Effectiveness of Oral Health Educational Interventions on Oral Health Status among Visually Impaired Children

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ABSTRACT:

Background and Objectives: Visually impaired children encounter unique challenges in maintaining oral hygiene, resulting in higher rates of caries and periodontal disease compared to sighted peers. This study aimed to evaluate the effectiveness of a tailored Audio, Tactile, and Performance (ATP) intervention on oral health behaviors and clinical status among visually impaired children in Erbil, Iraq. **Methods:** A pre-test/post-test interventional study was conducted with 69 visually impaired students aged 6–15 years. Baseline data included dmft/DMFT, Oral Hygiene Index (OHI), Gingival Index (GI), and an interview-based questionnaire on oral health behaviors. Participants received a multisensory ATP program (audio instructions, tactile training, and performance-based practice), followed by reinforcement sessions. Follow-up assessments were conducted after two months. **Results:** The mean OHI score decreased significantly from 2.07 to 1.23 ($p < 0.001$), while mean GI reduced from 2.10 to 1.65 ($p < 0.001$). Brushing frequency improved, with twice-daily brushing increasing from 28.1% to 71.9% ($p < 0.001$). Horizontal brushing decreased from 54.4% to 10.5%, while combined techniques increased from 40.4% to 80.7% ($p < 0.001$). Similarly, brushing both morning and evening improved from 38.6% to 71.9% ($p = 0.002$). **Conclusion:** The ATP oral health program applied in the study resulted in significantly improved clinical outcomes and oral hygiene behaviors. This indicates that, as a culturally adaptable intervention for children who are blind, it is effective.

Keywords: Adolescent; Blindness; Child; Dental Caries; Health Education.

1. Introduction

Oral health is an essential part of broader health status, especially regarding vulnerable groups like children who are visually impaired and face special challenges with oral hygiene (Sharififard, Sargeran, & Katayoun, 2022). Visual impairment decreases the ability to see the buildup of plaque, signs of dental disease and proper techniques for brushing, leading to higher rates of dental caries and periodontal disease, and less favorable oral health compared to sighted children (Shah et al., 2024). The challenges of maintaining oral hygiene for visually impaired children are complex and require a distinctive type of education that adjusts for their sensory loss while providing important knowledge and skills related to oral health (AlSadhan, Al-Jobair, Bafaqeeh, Abusharifa, & Alagla, 2017; Bhor, Vinay, Ambildhok, & Shetty, 2021).

Recent studies have indicated that conventional methods of oral health education that involve visual aids and demonstrations are not effective for individuals with visual impairments. This indicates that new approaches that incorporate multiple senses are needed (Masoumi, Askarizadeh, & Ghasemi, 2021). Specialized educational interventions using a variety of learning modules have been developed and executed using audio instructions, tactile models, Braille materials, and performance-based methods. Although these approaches are still in an early stages of adaptation, they show promise to meet the oral health knowledge gap with children with visual impairments (Gautam, Bhambal, & Moghe, 2018; Santhoshi et al., 2024). These adapted methodologies recognize the heightened reliance on auditory and tactile senses characteristic of individuals who are visually impaired, transforming these compensatory abilities into effective learning tools for oral health promotion (Masoumi et al., 2021; Santhoshi et al., 2024).

Epidemiological findings consistently reveal troubling disparities in oral health outcomes for visually impaired and sighted children, wherein visually impaired populations have consistently higher indicators of dental caries, periodontal disease, and oral hygiene status. DMFT scores for visually impaired children will range from 3.89 to 5.33, compared to age-matched sighted controls (Ramadan, 2021; Tagelsir, Khogli, & Nurelhuda, 2013). Caries prevalence for visually impaired children also ranges from 57.7% (n=45) to 73.3% (n=30), which is substantially different from approximately 46.2% of normal children (n=100), indicating a pressing need for prevention programs. The gap between visual and non-visually impaired children extends beyond caries to overall oral health outcomes, including gingival inflammation, plaque, traumatic dental injury, indicating an overall pattern of disadvantage for oral health outcomes for visually impaired children which appears chronic (Ramadan, 2021; Майасари, Дарвита, Сетиавати, & Новринда, 2025).

