

Effective Use of Flipchart Media in Enhancing Oral and Dental Hygiene Knowledge Among Hearing-Impaired Children

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ABSTRACT

Deaf children often face substantial communication barriers that limit their access to essential oral-hygiene information, contributing to inadequate oral-health practices and poor clinical indicators, including an average debris index of 1.9, categorized as poor. Visual educational media such as flipcharts; featuring simple images, colors, and concise text offer a promising strategy to bridge communication gaps and enhance comprehension among children with hearing impairments. This study aimed to evaluate changes in oral-hygiene knowledge before and after the use of flipchart-based education at SLB-B Dharma Wanita Sidoarjo. A pre-experimental one-group pretest-posttest design was employed, involving 30 purposively selected respondents. Oral-hygiene knowledge was measured using a validated questionnaire administered prior to and following the educational intervention. Data were analyzed using the Wilcoxon Signed-Rank Test to determine differences in knowledge scores. The results demonstrated a statistically significant improvement in oral-hygiene knowledge after the intervention, with a p-value of 0.000 ($p < 0.05$). The findings indicate that flipchart media effectively support deaf children's understanding of oral-hygiene concepts by presenting information in a visual, engaging, and easily accessible format. In conclusion, flipchart-based education positively influences dental and oral-hygiene knowledge among deaf children at SLB-B Dharma Wanita Sidoarjo, underscoring the value of visual learning tools in special-needs education.

Keywords: flipchart; oral hygiene; knowledge; deafness

INTRODUCTION

Children with special needs require tailored and sustained attention due to the developmental limitations or functional impairments they experience [1-5]. These limitations may manifest across cognitive, sensory, motor, emotional, or social domains, shaping how children perceive their surroundings, interact with others, and acquire essential life skills necessary for daily functioning. One such condition is hearing impairment, a sensory deficit that restricts auditory perception and consequently limits verbal communication [6-10]. This impairment substantially reduces the child's ability to receive, process, interpret, and respond to spoken information, making everyday communication, classroom learning, and health-related instruction considerably more challenging [11]. The absence or reduction of auditory input not only affects linguistic development but also influences broader cognitive processes, including attention, memory, and conceptual understanding.

Because hearing-impaired children rely predominantly on visual cues rather than spoken language, they often face substantial obstacles in accessing health information, particularly information traditionally delivered through verbal explanation. This includes essential knowledge related to oral and dental hygiene, which is commonly taught through spoken instructions, demonstrations accompanied by verbal cues, or auditory reminders. The communication barrier inherent in hearing impairment can negatively influence their health behaviors, especially those requiring comprehension of sequential verbal instructions or detailed demonstrations, such as proper tooth-brushing techniques, plaque control strategies, and routine oral-care practices [12]. Without accessible and appropriately adapted educational materials, hearing-impaired children may struggle to understand the rationale behind oral-hygiene practices, the correct methods for performing them, and the long-term consequences of inadequate oral care.

Furthermore, the reliance on visual learning places hearing-impaired children at a disadvantage when health information is not presented in formats that align with their perceptual strengths. Conventional health education often assumes intact auditory processing, thereby unintentionally excluding children with hearing impairments from fully benefiting from such instruction. As a result, gaps in oral-health knowledge may persist, contributing to suboptimal hygiene behaviors and increasing the risk of dental caries, gingivitis, and other preventable oral-health conditions. These challenges highlight the critical need for educational approaches that are not only inclusive but also specifically designed to accommodate the unique communication needs of hearing-impaired learners.

