Original Article

School-Based Oral Health Promotion Program for Visually Impaired Adolescents in Thailand: A Before-And-After Study

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Abstract

Visual impairment causes some challenges for adolescents' oral health. This study aimed to develop an oral health promotion for visually impaired adolescents and evaluate the effect of the program on oral health literacy and oral behaviors. This one-group before–after study enrolled 27 visually impaired adolescents (grade 7-12) from the Bangkok school for the blind was conducted during June 2022 to January 2023. Clinical examination, oral health knowledge, word comprehension, and oral health behaviors were evaluated at baseline, immediately after the intervention and at a six-month follow-up. The oral health promotion including developing oral health literacy and tooth brushing skills via workshops and audio media, creating a supportive environment in school, developing an oral health policy, and reorienting oral health service was implemented. Caries prevalence was 76.5%. Mean (SD) DMFT was 2.41 (2.09) and mean (SD) OHI-S score was 1.74 (0.84) at baseline. Comparing the baseline and post-intervention immediately, there were significant improvements in the knowledge about tooth decay (p=0.044), oral health care (p=0.022) and cariogenic food (p<0.001). After six months, there were significant improvements in knowledge about tooth decay (p=0.005), gingivitis (p=0.040) and cariogenic foods (p=0.001) when compared with the baseline. There were significantly more adolescents who understood the dental keywords after six months in the words "periodontitis", "sealant", "dental pulp", "cervical tooth region" and "dental plaque". The significant improvement in behavior was only seen in the use of fluoride in toothpaste (p=0.034). School-based oral health promotion programs can improve oral health literacy and behaviors in using fluoride toothpaste among visually impaired adolescents.

Keywords: Adolescents, Blindness, Oral health promotion, School-based program, Visually impairment

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Introduction

Blindness is a visual impairment characterized by the complete or significant loss of vision in one or both eyes. The World Health Organization (WHO) defined blindness as having visual acuity of less than 3/60 or corresponding visual field loss in the better eye with the best possible correction.[1] Visual impairment includes low

vision which is defined as visual acuity worse than 6/12 (low), 6/18 (moderate) and 6/60 (severe), and blindness. Around 2.2 billion of world population have visual impairment or blindness.[2] In Thailand, there are 184,542 visually impaired people who registered in the Ministry of Public Health system in 2024, accounting for 0.28 percent of the Thai population.[3] Individuals who are visually impaired often experience difficulties in performing everyday tasks that require visual perception, such as reading, recognizing faces, and navigating their surroundings.[1] However, the impacts on oral health are often overlooked.

Several studies show that visually impaired people have poorer oral hygiene than sighted people. They have a higher prevalence of dental caries, gingivitis and other difficulties with oral function.[4] In visually impaired people, it is more difficult to maintain oral hygiene since their perceptual ability depends primarily on touching and hearing, therefore they cannot detect their oral problems as promptly as others. Moreover, they have less opportunity to access dental service and to obtain knowledge about oral health care.[5] Focusing on preventive dentistry in young visually impaired people could improve their oral health status and reduce the need for more complex treatment later on.

Understanding these challenges and implementing appropriate strategies to address them is essential to ensure that individuals with visual impairment receive adequate oral health care and can maintain optimal oral health.[6] Oral health promotion program in school, which includes changing the environments to accident-free areas, developing healthy meal plans, cooperating with local hospitals to refer students with complicated oral conditions and providing oral health education for students, is a good way to help visually impaired people to have better knowledge, skills and access to dental services. Despite the potential benefits, there is a notable gap in the literature concerning oral health promotion programs specifically tailored to visually impaired schools.

The primary objective of this study is to develop an oral health promotion program in schools catering to visually impaired adolescents. The study aims to assess oral health literacy and oral behaviors among this population and, subsequently, discuss potential solutions to enhance oral health outcomes. By focusing on preventive measures and education, this research seeks to contribute valuable insights that can positively impact the oral health of visually impaired individuals, fostering better knowledge, skills, and access to dental services.

Materials and Methods

This one-group before–after study did not include a separate control group, and outcomes before and after the intervention were compared within the same group of participants. This study has been approved by the Human Research Ethics (HREC-DCU 2022-051), and informed consent was acquired from the participants in the study. The responses of the participants were kept confidential and were not linked to their identities. The data analysis was performed in block form, rather than individually, to assure anonymity and confidentiality. The study duration was from June 2022 to January 2023.