Recent investigations have yielded compelling evidence supporting the effectiveness of specialized oral health educational interventions for visually impaired children. The study by Santhoshi et al. (2024) demonstrated that combination approaches utilizing both Braille and Non-Visual Desktop Access (NVDA) technologies achieved superior improvements in oral health knowledge scores (6.36 ± 0.52) and significant reductions in plaque scores compared to control groups (Santhoshi et al., 2024). Similarly, Mahapatra et al. (2024) reported significant improvements in salivary pH levels (from 6.20 ± 0.41 to 6.96 ± 0.20) and buffering capacity among visually impaired children following Audio-Tactile Performance interventions, indicating measurable physiological improvements in oral health status (Deshpande et al., 2024).

The necessity for this study is underscored by the lack of culturally adapted, systematically evaluated oral health educational interventions targeting visually impaired children in Iraq, where cultural, language, and socio-economic factors may affect the effectiveness and acceptability of specific interventions. This study aims to investigate the efficacy of a culture-specific Audio, Tactile, and Performance (ATP) educational intervention in enhancing oral health knowledge, oral health

behaviours/practice, and clinical outcomes among visually impaired children in Erbil, Iraq.

2. Methodology

Study design and setting

This study was designed as an interventional study using a single-group pre-test and post-test design to assess the effectiveness of an oral health educational program on the oral health status of visually impaired children. The study was conducted in December 2024 at the Runaky Institute for the Vision Impaired, located in Erbil city, Kurdistan Region, Iraq.

Participants

All students with visual impairment enrolled at the institute during the study period were considered for inclusion. Since there was only one institute serving this group in the city, a convenient sampling approach was adopted. Out of the total registered children, 73 were initially assessed for eligibility. After applying the inclusion and exclusion criteria, four children were excluded: three due to uncooperative behavior during the initial examination and one due to exceeding the upper age limit. At the post-test phase, two children were absent and were therefore excluded from follow-up. Ultimately, 69 students participated in both pre-test and post-test evaluations.

Children aged between 6 and 15 years of either sex who were enrolled in the institute and diagnosed with visual impairment were included. Children were required to be physically capable of tooth brushing training and have parental consent for participation. Exclusion criteria included children with other disabilities such as hearing impairment or mutism, those with severe systemic illnesses that could affect oral health, uncooperative children who refused examination or training, and children whose parents or guardians did not provide written consent.

Data Collection

Data collection was carried out in three stages: a baseline assessment, the educational intervention, and a follow-up assessment after two months.

Baseline oral examination and questionnaire

At baseline, each child underwent an oral health examination guided by the World Health Organization (WHO) criteria for oral health surveys (2013) (Organization, 2013). The oral assessment included:

Dental caries measured using decayed, missing, and filled teeth in primary and permanent dentition (dmft/DMFT indices) (Gudipaneni et al., 2022).

Oral hygiene status assessed using the Simplified Oral Hygiene Index (OHI-S) by Greene and Vermillion (1964) (Greene & Vermillion, 1964).

Gingival health evaluated using the Gingival Index (GI) by Silness and Löe (1963) (Löe & Silness, 1963).

Clinical examinations were performed by a single trained examiner to ensure diagnostic consistency. Disposable dental mirrors, explorers, headlamps, sterile gloves, and masks were used, following recommended cross-infection control measures. To verify examiner reliability, intra-examiner calibration was performed on 15 children, with repeated measures of dmft/DMFT, OHI-S, and GI. The intra-class correlation coefficient (ICC=0.9) and Kappa value (K=1.0) confirmed excellent consistency.

Additionally, a structured questionnaire adapted from WHO (2013) was administered through a face-to-face interview. The tool, validated by four oral health experts and pilot tested on 10 visually impaired children, collected socio-demographic details, medical history, oral health behaviors (e.g., frequency, duration, and techniques of brushing), parental involvement in tooth brushing, dental service utilization, and dietary sugar intake.

Educational intervention and reinforcement

Following the baseline assessment, participants received a specially tailored oral health educational program designed on Audio-Tactile-Performance (ATP) principles to accommodate visual impairment. The 20-minute individualized sessions included:

Audio component: Verbal explanations on oral health and brushing; for grades 1–5, this included a simple Kurdish song, and for grades 6–9, a narrative story.

Tactile component: Children familiarized themselves with the parts and proper use of a toothbrush through hand-over-hand teaching.

Performance component: Personalized tooth brushing practice using an oversized dental arch model and supervised repetition until independent performance was achieved.

Each child was provided with a toothbrush and fluoridated toothpaste to encourage continued practice. A reinforcement session was conducted two weeks later to enhance retention.