The oral-health status of children in Indonesia reflects broader national challenges. According to the Ministry of Health of the Republic of Indonesia, the national average Oral Hygiene Index-Simplified (OHI-S) score is 1.46, which remains above the national target of ≤ 1.2 for the "good" oral hygiene category [13]. This indicates that, at the population level, oral hygiene practices are still suboptimal. Oral and dental health problems continue to be prevalent among school-aged children, a developmental period that is crucial for establishing foundational knowledge, habits, and motor skills related to personal hygiene [4]. Evidence consistently shows that the oral hygiene status of hearing-impaired schoolchildren is poorer than that of children with normal hearing. This disparity is attributed to both physical and cognitive limitations that hinder independent tooth-brushing and reduce the child's ability to understand and follow oral-health instructions [14]. Poor oral hygiene contributes to the accumulation of debris and calculus, which in turn increases the risk of gingivitis and periodontal disease. These conditions are characterized by swollen and easily bleeding gums, halitosis, discomfort during chewing, and, in advanced cases, tooth mobility or tooth loss [15]. Such oral-health problems can further affect children's nutritional intake, self-esteem, social interaction, and overall quality of life.

Multiple interrelated factors contribute to inadequate oral hygiene among hearing-impaired children. Sensory limitations impede comprehension of verbal instructions, while insufficient parental supervision, limited oral-health literacy within families, and restricted access to dental services for children with special needs further exacerbate the problem. Among these factors, lack of knowledge regarding oral hygiene stands out as a critical determinant. Hearing-impaired children often struggle to absorb conventional health information delivered verbally, which increases debris accumulation and elevates the risk of dental caries and periodontal disease [16]. Therefore, oral-health education for hearing-impaired children requires an inclusive, adaptive approach capable of overcoming communication barriers and enhancing understanding of basic concepts, such as proper tooth-brushing techniques, the importance of maintaining oral cleanliness, and the consequences of poor oral hygiene. Because hearing-impaired children tend to learn more effectively through demonstration, visual cues, and concrete representations rather than verbal explanations, educational tools that emphasize visual communication are particularly suitable for this population [14].

Previous studies have demonstrated that visual media; such as comics, illustrated booklets, posters, and videos can significantly improve oral-hygiene knowledge among hearing-impaired children [17]. Flipcharts, a simple and inexpensive printed visual aid consisting of sequential sheets that combine images, colors, and concise text, have also been reported as effective tools in oral-health education. Flipcharts present information in a structured, engaging, and easily digestible format, making them highly appropriate for learners who depend on visual cues [18]. Their portability, clarity, and adaptability allow educators to deliver step-by-step demonstrations, reinforce key messages, and maintain children's attention more effectively than verbal instruction alone.

A preliminary assessment of debris index scores among 15 hearing-impaired students at SLB-B Dharma Wanita Sidoarjo revealed an average debris index of 1.9, categorized as poor; 60% of students fell into the poor category, 33% into the moderate category, and only 7% into the good category [19]. These findings indicate that oral hygiene among hearing-impaired students at the school is substantially below recommended standards. The school also reported that the School Dental Health Program (*Usaha Kesehatan Gigi Sekolah*, UKGS) had not been functioning effectively due to limited information dissemination and the absence of dental-health personnel responsible for implementing the program. This gap in structured oral-health education further underscores the need for accessible, visually oriented educational interventions.

Given the substantial impact of poor oral hygiene on the well-being of children with special needs, and considering the potential of flipchart media as an accessible, visually oriented educational tool, this study was conducted to examine the effect of flipchart-based education on oral-hygiene knowledge among hearing-impaired children at SLB-B Dharma Wanita Sidoarjo. The findings are expected to contribute to the development of more inclusive oral-health education strategies, support efforts to improve dental-hygiene outcomes in this vulnerable population, and inform future school-based oral-health programs tailored to children with sensory impairments.

METHODS

This study employed a pre-experimental research design using a one-group pretest–posttest model, in which the same group of respondents was assessed before and after the intervention without the inclusion of a comparison or control group. This design was selected to evaluate changes in the dependent variable following exposure to the intervention within a single population, allowing researchers to observe the direct effect of the educational treatment on participants' knowledge levels [20-22].

Ethical approval for this study was obtained from the Health Research Ethics Committee of Poltekkes Kemenkes Surabaya. Additional permission was secured from the school administration prior to data collection. All respondents were informed about the study objectives, procedures, potential benefits, and their right to withdraw at any time without penalty. Written informed consent was obtained from participants and their guardians. Data collection was assisted by three trained enumerators who received standardized instruction to ensure consistent delivery of the educational intervention and adherence to ethical and methodological protocols.

