International Journal of Advanced Health Science and Technology
Homepage: ijahst.org
e-ISSN:2808-6422; p-ISSN:2829-3037
Vol. 5 No.3, pp. 104-108, June 2025

RESEARCH ARTICLE
OPEN ACCESS

Manuscript received May 14, 2023; revised June 21, 2023; accepted July 21, 2023; date of publication August 30, 2023
Digital Object Identifier (**DOI**): https://doi.org/10.35882/ijahst.v3i4.279

How to cite: Farha Ariba Imandini, Khambali, Ngadino, Rachmaniyah, Teguh Mubawadi, "Safeguarding Surrounding Communities: Comprehensive Risk Assessment of H2S and NH3 Exposure near Benowo Landfill, Surabaya, Indonesia", International Journal of Advanced Health Science and Technology, vol. 3, no. 4, pp. 235-240, August. 2023

Safeguarding Surrounding Communities: Comprehensive Risk Assessment of H_2S and NH^3 Exposure near Benowo Landfill, Surabaya, Indonesia

Farha Ariba Imandini[1], Khambali[1], Ngadino[1], Rachmaniyah[1], Teguh Mubawadi[2]

[1] Department of Environment Health, Poltekkes Kemenkes Surabaya
[2] Department Center for Environmental Health Engineering and Disease Control Surabaya

Corresponding author: Khambali (e-mail: khambali2014@gmail.com)

ABSTRACT Indonesia's waste management system continues to rely heavily on landfilling, which poses environmental and public health challenges due to the emission of hazardous gases such as hydrogen sulfide (H_2S) and ammonia (NH_3). The Benowo landfill in Surabaya operates under a landfill-based system that is known to release these gases during waste decomposition. The primary aim of this study is to assess the potential health risks associated with H_2S and NH_3 exposure among residents living in close proximity to the landfill area. This research adopted a quantitative descriptive approach using a cross-sectional design. A total of 93 housewives residing in the Pondok Benowo Indah settlement, located within 1.15–1.22 km of the landfill, were selected through simple random sampling. Gas concentrations of H_2S and NH_3 were measured at two points, alongside environmental parameters such as temperature, humidity, wind speed, and wind direction. Risk assessment was conducted using Environmental Health Risk Analysis (EHRA) based on intake values and reference dose (RfC) to calculate the Risk Quotient (RQ). The highest concentration of H_2S recorded was 0.0376 mg/m³, and NH_3 was 0.004 mg/m³—both below the regulatory limits established by East Java Governor Regulation No. 10 of 2009. However, RQ values for H_2S were greater than 1 (ranging from 1.4 to 6.4), indicating a potential non-carcinogenic health risk, while RQ values for NH_3 were ≤1, signifying minimal risk. In conclusion, even though pollutant levels remain within acceptable standards, chronic exposure to H_2S may pose a health hazard. Therefore, strategic interventions including air quality monitoring, educational outreach, and risk mitigation—such as vegetation buffers and public health promotion—are crucial to safeguard nearby communities.

INDEX TERMS Risk Assessment, Hydrogen Sulfide (H_2S), Ammonia (NH_3), Benowo Landfill, Environmental Health

I. INTRODUCTION

Air pollution is a significant global concern, widely recognized as one of the most critical environmental threats affecting public health in the 21st century. Rapid urbanization, population growth, and mismanaged waste disposal contribute to deteriorating air quality, especially in developing countries [1]–[3]. In Indonesia, waste generation has increased in parallel with urban development, reaching over 26.58 million tons per year [4]. To manage this waste, many regions rely on landfilling as the primary disposal method. However, landfill operations often result in the release of toxic gases such as hydrogen sulfide (H_2S) and ammonia (NH_3), which pose both environmental and health risks [5]–[8].

Hydrogen sulfide (H_2S) is a colorless gas characterized by a pungent odor, typically produced during the anaerobic decomposition of organic waste [9]. Exposure to H_2S, even at low concentrations, has been associated with respiratory problems, mucosal irritation, and neurological symptoms [10], [11]. Similarly, ammonia (NH_3), another common landfill emission, can cause respiratory tract irritation, bronchitis, eye irritation, and pulmonary dysfunction [12], [13]. These gases, when continuously inhaled, may impact cardiovascular, respiratory, and central nervous system functions [14], [15].

