represents cumulative caries experience, this result should not be interpreted as evidence that higher oral health knowledge reduces dental caries or that knowledge directly determines caries severity. The cross-sectional design also prevents determination of temporal sequence and causality. The findings suggest that adequate knowledge alone may not be sufficient to produce favorable oral health outcomes among students with visual impairment and that accessible education

should be accompanied by practical skill training, behavioral reinforcement, family support, school-based monitoring, and appropriate preventive dental services. Future research should employ larger and multisite samples and longitudinal or intervention-based designs to examine changes over time. Further studies should also incorporate toothbrushing behavior, dietary habits, fluoride exposure, family support, dental service utilization, and objective oral hygiene measures to identify factors that may explain the high caries burden and to determine how Braille, audio, tactile, and audio-tactile approaches can be integrated into effective and sustainable oral health promotion programs for visually impaired students.

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DATA AVAILABILITY

The data supporting the findings of this study are available from the corresponding author upon reasonable request, subject to applicable ethical and institutional restrictions.

AUTHOR CONTRIBUTION

Andini Kumala Anggraini contributed to the conceptualization, study design, data collection, data analysis, and preparation of the original manuscript. Ratih Larasati contributed to the study methodology, supervision, interpretation of the findings, and critical revision of the manuscript. Sri Hidayati contributed to supervision, methodological review, interpretation of the results, and critical revision of the manuscript. All authors reviewed and approved the final version of the manuscript and agreed to be accountable for all aspects of the work.

DECLARATIONS

ETHICAL APPROVAL

The study was conducted after obtaining permission from the study setting and ethical approval in accordance with the applicable research ethics requirements. The specific ethical approval number and issuing institution should be added if required by the target journal.

CONSENT FOR PUBLICATION PARTICIPANTS

Informed consent was obtained from the participants and, where applicable, from their parents or legal guardians before data collection. The participants were informed about the study procedures and their participation rights.

COMPETING INTERESTS

The authors declare that they have no competing interests that could have influenced the conduct, analysis, or reporting of this study.

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