Theoretical Framework - Ecological Model

The design of this study was based on the ecological model for health behavior[7], encompasses interrelated multi-level approaches. Prior the intervention design, the consultative meeting with stakeholders consist of the director of school, members of school board, head of school health education and representative of teachers and students who were visually impaired was convened to develop the blueprint for intervention framework. At the individual level, tactile and auditory educational materials and personalized support enhance oral health knowledge and skills. Interpersonal strategies involve relationships with family, friends, peers, and social networks to influence of social support, communication patterns, and social norms on individual behavior. Organizational efforts focus on integrating inclusive oral health education into the curriculum and ensuring accessible resources within the school environment. Community engagement includes workshops and accessible dental services, while policy advocacy aims to prioritize oral health needs at the public policy level. Continuous evaluation and feedback loops ensure the adaptability and effectiveness of the program, creating a comprehensive and inclusive

framework for promoting positive oral health behaviors among visually impaired students.

Study population

Visually impaired high school students (Grade 7- 12) from the Bangkok School for the Blind who can communicate through listening were included in this study. The exclusion criteria for this study involved individual students with physical, mental, or hearing impairment. The visually impaired students received a verbal explanation in detail of the study design and they were asked to give their informed consent. The participants comprised of 27 visually impaired adolescents who attended the Bangkok School for the Blind.

Research Instruments

An online questionnaire using screen reader, text-to-speech (TTS) and speech recognition program on the phone can help the participants to read and answer the questionnaires. The questionnaire consisted of four parts: demographic characteristics, oral health knowledge, oral health behavior, and word comprehension. The 24-item oral health knowledge section covered causes of dental caries, oral health care, and cariogenic foods. The 12-item oral health behavior section assessed participants' habits, and the word comprehension section comprised 20 words. The questionnaire underwent validation by experts, ensuring content relevance and clarity.

Data collection procedures

Before the study

Prior to the intervention, telephone interviews with one teacher and two students provided insights into oral health behavior, dental utilization, school environments, and the oral health education curriculum. Baseline data, including demographic information, were collected from the 27 participants through online questionnaires. Oral examinations for plaque (using the simplified oral hygiene index - OHI-S) and caries status (using decayed, missing, and filled teeth - DMFT index) were conducted for 17 students at the initial visit.

Oral health promotion intervention

After completion of the baseline survey, the interventions were conducted at the Bangkok School for the Blind and divided into four key parts of health promotion actions following the Ottawa Charter8 including: 1) developing personal skills; 2) creating supportive environments; 3) promoting oral health through public policy; 4) reorientating oral health service. While all components were implemented as part of a comprehensive program, outcome evaluation primarily focused on changes in oral health literacy and oral health behaviors.

Part I Developing personal skills: This core component aims to promote understanding and to support the development of personal skills which enable individuals to take action to promote their health through the workshops. The three-hour session utilized audio-tactile aids (audio clip and dental model) and focused on: dietary components and their effects on oral tissues; the importance of a balanced diet; etiology of dental caries, gingivitis, clinical manifestations, treatment modalities; prevention of dental caries, sealant; the importance of brushing teeth twice daily and proper tooth-brushing technique; and the importance of a regular dental visit. Hand-on tooth brushing using modified bass technique was practiced in small groups. Furthermore, audio media was sent via participants' Line group (social communication) every month for three months.

Part II Creating supportive environments: The study emphasized the creation of a supportive school environment to facilitate oral health promotion among visually impaired adolescents. A participatory approach was employed to ensure that the learning environment was inclusive, accessible, and responsive to the specific needs of students with visual impairment. Environmental modification and supportive learning processes were developed through consultations with key stakeholders, including school administrators, teachers, caregivers, and students. Focus group discussions were conducted to explore barriers to oral health practices within the school setting and to identify feasible environmental supports. Findings from these discussions informed the design of tailored activities and materials. As part of the program implementation, schools were encouraged to provide healthier snack and beverage options in vending machines. To support regular tooth brushing, school nurses were encouraged to implement a standardized

tooth-brushing protocol, and toothbrushes with 1,500 ppm fluoride toothpaste were provided to all students.

Part III Promoting oral health through public policy and community participation: This component served as an enabling strategy aimed at institutional support rather than a directly evaluated outcome. Policy-level discussions were conducted to establish school-based guidelines that supported regular oral health activities, including scheduled toothbrushing after meals, provision of fluoride toothpaste and appropriate oral hygiene equipment, and screening and referral system for dental services provided by volunteer dentists in school dental clinics. Advocacy efforts were directed toward the school board to encourage the adoption of a healthy food policy, including guidance for donors to provide healthier food options and promoting healthy meals in the school cafeteria. These actions were intended to support and sustain individual-level behavior changes promoted in the program. The study also encouraged the incorporation of oral health promotion into the health-related regulations and annual action plans of the school.

Part IV Reorientation oral health service: Reorientation of oral health services was implemented as a supportive structural component of the program. The research team facilitated collaboration among school administrators, school nurses, and teachers to support the establishment of preventive oral health services within the school. In addition, a referral pathway for students requiring further or specialized dental treatment to local hospitals was discussed and coordinated. This component aimed to improve access to preventive care and continuity of oral health services, although its outcomes were not quantitatively evaluated in this study.