Follow-up assessment

After two months, participants were re-examined using the same indices (OHI-S and GI) and re-interviewed with the structured questionnaire on oral hygiene behavior. Pre- and post-intervention data were compared to measure the effectiveness of the ATP educational

Statistical Analysis

All data were entered and analyzed using the Statistical Package for Social Sciences (SPSS) version 26. Descriptive statistics including means, medians, standard deviations, and percentages were computed for baseline variables. To compare pre- and post-intervention outcomes within the same group, the Wilcoxon signed-rank test was applied to median scores of OHI-S and GI. The McNemar-Bowker test was used to analyze changes in categorical variables such as tooth brushing frequency, methods, and times. A p-value ≤0.05 was considered statistically significant.

3. Results

Table 1 presents the age and sex distribution of the study participants. The mean age was 10.9 ± 3.0 years. A total of 18 (26.1%) children were in the 6–8 years age group, 18 (26.1%) were between 9–11 years, and 33 (47.8%) were in the 12–15 years group. With regard to sex, 32 (46.4%) of the participants were male and 37 (53.6%) were female.

Table 1. Age and sex distribution.

Variables		No.	(%)
Age (years)	Mean ± SD	10.9 ± 3.0	
	6-8	18	(26.1)
	9-11	18	(26.1)
	12-15	33	(47.8)
Sex	Male	32	(46.4)
	Female	37	(53.6)
	Total	69	(100.0)

Table 2 describes the oral hygiene practices and toothbrushing patterns among the participants. Out of 69 children, 60 (87.0%) reported brushing their teeth with toothpaste, while 9 (13.0%) did not. Among the 60 children who brushed, 30 (50.0%) brushed once daily, 16 (26.7%) brushed twice daily, and 14 (23.3%) brushed only once a week. Regarding brushing technique, 32 (53.3%) used a horizontal method, 3 (5.0%) used the vertical method, and 25 (41.7%) combined both. In terms of brushing time, 6 (10.0%) brushed only in the morning, 31 (51.7%) only in the evening, and 23 (38.3%) brushed both morning and evening. As for brushing duration, 7 (11.7%) brushed for less than one minute, 30 (50.0%) brushed for one minute, 8 (13.3%) brushed for two minutes, while 15 (25.0%) did not know their brushing duration. Frequency of changing the toothbrush showed that only 2 (3.3%) changed within 0–3 months, 14 (23.3%) between 4–6 months, and the majority, 44 (73.3%), between 7–12 months.

Table 2. Oral hygiene practices and patterns of toothbrushing.

Variables		No.	(%)
Tooth brushing (n = 69)	Yes (using a toothpaste)	60	(87.0)
	No	9	(13.0)
Frequency of toothbrushing (n = 60)	Once daily	30	(50.0)
	Twice daily	16	(26.7)
	Once a week	14	(23.3)
	Horizontal	32	(53.3)
	Vertical	3	(5.0)

Method of brushing (n = 60)	Both (vertical and horizontal)	25	(41.7)
Time of brushing (n = 60)	In the morning	6	(10.0)
	In the evening	31	(51.7)
	Both morning and evening	23	(38.3)
Brushing duration (n = 60)	Less than 1 minute	7	(11.7)
	1 minute	30	(50.0)
	2 minutes	8	(13.3)
	Don't know	15	(25.0)
Frequency of changing the toothbrush (n = 60)	0-3 months	2	(3.3)
	4-6 months	14	(23.3)
	7-12 months	44	(73.3)

Table 3 summarizes the medical and dental history of the participants. Out of 69 children, 65 (94.2%) reported no medical problems, while 1 (1.4%) had cardiac disease, 1 (1.4%) had diabetes mellitus, and 2 (2.9%) reported other conditions. Regarding dental visits, 37 (53.6%) had visited a dentist, whereas 32 (46.4%) had never been. Among the 37 children who had visited the dentist, 10 (27.0%) went for pain relief, 14 (37.8%) for dental fillings, 9 (24.3%) for routine check-ups, and 4 (10.8%) could not recall the reason. When asked about assistance with toothbrushing (n = 60 children who brushed), 25 (41.7%) brushed independently, 32 (53.3%) were helped by their parents, and 3 (5.0%) were assisted by a sibling.

Table 3. Medical and dental history.