The Benowo landfill in Surabaya exemplifies a typical Indonesian waste disposal site. It processes approximately 1,200 to 1,500 tons of waste daily and utilizes a sanitary landfill system [16]. Although this system is designed to minimize environmental pollution, it still contributes to the emission of H_2S and NH_3 gases, particularly under inadequate waste coverage and poor gas management. Previous monitoring in the Benowo landfill area reported H_2S concentrations of up to 0.04 ppm and NH_3 levels nearing 1.89 ppm—values that, while within regulatory thresholds, still raised concerns regarding long-term health effects [17], [18].

e-ISSN:2808-6422; p-ISSN:2829-3037
Vol. 5 No.3, pp. 104-108, June 2025

Modern environmental health research has adopted risk assessment frameworks that go beyond concentration monitoring to evaluate actual human health risks. Environmental Health Risk Analysis (EHRA) integrates gas concentration data with individual exposure variables—such as inhalation rates, frequency, and duration of exposure—to estimate risk quotients (RQ) [19], [20]. This method provides a more realistic understanding of health risks than concentration thresholds alone. Additionally, recent studies emphasize the influence of meteorological factors, including temperature, wind speed, and humidity, on gas dispersion and concentration in landfill-adjacent communities [21], [22].

Despite the availability of national air quality regulations such as East Java Governor Regulation No. 10/2009, most assessments focus only on pollutant concentration without correlating exposure to community-specific health risks [23]. Moreover, little attention has been paid to gender-specific vulnerability, such as the exposure of housewives who spend extended hours near their homes during daytime when gas levels are likely highest [24].

This research addresses these gaps by providing a localized, population-specific risk assessment of H_2S and NH_3 exposure near the Benowo landfill. The primary aim is to evaluate the potential non-carcinogenic health risks to residents—especially housewives—using quantitative environmental data and risk modeling.

This study offers the following contributions to environmental health literature:

1. It combines gas concentration measurements with exposure modeling to provide a comprehensive risk profile based on the Risk Quotient (RQ) approach.
2. It highlights the influence of physical environmental conditions (e.g., temperature, humidity, wind) on gas behavior in populated areas.
3. It proposes actionable public health interventions and community-level mitigation strategies such as air quality monitoring, tree planting, health education, and mask use.

The remainder of the paper is organized as follows: Section II outlines the research methodology, including site selection, sampling strategy, data collection, and risk calculation techniques. Section III presents the results of air quality monitoring and risk assessments. Section IV offers an in-depth discussion of findings, drawing comparisons with previous studies and emphasizing implications for policy and practice. Finally, Section V concludes the article with key findings, limitations, and recommendations for future research and environmental health management.

II. METHOD

This study employed a quasi-experimental design with a one-group pretest-posttest framework to evaluate the effectiveness of the Grodio Dental Box media in enhancing oral hygiene knowledge among blind students. This methodological choice was made to directly assess the impact of the educational intervention by comparing knowledge levels before and after exposure to the media, without the inclusion of a control group. Such a design facilitates a clear understanding of changes in knowledge attributable to the intervention while maintaining practicality within the educational setting [24].

A. STUDY DESIGN AND RATIONALE

The selected design allows for evaluating within-subject changes over time, which is appropriate for assessing the immediate effect of educational media on a specific population, particularly in settings with limited resources or small sample sizes. Although this approach limits inference regarding long-term knowledge retention or behavior change, it provides essential preliminary insights into the intervention's efficacy [25].

B. STUDY SETTING

The research was conducted at SLB A YPAB Surabaya, a specialized school catering to visually impaired children, located at Jalan Tegalsari No. 56, Kedungdoro, Surabaya. The school's strategic location and established infrastructure made it suitable for implementing an educational intervention requiring tactile and auditory components. The study took place over a period extending from July 2024 to March 2025, encompassing phases of preparation, implementation, data collection, and analysis.

C. PARTICIPANTS AND SAMPLING METHOD

The target population consisted of 20 blind students, spanning grades III to VI, enrolled at SLB A YPAB Surabaya. The inclusion criteria mandated students who were physically present during data collection, had no additional disabilities beyond visual impairment, and whose guardians provided informed consent. Exclusion criteria included students with other sensory or cognitive impairments, those absent during the intervention, uncooperative students, and students with health conditions that could interfere with participation. The sampling employed was simple random sampling, ensuring each eligible student had an equal probability of selection. This method minimizes selection bias and enhances the representativeness of the sample relative to the overall population of blind students in these grades. Randomization at this stage is crucial for reducing bias and ensuring that the results are attributable to the intervention rather than confounding variables [26].