Study setting and timeline

The research was conducted at SLB-B Dharma Wanita Sidoarjo, a specialized educational institution in East Java, Indonesia, dedicated to serving children with hearing impairments through adapted curricula and communication-support strategies. The study unfolded across several structured phases to ensure systematic preparation, controlled implementation of the intervention, and rigorous post-intervention evaluation. Initial coordination, administrative approval, and baseline data collection were carried out between August and September 2025, during which researchers established rapport with school personnel, finalized respondent eligibility, and prepared research instruments. The educational intervention was subsequently delivered during January and February 2026, allowing sufficient time for repeated instructional sessions and reinforcement of learning materials. Following the intervention period, data processing, statistical analysis, and manuscript development were conducted from March to April 2026. This extended and carefully sequenced timeline ensured adequate logistical preparation, consistency in intervention delivery, and a meaningful interval for assessing changes in participants' knowledge after exposure to the flipchart-based educational program.

Study design, subjects, and recruitment procedures

The study population consisted of all hearing-impaired students enrolled at SLB-B Dharma Wanita Sidoarjo, totaling 72 individuals. A sample of 30 respondents was selected using purposive sampling, a non-probability technique that allows researchers to recruit participants who meet specific inclusion criteria relevant to the research objectives [23-26]. The inclusion criteria were: (1) hearing-impaired students aged 15–20 years, (2) willingness to participate, (3) mild to moderate hearing impairment, (4) absence of additional disabilities, (5) not using hearing aids, and (6) ability to read and understand simple written text consistent with the flipchart content. Exclusion criteria included: absence during data collection, refusal to participate, use of hearing aids, or severe hearing impairment that prevented comprehension of visual educational materials. A sample size of 30 was considered adequate for detecting pretest–posttest differences in a pre-experimental design using non-probability sampling [23].

Independent variable: Flipchart-based oral health education

The independent variable in this study was oral-health education delivered using flipchart media. The flipchart consisted of sequential visual panels combining images, colors, and short text explanations designed to facilitate comprehension among hearing-impaired learners. The educational content covered essential oral-health topics, including the recommended frequency and timing of tooth-brushing, foods beneficial and harmful to dental health, correct tooth-brushing techniques, and the importance of routine dental check-ups every six months. The intervention was delivered in small groups of five students to optimize interaction and ensure individualized attention. Communication during the sessions incorporated body language, lip-reading cues, and Indonesian Sign Language (SIBI), accompanied by demonstrations using a dental model (phantom). The educational session was conducted twice: once on the same day as the pretest and repeated on the eighth day to reinforce learning.

On the first day of data collection, respondents completed the pretest to assess baseline knowledge. Immediately afterward, the flipchart-based oral-health education was delivered in small groups. The session included visual explanations, sign-language interpretation, and hands-on demonstrations of tooth-brushing techniques. The same educational session was repeated on the eighth day to strengthen retention and comprehension. The posttest was administered on the fifteenth day, three days after the second educational session, allowing respondents sufficient time to internalize, practice, and consolidate the newly acquired knowledge before reassessment.

Dependent variable: Oral-hygiene knowledge and measurement procedures

The dependent variable was the oral-hygiene knowledge of hearing-impaired students. Knowledge was measured using a validated questionnaire administered during the pretest and posttest phases. The questionnaire consisted of multiple items assessing conceptual understanding and practical knowledge related to oral hygiene. Responses were scored on an ordinal scale and categorized into three levels: good ($\geq 76\%$ correct answers), moderate (56–75% correct answers), and poor ($\leq 55\%$ correct answers) [4]. All questionnaire items had previously undergone validity and reliability testing, with item-total correlation values exceeding the critical r-table threshold, confirming their suitability for use in this study.

Data processing and statistical analysis

Data processing involved several stages: editing to check completeness and accuracy, coding to categorize responses, data entry into the Statistical Package for the Social Sciences (SPSS), and data cleaning to ensure consistency and remove errors. Descriptive statistics were used to summarize respondent characteristics and knowledge categories, in the form of frequency and percentage [27–29]. Because the dependent variable was measured on an ordinal scale and the data did not meet parametric assumptions, the Wilcoxon Signed-Rank Test, a non-parametric statistical test was employed to compare pretest and posttest scores. A p-value of <0.05 was considered statistically significant, indicating that the intervention produced a meaningful change in oral-hygiene knowledge [31].