Variables		No.	%
Medical history (n = 69)	None	65	94.2
	Cardiac disease	1	1.4
	Diabetes mellitus	1	1.4
	Others	2	2.9
Visiting the dentist (n = 69)	Yes	37	53.6
	No	32	46.4
Reason for the visit (n = 37)	Pain	10	27.0
	Filling	14	37.8
	Routine check-up	9	24.3
	I don't remember	4	10.8
Who helps with toothbrushing (n = 60)	Him or herself	25	41.7
	Parents	32	53.3
	Sister or brother	3	5.0

Table 4 presents the pattern of sugar intake among the participants. Out of 69 children, 34 (49.3%) consumed sugar once daily, 22 (31.9%) consumed it twice daily, and 10 (14.5%) reported intake more than twice a day, while 3 (4.3%) did not consume sugar at all. Regarding the timing of sugar consumption, only 1 (1.4%) consumed sugar with meals, the majority 62 (89.9%) consumed it in between meals, 3 (4.3%) consumed it before sleep, and another 3 (4.3%) reported no sugar intake.

Table 4. Pattern of sugar intake.

Variables		No.	%
Frequency of sugar intake (n = 69)	Once	34	49.3
	Twice	22	31.9
	More	10	14.5
	None	3	4.3
Time of intake (n = 69)	With meal	1	1.4
	In between meals	62	89.9
	Before sleep	3	4.3
	None	3	4.3
Total		69	100.0

The DMFT was used to assess the dental caries. It was very high in 40.6% and high in 21.7% of the children, while it was very low in 13% and low in 10.1% of the children (Figure 1).

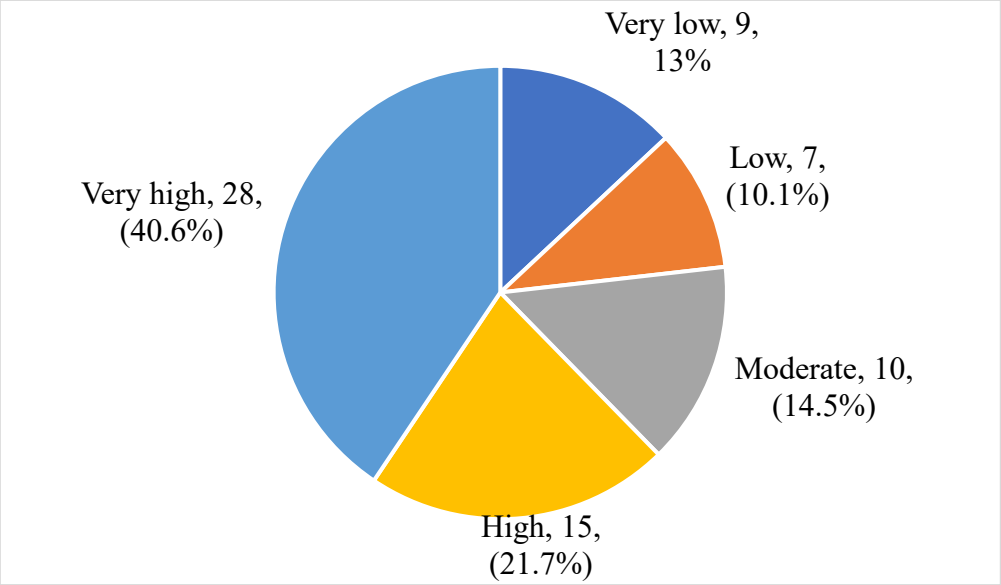

Figure 1. DMFT categories in the studied sample.

Table 5 presents the oral health outcomes of the participants before and after the health education program. The mean Oral Hygiene Index (OHI) score decreased significantly from 2.07 (median = 2.00) before the program to 1.23 (median = 1.00) after the program ($p < 0.001$), reflecting a substantial improvement in oral cleanliness. Similarly, the mean Gingival Index (GI) score reduced from 2.10 (median = 2.00) before the intervention to 1.65 (median = 2.00) after ($p < 0.001$), indicating a significant reduction in gingival inflammation.

Table 5. Oral health outcomes before and after the educational program.