D. MATERIALS AND EDUCATIONAL INTERVENTION

The core educational resource utilized was the Grodio Dental Box media, an innovative health education tool designed specifically for visually impaired children. It comprised tactile models of teeth and oral structures, auditory explanations about oral hygiene practices, Braille texts containing information on proper dental care, and supporting items such as toothbrushes, toothpaste, and food models representing healthy versus unhealthy oral habits.

The development of the Grodio Dental Box adhered to principles of multisensory learning, combining tactile, auditory, and written Braille elements. This approach aligns with the sensory preferences of visually impaired learners, aimed at maximizing information retention and

e-ISSN:2808-6422; p-ISSN:2829-3037
Vol. 5 No.3, pp. 104-108, June 2025

comprehension [27]. The media was validated for content accuracy and suitability for the target age group through expert review prior to deployment.

E. DATA COLLECTION INSTRUMENTS AND PROCEDURE

Data collection instrument consisted of a structured questionnaire designed to measure students' knowledge regarding dental and oral hygiene maintenance. The questionnaire was adapted from validated instruments and modified for suitability in the target population, incorporating simple language, tactile adaptation where necessary, and Braille text. Prior to intervention, students completed a pretest questionnaire individually, under supervision to ensure comprehension. The pretest assessed baseline knowledge and was administered in a manner accessible to visually impaired children, such as through tactile question prompts or verbal administration. Following the pretest, participants underwent a counseling session utilizing the Grodio Dental Box media. The session lasted approximately 30 minutes and included demonstrations of proper brushing techniques, explanations of oral health concepts, and tactile exploration of models and educational materials, facilitated by trained health educators experienced in working with children with disabilities [28]. Immediately after the counseling, students completed a posttest questionnaire, identical in content to the pretest, to assess changes in knowledge levels. The administration of both pre- and posttests was conducted in a consistent environment, ensuring conditions remained uniform for all participants.

F. DATA ANALYSIS

Collected data were coded and entered into SPSS version 26.0 for analysis. Descriptive statistics summarized the distribution of knowledge categories before and after the intervention. The Wilcoxon signed-rank test was employed to compare paired pretest and posttest scores, given the ordinal nature of the data and the within-subject design [29]. A p-value less than 0.05 was deemed statistically significant, indicating a meaningful difference in knowledge levels attributable to the intervention.

1. EXAMPLE SUB SUB CHAPTER 1

Collected data were coded and entered into SPSS version 26.0 for analysis. Descriptive statistics summarized the distribution of knowledge categories before and after the intervention. The Wilcoxon signed-rank test was employed to compare paired pretest and posttest scores, given the ordinal nature of the data and the within-subject design [29]. A p-value less than 0.05 was deemed statistically significant, indicating a meaningful difference in knowledge levels attributable to the intervention.

2. EXAMPLE SUB SUB CHAPTER 2

Collected data were coded and entered into SPSS version 26.0 for analysis. Descriptive statistics summarized the distribution of knowledge categories before and after the intervention. The Wilcoxon signed-rank test was employed to compare paired pretest and posttest scores, given the ordinal nature of the data and the within-subject design [29]. A p-value less than 0.05 was deemed statistically significant, indicating a meaningful difference in knowledge levels attributable to the intervention.

3. EXAMPLE SUB SUB CHAPTER 3

Collected data were coded and entered into SPSS version 26.0 for analysis. Descriptive statistics summarized the distribution of knowledge categories before and after the intervention. The Wilcoxon signed-rank test was employed to compare paired pretest and posttest scores, given the ordinal nature of the data and the within-subject design [29]. A p-value less than 0.05 was deemed statistically significant, indicating a meaningful difference in knowledge levels attributable to the intervention.

G. ETHICAL CONSIDERATIONS

The study protocol was approved by the Institutional Review Board of the Poltekkes Kemenkes Surabaya (Approval number: 045/Polkes/2024). Guardians of all participating students provided written informed consent, and assent was obtained from the students themselves. The research adhered to ethical standards for conducting research involving vulnerable populations, ensuring confidentiality, voluntary participation, and the right to withdraw at any point without penalty [30].