RESULTS

The study was conducted at SLB-B Dharma Wanita Sidoarjo, involving a total of 30 hearing-impaired students as research respondents. All participants took part in a structured sequence of research activities designed to measure changes in oral-hygiene knowledge following the educational intervention. The sequence consisted of an initial assessment of baseline knowledge (pretest), the delivery of an oral-health education session using flipchart media, and a subsequent reassessment of knowledge (posttest) after the intervention period. Each respondent completed all stages of the study, ensuring consistency in exposure to the educational content and comparability of pretest and posttest scores.

During the pretest phase, students were asked to answer a validated knowledge questionnaire that assessed their understanding of essential oral-hygiene concepts, including brushing frequency, appropriate brushing techniques, dietary factors affecting dental health, and the importance of routine dental check-ups. Following this baseline measurement, the educational intervention was administered using flipchart media specifically designed to accommodate the visual learning preferences of hearing-impaired children. The flipchart presented information through sequential images, color-coded cues, and concise text, supported by sign-language interpretation and demonstrations using a dental model. After the intervention, students completed the posttest to evaluate the extent to which their knowledge had improved.

The data obtained from both pretest and posttest assessments were subsequently analyzed to determine changes in oral-hygiene knowledge before and after the educational intervention. This analytical process enabled the researchers to identify whether flipchart-based education produced measurable improvements in students' understanding of oral-health practices and to assess the effectiveness of visual learning tools for hearing-impaired learners.

Respondent characteristics

The characteristics of respondents in this study encompassed sex, age, and degree of hearing impairment, providing a comprehensive demographic profile of the sample. Of the 30 participating students, 18 (60%) were male and 12 (40%) were female, indicating a slightly higher proportion of male respondents within the study population. This distribution suggests that male students constituted the dominant group in the school's hearing-impaired cohort during the period of data collection, a pattern that may reflect broader enrollment trends or demographic characteristics within the institution.

In terms of age distribution, respondents ranged from 15 to 20 years old, representing a wide span of late-adolescent developmental stages. The largest age group was 19 years, comprising 8 students (27%), followed by those aged 15 years (23%), 18 years (20%), and 20 years (13%). Smaller proportions were observed among students aged 16 years (10%) and 17 years (7%).

This variation reflects a broad representation of late-adolescent students within the school's hearing-impaired population, capturing individuals at different cognitive, emotional, and social maturity levels. Such diversity is relevant because age may influence the ability to comprehend educational materials, internalize health information, and apply oral-hygiene practices independently. The demographic spread therefore illustrates a heterogeneous respondent group, both in terms of sex and age composition, offering a meaningful foundation for interpreting the effectiveness of the flipchart-based oral-health education delivered in this study.

Regarding the degree of hearing impairment, 17 respondents (57%) were categorized as having mild hearing impairment, while 13 respondents (43%) were classified as having moderate impairment. This distribution suggests that the majority of students possessed sufficient residual hearing and visual literacy to engage effectively with visual educational materials such as flipcharts.

Overall, the demographic profile demonstrates a diverse group of respondents, particularly in terms of age distribution and severity of hearing impairment. This diversity provides a meaningful contextual foundation for interpreting the outcomes of the flipchart-based oral-health education. The predominance of students with mild hearing impairment suggests that most respondents possessed sufficient residual hearing and visual literacy to engage effectively with visually oriented educational materials. Meanwhile, the concentration of participants within the late-adolescent age range indicates that the intervention was delivered to individuals who are undergoing important cognitive, social, and behavioral transitions—an age period in which health-related knowledge and habits begin to consolidate more firmly.