	Before the health education program		After the health education program		
	Mean	Median	Mean	Median	p-value
OHI	2.07	2.00	1.23	1.00	< 0.001
GI	2.10	2.00	1.65	2.00	< 0.001

*Calculated by the Wilcoxon signed ranks test

Table 6 outlines the changes in oral hygiene practices before and after the educational program. Prior to the intervention, 57 (87.7%) children reported brushing their teeth, which increased to 65 (100.0%) afterwards. The frequency of toothbrushing also improved significantly: 30 (52.6%) brushed once daily, 16 (28.1%) brushed twice daily, and 11 (19.3%) brushed only once a week before the program. Afterward, 14 (24.6%) brushed once daily, 41 (71.9%) brushed twice daily, and only 2 (3.5%) brushed once a week ($p < 0.001$). A notable shift was observed in brushing methods: horizontal brushing decreased from 31 (54.4%) to 6 (10.5%), vertical brushing increased slightly from 3 (5.3%) to 5 (8.8%), while combined vertical and horizontal brushing rose markedly from 23 (40.4%) to 46 (80.7%) ($p < 0.001$). Regarding brushing times, 6 (10.5%) brushed only in the morning, 29 (50.9%) only in the evening, and 22 (38.6%) both morning and evening before the program. After the intervention, 4 (7.0%) brushed only in the morning, 12 (21.1%) only in the evening, and a substantial 41 (71.9%) brushed both morning and evening ($p = 0.002$).

Table 6. Oral hygiene practices before and after the educational program.

Variables		Before	After	p-value*
		No. (%)	No. (%)	
Tooth brushing	Yes	57 (87.7)	65 (100.0)	N/A
	No	8 (12.3)	0 (0.0)	
Frequency of toothbrushing	Once daily	30 (52.6)	14 (24.6)	p < 0.001
	Twice daily	16 (28.1)	41 (71.9)	
	Once a week	11 (19.3)	2 (3.5)	
Method of brushing	Horizontal	31 (54.4)	6 (10.5)	p < 0.001
	Vertical	3 (5.3)	5 (8.8)	
	Both (horizontal and vertical)	23 (40.4)	46 (80.7)	
Time of brushing	In the morning	6 (10.5)	4 (7.0)	0.002
	In the evening	29 (50.9)	12 (21.1)	
	Both (morning and evening)	22 (38.6)	41 (71.9)	

*Calculated by McNemar-Bowker test.

4. Discussion

Oral health education programs play a crucial role in improving health outcomes among vulnerable populations, particularly children with disabilities who face significant barriers to maintaining adequate oral hygiene. Visual impairment in childhood represents a complex condition that not only affects sensory perception but also impacts learning abilities and daily self-care practicesn (Bhor et al., 2021). The present study evaluated the effectiveness of a specially designed Audio, Tactile, and Performance (ATP) educational intervention on improving oral health knowledge, practices, and clinical indicators among visually impaired children in Erbil, Iraq. The findings revealed significant improvements in both clinical oral health parameters and behavioral practices following the implementation of the ATP intervention, demonstrating substantial reductions in the Oral Hygiene Index from and Gingival Index from, alongside marked improvements in toothbrushing frequency and technique.

The findings herein corroborate those of several recent studies examining oral health interventions with visually impaired children. For example, data from a systematic review by Kumaraguru et al. (2024) showed statistically significant mean differences favoring ATP interventions on plaque index scores at 180 days (MD = -0.10; p = 0.0009) and gingival index scores at 90 days (MD = -0.15; p < 0.00001) (Kumaraguru, Srisakthi, Yuwanati, & Arumugham, 2024). Similarly, Siddique et al. (2024) demonstrated comparable effectiveness between Braille and ATP techniques, with both groups showing decreased OHI-S index scores (Braille: 1.286 to 0.903; ATP: 1.364 to 1.058) (Sabin Siddique, Minimol, Kumar, & Muraleedharan, 2024). The consistency of these findings across different populations and geographical settings suggests that ATP interventions represent a robust and transferable approach to oral health education for visually impaired children.

The improvement in toothbrushing practices observed in this study, particularly the increase in twice-daily brushing from 28.1% to 71.9% and the adoption of combined vertical and horizontal brushing techniques from 40.4% to 80.7%, reflects similar patterns reported in recent literature. Santhoshi et al. (2024) found that combined Braille and NVDA (non-visual desktop access) methods achieved the highest knowledge scores (6.36 ± 0.52) compared to individual methods. This consistency may be attributed to the multi-sensory nature of ATP interventions, which engage multiple learning pathways simultaneously, compensating for the absence of visual learning cues (Santhoshi et al., 2024). The

effectiveness of such comprehensive approaches has been further supported by longitudinal studies, including work by Křížová et al. (2024), which demonstrated gradual plaque reduction following repeated oral hygiene training among visually impaired youth (Křížová et al., 2024).