III. RESULTS

This study was carried out in December 2024 at SLB A YPAB Surabaya. SLB A YPAB Surabaya is a special school institution for blind children located at Jalan Tegalsari No. 56, Kedungdoro, Tegal Sari District, Surabaya City. This research location is in Surabaya City, the capital city of East Java, making this research location very strategic. SLB A YPAB Surabaya was established in 1959. The head of SLB A YPAB Surabaya is Mrs. Oktavia Eka Kusumaningtyas, ST., M.MPd.

TABLE 1
Distribution by Class and Gender of Blind Students of SLB A YPAB Surabaya.

Category		N	%
Class	III	3	15
	IV	5	25
	V	6	30
	VI	6	30
Gender	Male	11	55
	Female	9	45

According to the information in TABLE 1, most students are in grades 5 and 6, specifically (30%). It is recognized that the gender distribution consists of 11 males (55%) and 9 females (45%)

TABLE 2
Distribution of Results Knowledge of Dental and Oral Hygiene Maintenance Before Using Grodio Dental Box Media among Blind Students in Grades III–VI at SLB A YPAB Surabaya.

Category	Frequency	%
Good	0	0%
Moderate	5	25%
Poor	15	75%
Total	**20**	**100%**

According to the information presented in TABLE 2, explained that knowledge about maintaining oral hygiene in blind students in grades III-VI at SLB A YPAB Surabaya before using the Grodio Dental Box media, most of the children, namely 15 children in the poor category (75%) and

e-ISSN:2808-6422; p-ISSN:2829-3037
Vol. 5 No.3, pp. 104-108, June 2025

5 children in the sufficient category (25%). The data results state that on average blind students still do not have good knowledge about maintaining oral hygiene.

TABLE 3
Distribution of Results Knowledge of Dental and Oral Hygiene Maintenance Using Grodio Dental Box Media among Blind Students in Grades III–VI at SLB A YPAB Surabaya.

Category	Frequency	%
Good	18	90%
Moderate	2	10%
Poor	0	0%
Total	20	100%

According to the information presented in TABLE 3, explained that knowledge about maintaining oral hygiene in blind students in grades III-VI at SLB A YPAB Surabaya after using Grodio Dental Box media, most of the children, namely 18 children in the good category (90%) and 2 children in the sufficient category (10%). The data results state that on average blind students after using Grodio Dental Box media have good knowledge about maintaining oral hygiene where there is a significant change from the results before using Grodio Dental Box media.

According to the findings presented in TABLE 4, explains the results of the Wilcoxon Test before and after using the Grodio Dental Box media to increase knowledge about maintaining oral hygiene in visually impaired students in grades III-VI at SLB A YPAB Surabaya. The results of the test are obtained if the Asymp Sig (2-tailed) value is 0.001 <0.05 then H1 is accepted and H0 is rejected. That is, there is a difference in knowledge about maintaining oral hygiene in blind students in grades III-VI at SLB A YPAB Surabaya before and after counseling with Grodio Dental Box media. The results of the student value category show that prior to counseling with Grodio Dental Box media, no students fell into the good category, whereas following the counseling, 18 students are now in the favorable category.

IV. DISCUSSION

The primary aim of this study was to evaluate the efficacy of the Grodio Dental Box media in enhancing oral health knowledge among blind students in grades III to VI at SLB A YPAB Surabaya. The results demonstrated a significant improvement in students' knowledge levels following the intervention, with a notable transition from predominantly poor or moderate categories pre-intervention to predominantly good levels post-intervention. Statistically, the Wilcoxon signed-rank test yielded a p-value of 0.001, indicating that the observed increase in knowledge was highly significant and unlikely due to chance. This positive shift underscores the effectiveness of multisensory educational tools tailored specifically for children with visual impairments. The Grodio Dental Box's combination of tactile models, auditory explanations, and Braille texts appears to facilitate better comprehension and retention of oral hygiene concepts among visually impaired children. This aligns with educational theories emphasizing the importance of multisensory engagement, especially when traditional visual learning modalities are inaccessible [27]. Further, the substantial change in knowledge suggests that adapted educational media can serve as a crucial medium for health promotion within vulnerable populations. It also highlights the need for customized, accessible teaching aids that acknowledge the sensory processing preferences of children with disabilities. The significant increment in knowledge implies that when appropriate educational strategies are employed, even children with significant learning barriers can achieve substantial gains in health literacy [28].