These demographic characteristics offer an essential overview of the population that received the visual-based dental and oral-hygiene intervention. They help clarify why the educational approach used in this study was particularly relevant and appropriate: adolescents with mild to moderate hearing impairment are likely to benefit substantially from structured, visually rich learning tools that compensate for limited auditory

Table 1. Distribution of respondents based on demographic characteristics at SLB-B Dharma Wanita Sidoarjo, 2026

Demographic characteristics	Category	Frequency	Percentage
Sex	Male	18	60
	Female	12	40
Age (years)	15	7	23
	16	3	10
	17	2	7
	18	6	20
	19	8	27
	20	4	13
Degree of hearing impairment	Mild	17	57
	Moderate	13	43

input. Moreover, understanding the demographic composition of the sample allows for more accurate interpretation of the intervention's effectiveness and supports the rationale for employing visual media such as flipcharts in oral-health promotion programs targeting hearing-impaired learners.

Oral-hygiene knowledge before and after the use of flipchart media

Based on Table 2, the initial measurement was conducted to determine the respondents' baseline level of oral-hygiene knowledge prior to receiving the flipchart-based educational intervention. The pretest results indicate that the majority of respondents demonstrated limited understanding of basic oral-health concepts. A total of 24 students (80%) fell into the "poor" knowledge category, while 6 students (20%) were classified as having "moderate" knowledge. Notably, none of the respondents achieved a "good" knowledge score during the pretest phase. These findings illustrate that the initial level of oral-hygiene knowledge among hearing-impaired students was generally low and unevenly distributed, underscoring the need for an educational approach that aligns with their communication characteristics and learning preferences.

The posttest assessment was administered after respondents had participated in the flipchart-based oral-health education sessions. The results reveal a substantial shift in the distribution of knowledge categories compared with the pretest findings. Following the intervention, 25 respondents (84%) achieved a "good" knowledge score, indicating a marked improvement in their understanding of oral-hygiene practices. Four respondents (13%) were categorized as having "moderate" knowledge, while only one respondent (3%) remained in the "poor" category. This transformation demonstrates a clear upward shift in knowledge levels, with the majority of students progressing from poor or moderate understanding to good comprehension after the educational intervention.

Importantly, the pretest results showed no respondents in the "good" category, whereas the posttest results indicate that most respondents reached this level after receiving the flipchart-based education. This dramatic improvement highlights the effectiveness of visual, structured, and communication-adapted educational media in enhancing oral-health knowledge among hearing-impaired learners. The findings suggest that flipcharts, when combined with sign-language support and demonstration techniques, can significantly improve comprehension and retention of oral-hygiene information in populations with sensory communication barriers.

Table 2. Distribution of oral-hygiene knowledge before and after flipchart-based education among hearing-impaired students at SLB-B Dharma Wanita Sidoarjo

Knowledge	Pretest		Posttest	
	Frequency	Percentage	Frequency	Percentage
Good	0	0	25	84
Moderate	6	20	4	13
Poor	24	80	1	3

Statistical analysis

Based on Table 3, changes in oral-hygiene knowledge were analyzed by comparing the pretest and posttest scores obtained before and after the educational intervention. The median pretest score was 40, with a minimum score of 13 and a maximum score of 73, indicating that most respondents initially demonstrated limited understanding of essential oral-hygiene concepts. This relatively low baseline reflects the communication barriers commonly experienced by hearing-impaired students, which may hinder their ability to access and internalize conventional health information.

Table 3. Results of the Wilcoxon Signed-Rank Test for oral-hygiene knowledge before and after flipchart-based education among hearing-impaired students at SLB-B Dharma Wanita Sidoarjo

Knowledge score	n	Median (minimum–maximum)	p-value
Before education	30	40 (13–73)	0.000
After education	30	96 (52–100)	

Following the flipchart-based educational intervention, the median posttest score increased substantially to 96, with a score range of 52–100. This marked improvement demonstrates that respondents not only acquired new knowledge but also retained and applied the information presented during the educational sessions. The shift in score distribution; from a predominantly low range to a substantially higher one illustrates the effectiveness of visual, structured, and communication-adapted educational media in enhancing oral-health literacy among hearing-impaired learners.