However, studies have reported variations in results, potentially attributable to the duration of the intervention, characteristics of the population, or methods of measuring outcomes. As an illustration, although this study reported an overall improvement in toothbrushing behaviors immediately following the intervention, Hema et al. (2024) indicated that group oral education methods resulted in a greater mean percentage reduction in plaque compared to the Braille method alone (Mean reduction = 0.33 vs 0.16, p = 0.037). These differences between studies could be due, partly, to the duration of the intervention, as shorter studies may also demonstrate less sustained behavior change over time. Additionally, it is important to note that throughout the study, parents supervised 53.3% of the cases, and parental supervision may be a confounding variable impacting intervention efficacy across different populations (Hema, Ganesan, Ahila, Thirumalai, & Kumar, 2024).

The high prevalence of parental assistance in toothbrushing observed in this study (53.3%) represents both a strength and a potential limitation in achieving independence in oral hygiene practices. While parental involvement can enhance immediate oral health outcomes, it may also limit the development of autonomous self-care skills among visually impaired children. Recent research by Pandiyan et al. (2024) emphasized the importance of developing independent oral hygiene capabilities among special needs children, particularly in institutional settings where parental supervision may be limited. This finding suggests that future interventions should incorporate strategies to gradually transition children toward independent oral hygiene practices while maintaining family involvement as a supportive element (Pandiyan, Arumugham, & Prabakar, 2023).

The clinical implications of the observed improvements are more than just short-term indicators of oral health. The significant reduction in gingival inflammation and plaque accumulation measured in this study is consistent with other research related to populations with special needs. For example, cross-sectional studies have consistently found that children with visual impairments suffer from greater rates of dental caries and periodontal disease than their sighted peers. By demonstrating the effectiveness of the ATP intervention to ameliorate these disparities experienced by visually impaired populations, some degree of generalization can be entertained for implementation of the ATP intervention on a wider scale in special education or healthcare systems that serve other populations with visual impairments (Buela, Srisakthi, & Chellappa, 2025; Mehta et al., 2025).

Future research should investigate the long-term sustainability of these advances and the incorporation of new technologies like B-FRESH (Blind-Friendly Efficient Smart Hygiene) media, which has demonstrated promising early efficacy in pilot studies. It would also be useful to review the cost-effectiveness of ATP interventions versus standard oral health education methodologies for the benefit of policy development and resource allocation in special populations across the healthcare system. The evidence continues to support multi-modal approaches, and with the current evidence surrounding multi-modal educational strategies, an oral health program that includes audio, tactile, and demonstration elements should be considered standard practice for children who are blind and other special populations (Ridwan, Isnanto, & Sugito, 2024).

Limitations

Several limitations in the study need to be acknowledged while interpreting the findings. First, employing a single-group pre-test/post-test design without having a control group, limits demonstration of causality and attributed any observed changes solely to the intervention, considering that other external factors may have affected the outcomes. Second, the two-month

follow-up was a relatively short timeframe over which to evaluate the sustainability of self-reported changes in oral hygiene behaviors and clinical outcomes. Third, the use of a convenient sample from a single specialized institute in Erbil, Iraq, limits the generalizability of the findings to visually impaired children in other districts, specifically from different cultures, socioeconomic status, and/or institutional contexts. In addition, self-reporting oral health behaviors such as frequency and duration of brushing may have been impacted by either recall or social desirability bias. Finally, there was a high parent involvement with regard to the oral care of their children, creating an extraneous variable in determining the extent of the effects of the interventions on children's self-care behaviours.

5. Conclusion

The present study evaluated a unique oral health educational program based on Audio, Tactile and Performance (ATP) which positively impacted oral health behaviours and clinical outcomes among children with visual impairment in Erbil, Iraq. Notably, there were substantial positive shifts from baseline to post-intervention on both oral hygiene index and gingival index scores. Additionally, the frequency, technique and time for toothbrushing improved. This is an indication of the potential for multisensory, 'non-visual' pedagogy to engage vulnerable populations in oral health when there are barriers. Integrating such targeted programs into special education and community health systems could help promote sustainable oral health practices and reduce disease burden among visually impaired children.

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