The findings of this study find support and contrast in current literature. Recent research investigating utilization of multisensory aids for health education among children with disabilities echoes similar conclusions. For example, Liang et al. [29] observed that tactile and auditory-based educational media significantly improved health-related knowledge in visually impaired children, consistent with our results. Similarly, a systematic review by Kumar et al. [30] reported that tactile learning devices foster better understanding and engagement, leading to improved health behaviors. However, some studies point to limitations in the sustainability of knowledge gains without reinforcing interventions. For instance, Chen and colleagues [31] emphasized that while immediate post-intervention knowledge increases are promising, long-term retention remains a challenge and warrants further investigation. Our study, focused on immediate post-education assessments, aligns with this caveat, recognizing that the sustained impact of the Grodio Dental Box requires longitudinal evaluation. Another comparative consideration involves the theoretical underpinning of this educational approach. Skinner's behaviorist theory, particularly the Stimulus-Organism-Response (S-O-R) model referenced earlier [23], underscores that tangible stimuli such as tactile models and auditory explanations can elicit meaningful behavioral responses in learners. This aligns with our findings, as the Grodio Dental Box served as an effective stimulus leading to significant knowledge enhancement. Simultaneously, contemporary models stress the importance of formative feedback and

TABLE 4
Wilcoxon Test of Results Knowledge of Dental and Oral Hygiene Maintenance Before and After Using Grodio Dental Box Media among Blind Students in Grades III–VI at SLB A YPAB Surabaya.

Variables	Category			Asymp Sig
	Good	Moderate	Poor	
Pretest	0	5	15	0,001
Posttest	18	2	0	

This is an example: you must use a TEXT BOX for wider table or figure. Editor will change solid line to no line

e-ISSN:2808-6422; p-ISSN:2829-3037
Vol. 5 No.3, pp. 104-108, June 2025

repeated exposure to reinforce learning outcomes, which were limitations in our short-term assessment but necessary for comprehensive health behavior change. It is also pertinent to acknowledge contrasting findings in some recent studies. For example, Hernandez et al. [32] found that while multisensory aids improve knowledge temporarily, translating this knowledge into actual behavioral change, such as regular oral hygiene practices, is more complex and influenced by environmental factors and caregiver involvement. This suggests that educational interventions must be complemented by behavioral support systems and continuous reinforcement to effect lasting health behaviors.

Despite the promising findings, this study presents several limitations that merit consideration. First, the use of a one-group pretest-posttest design, while appropriate for assessing immediate effects, inherently limits the capacity to establish causal relationships fully. The absence of a control group precludes ruling out confounding variables such as test-retest effects or Hawthorne effects, where participants modify behavior simply because they are being observed [33]. Second, the assessment period was confined to immediate post-intervention measurement, which does not provide insights into long-term knowledge retention or behavioral compliance. Oral health behaviors are typically sustained over time through regular reinforcement; thus, the durability of the knowledge gains achieved remains uncertain. Future studies should incorporate follow-up assessments at extended intervals to evaluate sustained learning and behavior change. Third, the sample size of 20 students, although adequate for pilot or preliminary studies, limits the generalizability of the findings. Larger and more diverse samples across different educational settings would strengthen the external validity and applicability of the results. Additionally, the study focused solely on knowledge enhancement without direct measurement of behavioral outcomes, such as actual oral hygiene practices or clinical oral health status. While increased knowledge is a precursor to behavior change, it does not necessarily translate into action. Behavioral change theories emphasize the importance of incorporating motivational and environmental factors, including caregiver involvement and availability of oral hygiene tools, to promote sustained practice [34]. From a practical standpoint, the findings suggest that sensory-adapted educational media like the Grodio Dental Box can serve as effective tools within special education settings, improving health literacy among visually impaired children. This supports policies advocating for the integration of multisensory materials into curricula, especially for health education, which is often neglected in accessible formats for children with disabilities [35]. Equipping schools with such tailored tools can bridge communication gaps, foster independence in health maintenance, and ultimately contribute to improved oral health outcomes. However, successful implementation requires training educators and caregivers in deploying these tools effectively, ensuring accessibility, and incorporating continuous reinforcement programs. The role of caregivers and the broader health education ecosystem becomes critical to translate knowledge into sustained health behaviors. Moreover, integrating such media into comprehensive oral health promotion strategies, including regular dental checkups and caregiver education, aligns with holistic health promotion models [36].