To determine whether the observed differences between pretest and posttest scores were statistically significant, the Wilcoxon Signed-Rank Test was employed. This non-parametric test was selected because the knowledge scores were ordinal and derived from paired measurements of the same respondents. The analysis yielded a p-value of 0.000 ($p < 0.05$), indicating a statistically significant difference between pre-intervention and post-intervention knowledge levels. In other words, the improvement in oral-hygiene knowledge following the flipchart-based education was not due to chance but represented a meaningful and measurable effect of the intervention.

Overall, the findings demonstrate that the use of flipchart media produced a clear and substantial enhancement in oral-hygiene knowledge among hearing-impaired students. This conclusion is supported by multiple indicators: the upward shift in knowledge categories from predominantly "poor" to predominantly "good," the marked increase in median scores between pretest and posttest assessments, and the statistical confirmation of a significant difference in knowledge levels following the intervention. Together, these results provide robust evidence that the flipchart-based educational approach was effective in facilitating cognitive gains among learners who rely heavily on visual communication.

Collectively, these outcomes affirm the value of visually oriented educational tools in overcoming communication barriers and improving health knowledge in populations with sensory impairments. The consistent improvement observed across descriptive and inferential measures underscores the importance of adapting health-education strategies to the perceptual strengths of hearing-impaired children. The findings also highlight the broader potential of structured visual media; such as flipcharts to serve as accessible, engaging, and pedagogically appropriate instruments for promoting oral-health literacy in special-needs educational settings.

DISCUSSION

Oral-hygiene knowledge before the use of flipchart media

Before the educational intervention was administered, the majority of respondents demonstrated oral-hygiene knowledge within the "poor" category, indicating that their understanding of fundamental concepts related to dental and oral health was far from optimal. This initial condition suggests that students had not fully grasped the importance of maintaining oral hygiene, nor had they previously received health information that was appropriately adapted to their communication needs and learning characteristics as hearing-impaired individuals. The limited baseline knowledge reflects a broader challenge faced by children with hearing impairments, who often experience restricted access to conventional health education due to communication barriers.

This finding aligns with the inherent communication limitations associated with hearing impairment, which significantly restrict the ability of hearing-impaired children to comprehend information delivered verbally [12]. Item-level analysis of the questionnaire revealed that the lowest scores were observed in questions related to correct tooth-brushing techniques and recommended dental-check-up schedules. These results indicate that most respondents brushed their teeth merely as a habitual daily activity without understanding the proper technique, brushing direction, duration, or optimal timing. In contrast, respondents performed relatively better on items related to foods beneficial for dental health, likely because such information is more frequently encountered in daily life and reinforced by parents or teachers.

These findings are consistent with previous studies reporting that children with communication and language limitations tend to experience slower intellectual and academic development compared with their peers [32]. Furthermore, children with special needs generally exhibit poorer oral-health status than children without disabilities [33]. Additional research has shown that hearing-impaired children often possess low levels of oral-hygiene knowledge due to difficulties in receiving, processing, and interpreting information [16].

According to Green's health-behavior framework, as cited by Notoatmodjo, health behavior is influenced by predisposing factors (knowledge), enabling factors (facilities), and reinforcing factors (support from health workers and the surrounding environment). Among hearing-impaired children, limited access to information serves as a dominant predisposing factor contributing to low oral-hygiene knowledge [34]. Knowledge is shaped by education, environment, and experience; because hearing-impaired children receive relatively less information through conventional auditory channels, their knowledge tends to develop more slowly than that of children with normal hearing. Consequently, learning methods must be adapted to their communication style, emphasizing visual cues and simplified explanations [35].

Taken together, these findings demonstrate that the respondents' low initial knowledge was largely attributable to restricted access to comprehensible information. This reinforces the rationale for using visually oriented educational media such as flipcharts, which present material through images, colors, and simple text formats that are more easily understood, processed, and remembered by hearing-impaired learners.