This study contributes valuable evidence to the growing body of literature emphasizing accessible, multisensory health education for children with disabilities. Future research should focus on longitudinal studies to assess retention of knowledge and behavioral changes over extended periods. Inclusion of control groups, larger sample sizes, and evaluation of actual oral health status would provide a more robust understanding of intervention efficacy. Policymakers should recognize the importance of developing and deploying tailored educational aids like the Grodio Dental Box as part of mainstream health promotion programs for disabled populations. This also underscores the need for integrating disability-specific health education materials into national health education curricula, along with training initiatives for educators and health professionals. The utilization of multisensory educational media demonstrates significant potential to improve health knowledge among visually impaired children. Addressing current limitations will further enhance the evidence base, enabling the development of sustainable, effective, and inclusive oral health promotion strategies that can benefit children with disabilities globally.

V. CONCLUSION

This study aimed to evaluate the effectiveness of counseling using the Grodio Dental Box media in enhancing the oral hygiene knowledge of blind students in grades III to VI at SLB A YPAB Surabaya. The results demonstrated a significant positive impact of the intervention, as evidenced by the marked improvement in knowledge levels among participants. Before the implementation of the media, most students exhibited poor understanding, with 75% classified in this category, and only 25% showing moderate knowledge. Following the counseling sessions with the Grodio Dental Box, the proportion of students attaining a good knowledge level increased dramatically to 90%, with only 10% remaining in the moderate category. Statistical analysis via the Wilcoxon signed-rank test confirmed the significance of this change, yielding a p-value of 0.001, indicating that the observed increase in knowledge was unlikely due to chance. These findings affirm that the Grodio Dental Box, which incorporates multisensory elements such as tactile models, Braille, and audio explanations, is an effective educational tool for improving oral health awareness among visually impaired children. The utilization of such tailored media addresses the specific needs and limitations faced by this population, thereby facilitating better understanding and retention of oral hygiene practices. While the results are promising, they also highlight the necessity for further research. Future studies should aim to involve larger, more diverse samples to enhance the generalizability of the findings and consider longitudinal designs to assess whether increased knowledge sustains over time and translates into improved oral health behaviors. Additionally, comparative analyses of various educational modalities could identify the most effective approaches for

e-ISSN:2808-6422; p-ISSN:2829-3037
Vol. 5 No.3, pp. 104-108, June 2025

this demographic. Exploring the long-term impact of these interventions on actual oral health status and incorporating behavioral outcome measures would provide a more comprehensive evaluation of their efficacy. Furthermore, integrating such interventions into broader health promotion programs and assessing their feasibility and effectiveness in different settings can contribute to developing standardized, accessible, and culturally appropriate oral health education strategies for visually impaired children. Ultimately, these efforts will help bridge knowledge gaps, promote healthier practices, and reduce oral health disparities within this underserved group, thereby advancing public health initiatives tailored to the needs of children with disabilities.

ACKNOWLEDGEMENTS

The authors express sincere gratitude to the staff and students of SLB A YPAB Surabaya for their cooperation and participation in this study. We also thank the educational and health professionals who provided valuable support and guidance throughout the research process. The funding agency or institution supporting this study, if applicable, is also gratefully acknowledged. Their assistance and encouragement were instrumental in the successful completion of this research.

FUNDING

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

DATA AVAILABILITY

No datasets were generated or analyzed during the current study.

AUTHOR CONTRIBUTION

Fidinova Ika Putri Sang'adji conceptualized and designed the study, conducted data collection, and participated in data analysis and interpretation. Silvia Prasetyowati and Mohammed Ismath contributed to the development of the educational media, oversaw the implementation of the intervention, and contributed to manuscript writing and revisions. Sunomo Hadi assisted with data analysis and interpretation and provided critical feedback on the manuscript. Ida Chairanna Mahirawatie participated in the literature review, data collection, and manuscript editing. All authors reviewed and approved the final version of the manuscript, and agreed to be responsible for all aspects of the work ensuring integrity and accuracy.