Oral-hygiene knowledge after the use of flipchart media

Following the flipchart-based educational intervention, the majority of respondents exhibited substantial improvements in oral-hygiene knowledge, with most shifting into the "good" category. Item-level analysis revealed that respondents were able to correctly answer questions related to beneficial foods, recommended brushing frequency and timing, and dental-check-up schedules. These results indicate that the information was effectively received and retained when delivered through visually engaging media. Respondents also demonstrated improved understanding of correct tooth-brushing techniques, suggesting that the flipchart content was successfully absorbed and translated into cognitive comprehension.

Although overall knowledge improved markedly, some variation remained in respondents' understanding of certain daily oral-hygiene habits. This suggests that repeated exposure to simplified information may further enhance uniform comprehension across the group. The findings support previous research demonstrating that visual media improve hearing-impaired children's understanding of oral-hygiene maintenance [17], and that illustrated media produce measurable increases in knowledge following intervention [36]. Because hearing-impaired children rely heavily on visual perception to acquire information, media that combine images with concise explanations help them more easily relate the material to real-life situations [17].

These results are consistent with the notion that knowledge is primarily acquired through sensory pathways, particularly vision. Thus, visual media such as flipcharts make information more accessible, comprehensible, and memorable especially for children with hearing impairments [34]. The marked improvement in post-intervention scores underscores the effectiveness of visual learning tools in overcoming communication barriers and enhancing health literacy among hearing-impaired students.

Analysis of the effect of flipchart media on oral-hygiene knowledge

Statistical analysis demonstrated a significant increase in oral-hygiene knowledge following the use of flipchart media, with most respondents transitioning from the "poor" category before the intervention to the "good" category afterward. These findings are consistent with earlier studies reporting that visual media enhance oral-hygiene knowledge among hearing-impaired children because information presented through images, colors, and visually appealing layouts is more easily received, processed, and remembered [37].

Flipchart media consist of sequential sheets arranged like an album or calendar, presenting learning material gradually and systematically, an approach well suited for children with limited verbal comprehension [38]. Several characteristics of flipchart media likely contributed to their effectiveness in this study: (1) concise and practical information delivery that helps students grasp essential concepts; (2) the use of images, colors, and simple diagrams that enhance engagement and memory retention; and (3) flexibility in adapting the media to different group sizes and levels of interaction [39]. Because hearing-impaired children benefit from visual aids to support comprehension [17], the flipchart intervention was well received and effectively understood by respondents. This aligns with the view that hearing-impaired children possess normal intellectual capacity but may experience academic delays due to communication barriers rather than cognitive limitations.

The results also correspond with previous studies indicating that flipchart-based health education effectively improves children's knowledge before and after intervention [40]. These findings strengthen recommendations for broader implementation of flipchart media in oral-health education programs for hearing-impaired children.

The observed increase in knowledge can be explained through the Stimulus-Organism-Response (S-O-R) framework, in which a specific stimulus elicits a response from the individual receiving it. In this study, the stimulus was the oral-health educational content delivered through flipchart media; the organism was the hearing-impaired students who processed the information visually; and the response was the measurable increase in knowledge following the intervention. This pattern indicates that the visual stimulus provided through the flipchart was effectively received and cognitively processed by respondents, resulting in improved knowledge. This aligns with the principle that appropriately designed health-education stimuli can influence an individual's knowledge and behavior [34].

Study limitations

This study has several limitations that should be acknowledged to provide a balanced interpretation of the findings. First, the researchers did not fully master sign language, which occasionally restricted the depth and fluidity of direct communication with respondents, particularly during question-and-answer sessions and clarification of questionnaire items. Although this challenge was mitigated through translation assistance from school staff and the support of trained enumerators who ensured consistent delivery of educational material, the absence of full sign-language proficiency may have influenced the precision of message transmission and the degree of respondent engagement. Future studies would benefit

from involving researchers or educators with advanced sign-language competence to enhance communication accuracy and minimize potential misunderstandings during both instruction and assessment.

Second, the study employed a pre-experimental one-group pretest–posttest design without a control group. While this design is useful for detecting changes within the same population, it limits the ability to attribute improvements solely to the intervention, as external factors; such as informal discussions among students, parental reminders, or exposure to other health messages may also have contributed to the observed changes. The absence of randomization further restricts internal validity, and future research should consider quasi-experimental or randomized controlled designs to strengthen causal inference.