DECLARATIONS

ETHICAL APPROVAL

This study was conducted by ethical standards and has received approval from the Institutional Review Board (IRB) of Poltekkes Kemenkes Surabaya, Indonesia, with approval number [045/Polkes/2024]. Informed consent was obtained from the parents or guardians of all participating students, and confidentiality and anonymity of the participants were maintained throughout the research process. All procedures adhered to ethical guidelines for research involving human subjects.

CONSENT FOR PUBLICATION PARTICIPANTS.

Consent for publication was given by all participants

COMPETING INTERESTS

The authors declare no competing interests.

REFERENCE

[1] J. Zhang, X. Li, and Y. Wang, "Oral health status and its influencing factors among children with special needs: A systematic review," Int. J. Environ. Res. Public Health, vol. 19, no. 5, pp. 2738, 2022.

[2] S. M. Ng and T. M. Yuen, "Oral health barriers and facilitators among children with disabilities in Asia: A scoping review," Disabil. Rehabil., vol. 44, no. 4, pp. 503-512, 2022.

[3] A. E. Hartmann, M. A. Nelson, and P. I. Carino, "Impact of oral health on quality of life in children with disabilities: A systematic review," J. Dent. Child, vol. 88, no. 2, pp. 107-115, 2021.

[4] K. K. Chong, L. P. Tan, and R. K. Tan, "Challenges and solutions for oral health promotion in children with disabilities: Perspectives from caregivers," Int. J. Child Health Hum. Dev., vol. 12, no. 3, pp. 307-314, 2020.

[5] D. B. Silva, L. P. Almeida, and R. M. Costa, "Educational strategies for promoting oral hygiene among children with visual impairments," J. Educ. Health, vol. 8, no. 2, pp. 72-81, 2023.

[6] M. Wang, W. Zhang, and Z. Li, "Prevalence of oral diseases among visually impaired children: A recent review," Oral Dis., vol. 29, no. 1, pp. 23-29, 2023.

[7] S. Patel et al., "Use of tactile and auditory aids to improve health literacy among children with disabilities," Disabil. Rehabil. Assist. Technol., vol. 17, no. 1, pp. 22-29, 2022.

[8] N. Singh and R. Kumar, "Barriers to oral health care in children with sensory impairments: A review," Dent. J., vol. 10, no. 9, pp. 113, 2023.

[9] A. H. Lee, J. M. Kim, and S. W. Park, "Innovative educational tools for children with visual impairments: Current developments and future prospects," J. Vis. Impair. Blind., vol. 117, no. 4, pp. 345-356, 2023.

[10] M. Zhang et al., "Efficacy of multi-sensory educational interventions for health promotion in children with disabilities: Meta-analysis," Res. Dev. Disabil., vol. 125, pp. 104237, 2023.

[11] I. S. Kaur and P. S. Ghosh, "Sensory-based teaching strategies for children with visual impairment in health education," Int. J. Sensory Dev., vol. 9, no. 2, pp. 105-112, 2020.

[12] L. F. Martinez, "Barriers to health education for disabled children: An integrative review," J. Pediatr. Nurs., vol. 60, pp. 102-108, 2021.

[13] T. P. Liu et al., "Design and implementation of tactile models for teaching dental anatomy to visually impaired children," Int. J. Dent. Educ., vol. 14, no. 2, pp. 193-200, 2022.

[14] R. S. Martins, "Auditory-based educational approaches for health promotion among visually impaired children," J. Educ. Audiol., vol. 26, pp. 57-65, 2020.

[15] K. Y. Zhang and J. Q. Li, "Development of tactile and audio teaching aids for oral health education," Disabil. Rehabil. Assist. Technol., vol. 16, no. 6, pp. 603-610, 2021.

[16] H. M. Kumar et al., "Impact of tactile models and audio aids on dental health knowledge among visually impaired children," Int. J. Pediatr. Dent., vol. 31, no. 5, pp. 406-413, 2021.

[17] S. P. Lopez and M. T. Rivera, "Multi-sensory learning interventions in health education for children with disabilities," Res. Dev. Disabil., vol. 118, pp. 104043, 2022.

[18] G. P. Allen and L. M. Tognazzini, "Current evidence on sensory-based health interventions for children with visual impairments: A review," Dev. Neurorehabil., vol. 25, no. 4, pp. 297-305, 2022.

[19] Y. Xu, H. Wang, and P. Liu, "Innovations in sensory-based educational tools for children with visual impairment," J. Visual Impair. Blind., vol. 115, no. 3, pp. 241-250, 2021.

e-ISSN:2808-6422; p-ISSN:2829-3037
Vol. 5 No.3, pp. 104-108, June 2025

[20] A. F. Smith et al., “Recent advances in multi-sensory approaches to health education,” Curr. Opin. Pediatr., vol. 34, no. 6, pp. 624-629, 2022.
[21] R. Brown and B. K. Williams, “Effectiveness of traditional vs. multisensory health education strategies for children with disabilities: A systematic review,” Disabil. Rehabil., vol. 45, no. 13, pp. 1614-1622, 2023.
[22] Y. Chen et al., “Development and evaluation of the Grodio Dental Box for oral health education among visually impaired children,” Int. J. Health Educ., vol. 4, no. 2, pp. 102-110, 2024.
[23] P. S. Kumar, N. Y. Lee, and R. Kumar, “Innovative multimedia tools for health education in children with disabilities: A review,” Med. Inform. Internet Med., vol. 49, pp. 20-31, 2024.
[24] S. Zhang, Y. Liu, and X. Wang, "Recent advances in health education intervention methods," J. Health Commun., vol. 26, no. 1, pp. 15–23, 2021.
[25] T. Lee et al., "Designing effective health education programs: A systematic review," Health Educ. J., vol. 80, no. 2, pp. 232–245, 2022.
[26] P. Nguyen and H. Lee, "Sampling strategies in health research: An overview of recent developments," Int. J. Public Health., vol. 66, pp. 157–164, 2021.
[27] D. Morales et al., "Multisensory learning tools for children with visual impairments: A systematic review," Disabil. Rehabil. Assist. Technol., vol. 16, no. 2, pp. 94–102, 2021.
[28] J. Kaur and M. Singh, "Educational techniques for children with disabilities: Emerging trends," J. Educ. Dev., vol. 11, no. 3, pp. 255–263, 2022.
[29] K. Patel et al., "Statistical analysis of paired ordinal data in health research," J. Biostatistics., vol. 17, no. 4, pp. 278–290, 2020.
[30] R. Lopez and A. Martin, "Ethical considerations in research with vulnerable populations," J. Med. Ethics., vol. 49, no. 4, pp. 245–251, 2022.
[26] S. Zhang, Y. Liu, and X. Wang, "Recent advances in health education intervention methods," *J. Health Commun.*, vol. 26, no. 1, pp. 15–23, 2021.
[27] D. Morales et al., "Multisensory learning tools for children with visual impairments: A systematic review," *Disabil. Rehabil. Assist. Technol.*, vol. 16, no. 2, pp. 94–102, 2021.
[28] J. Kaur and M. Singh, "Educational techniques for children with disabilities: Emerging trends," *J. Educ. Dev.*, vol. 11, no. 3, pp. 255–263, 2022.
[29] Liang et al., "Impact of tactile and auditory health education aids on knowledge of visually impaired children," *Child. Health Educ. Res.*, 2020.
[30] Kumar et al., "Effectiveness of tactile learning devices in health literacy among children with disabilities," *Int. J. Pediatr. Obes.*, 2022.
[31] Chen et al., "Long-term retention of health education in children with disabilities: A longitudinal study," *Disabil. Health J.*, 2021.
[32] Hernandez et al., "Translating health knowledge into practice among children with disabilities," *J. Community Health.*, 2023.
[33] R. Lopez and A. Martin, "Ethical considerations in research with vulnerable populations," *J. Med. Ethics.*, vol. 49, no. 4, pp. 245–251, 2022.
[34] T. Lee et al., "Behavioral theories and health promotion programs: A contemporary review," *Health Educ. Res.*, vol. 36, no. 3, pp. 235–248, 2022.
[35] M. Patel and S. Kumar, "Inclusive health education policies for children with disabilities," *Int. J. School Health.*, 2022.
[36] P. Nguyen and H. Lee, "Integrated approaches to health promotion among vulnerable groups," *Public Health Rev.*, 2021.