Third, the sample size was relatively small ($n = 30$) and selected using purposive sampling. Although appropriate for preliminary studies involving special-needs populations, the non-probability sampling technique limits generalizability. The findings may not fully represent all hearing-impaired children in other schools, regions, or age groups, particularly those with different degrees of hearing impairment or varying literacy levels. Larger and more diverse samples would improve external validity and allow subgroup analyses based on age, severity of impairment, or prior exposure to oral-health education.

Fourth, the measurement of oral-hygiene knowledge relied on a self-administered questionnaire. Despite prior validity and reliability testing, self-report instruments are inherently susceptible to response bias, including guessing, social desirability, or misinterpretation of items. Some respondents may have selected answers they perceived as correct without fully understanding the underlying concepts. Additionally, the questionnaire assessed knowledge rather than actual behavior; therefore, improvements in knowledge may not necessarily translate into sustained changes in oral-hygiene practices. Future studies should incorporate observational assessments or clinical indicators such as plaque index or debris index to evaluate behavioral and clinical outcomes.

Fifth, the intervention was delivered over a relatively short period, with reinforcement occurring only once. Although the posttest results showed substantial improvement, the study did not assess long-term retention of knowledge. Without follow-up measurements, it remains unclear whether the gains observed immediately after the intervention would persist over weeks or months. Longitudinal studies with multiple follow-up assessments are needed to determine the durability of learning and the potential need for periodic reinforcement.

Sixth, the educational content was delivered in small groups, and although efforts were made to standardize the sessions, variations in group dynamics, student attention, and interaction levels may have influenced learning outcomes. Some students may have benefited more from peer interaction or closer proximity to visual materials, while others may have required additional individualized support. Future interventions could explore one-on-one instruction or digital visual media that allow self-paced learning.

Finally, the study was conducted in a single institution with specific environmental, cultural, and administrative characteristics. The effectiveness of flipchart media may vary across schools depending on teacher involvement, availability of supporting materials, and institutional commitment to oral-health programs. Replication in multiple settings would help determine whether the intervention is broadly applicable across diverse educational environments for hearing-impaired children.

CONCLUSION

Before receiving the flipchart-based educational intervention, most hearing-impaired students at SLB-B Dharma Wanita Sidoarjo demonstrated oral-hygiene knowledge in the “poor” category, indicating limited understanding of basic dental-health concepts. After the intervention, the majority of respondents showed substantial improvement, with their knowledge shifting into the “good” category. These results confirm that flipchart media had a significant positive effect on increasing oral-hygiene knowledge among hearing-impaired students.

The findings support the use of flipcharts as a practical, low-cost, and visually oriented educational tool that aligns well with the learning needs of children with hearing impairments. Schools and health institutions are encouraged to incorporate flipchart-based materials into continuous oral-health education programs, particularly for students who rely heavily on visual communication.

Future studies should consider including a control group, extending the duration of educational exposure, involving respondents with more diverse characteristics, and examining changes in attitudes and behaviors in addition to knowledge, to provide a more comprehensive understanding of the intervention's long-term impact.

Ethical consideration, competing interest and source of funding

-This study adhered to established ethical principles for research involving human participants. Prior to data collection, ethical approval was obtained from the Health Research Ethics Committee of Poltekkes Kemenkes Surabaya under approval number EA/4341/KEPK-Poltekkes_Sby/V/2026. All components of the study; including the delivery of flipchart-based oral-health education, completion of the oral-hygiene knowledge questionnaire, and assessment of debris index were conducted in accordance with approved research procedures. Before participation, respondents and/or their parents or legal guardians received clear explanations regarding the study's objectives, procedures, and the expected involvement of respondents. Informed consent was obtained voluntarily. Confidentiality of respondent identity and data was maintained throughout data collection, processing, analysis, and reporting, ensuring that no personal information was disclosed in any part of the research output.

-The authors declare that no conflicts of interest were present in the conduct or publication of this study. No aspects of study design, implementation, analysis, interpretation, or reporting were influenced by external interests.

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