Table 1 describes the oral health promotion actions and the expected outcome. These outcomes are the bridge between what we do and what we are trying to achieve in oral health promotion interventions.

Table 1 *Expected outcome from Oral Health Promotion Program*

Intervention	Activity	Expected outcome
Developing personal skills	• Oral health literacy workshop and tooth brushing training • Audio media via group chat	• Increase oral health literacy • ncrease tooth brushing skill • Improve oral health behavior
Create supportive environment in school	• Consultative meeting with school board and stakeholder • Providing toothbrushes and 1500 ppm toothpastes	• Availability of healthy snacks and drinks in vending machines • Availability of toothbrushes 1500 ppm fluoride toothpastes
Promoting oral health through public policy	• Advocating school board to promote healthy food policy	• Promote healthy food from donation • Availability of healthy food in school cafeteria
Reorientation oral health service	• Facilitation health teacher to set preventive clinics in the school • Referring students for dental treatment in cooperation with local hospitals	• Having preventive clinics in the school • Number of students who have oral examination and are referred for treatment, if needed.

Post-Intervention and Follow-Up

Data on oral health knowledge and word recognition were collected immediately post-intervention and again six months later, utilizing the same questionnaire and clinical oral examinations as at baseline.

Statistics analysis

The statistical analysis was carried out using SPSS version 22 (IBM, Armonk, NY, USA). The paired *t*-test was employed to assess the clinical outcome and word comprehension both before and after the intervention.

For comparison of baseline data, immediately after, and six months post-intervention in the knowledge segments, we utilized repeated ANOVA. The Chi-square test was used to identify and compute categorical variables. A *P*-value of less than 0.05 was deemed statistically significant.

Results

A total of 27 visual impaired adolescents aged 13 - 20 years old (8 males, 19 females) were recruited for this study. The median age (interquartile range) was 16 (3) years. There were 14 (51.9%) totally blind students and 13 (48.1%) partially blind students. At baseline, 17 participants underwent clinical examination, showing a caries prevalence of 76.5 % with a mean (SD) DMFT of 2.41 (2.09) and a mean (SD) OHI-S score of 1.74 (0.84).

All 27 participants completed the immediate post-intervention assessment. At the six-month follow-up, 18 participants completed the questionnaire and were included in the main outcome analyses, resulting in an overall attrition rate of 33.3%. Reasons for loss to follow-up included absence on the examination date and non-response to the online questionnaire. Clinical re-examination at six months was available for nine participants only (Supplementary file).

Following the ATP-based intervention, significant improvements in oral health knowledge were observed, particularly in domains that were directly addressed through audio-tactile learning and hands-on practice. Immediately after the intervention, significant gains were observed in knowledge related to tooth decay (p=0.044), oral health care practices (p=0.022) and cariogenic foods (p<0.001). However, gingivitis (p=0.248) and dental attendance (p=0.645) showed no significant change. After six months, there were significant improvements in the categories of tooth decay (p=0.005), gingivitis (p=0.040), and cariogenic foods (p=0.001) when comparing at the baseline. Whereas the category of oral health care (p=0.050) and dental attendance (p=0.165) showed improvement but was not statistically significant. The total knowledge score highly increased over time. The percentage of knowledge score increased from 61.13 (at baseline) to 83.83 (at six months), suggesting a sustained effect of the ATP-based educational approach. (Table 2).

Table 2 *Knowledge scores at baseline, immediate and 6 months after intervention (n=18)*

Knowledge category	Knowledge score						*p* value (T0-T1)	*p* value (T0-T2)
	T0 (baseline)		T1 (immediate)		T2 (6m)			
	Mean	SD	Mean	SD	Mean	SD		
Tooth decay	1.5	0.618	1.89	0.323	1.94	0.236	0.044*	0.005*
Gingivitis	2.78	1.114	3.44	0.705	3.67	0.594	0.248	0.040*
Oral health care	5.5	1.286	7.21	1.251	7.07	1.328	0.022*	0.050
Dental attendance	1.56	0.511	1.78	0.428	1.89	0.323	0.645	0.165
Food	3	1.029	5.22	1.06	4.67	1.455	<0.001*	0.001*
Total	14.06	3.077	19.89	2.246	19.28	3.025	<0.001*	<0.001*

** p value analyzed using repeated ANOVA with statistically significant different (p<0.05)*

In terms of functional oral health literacy, word comprehension of key dental terms improved markedly after the intervention. The number of participants who correctly understood technical terms such as "periodontitis", "sealant", "dental pulp", "cervical tooth region" and "dental plaque" increased at six months compared with baseline (Fig. 1), reflecting enhanced conceptual understanding facilitated by multisensory learning strategies.

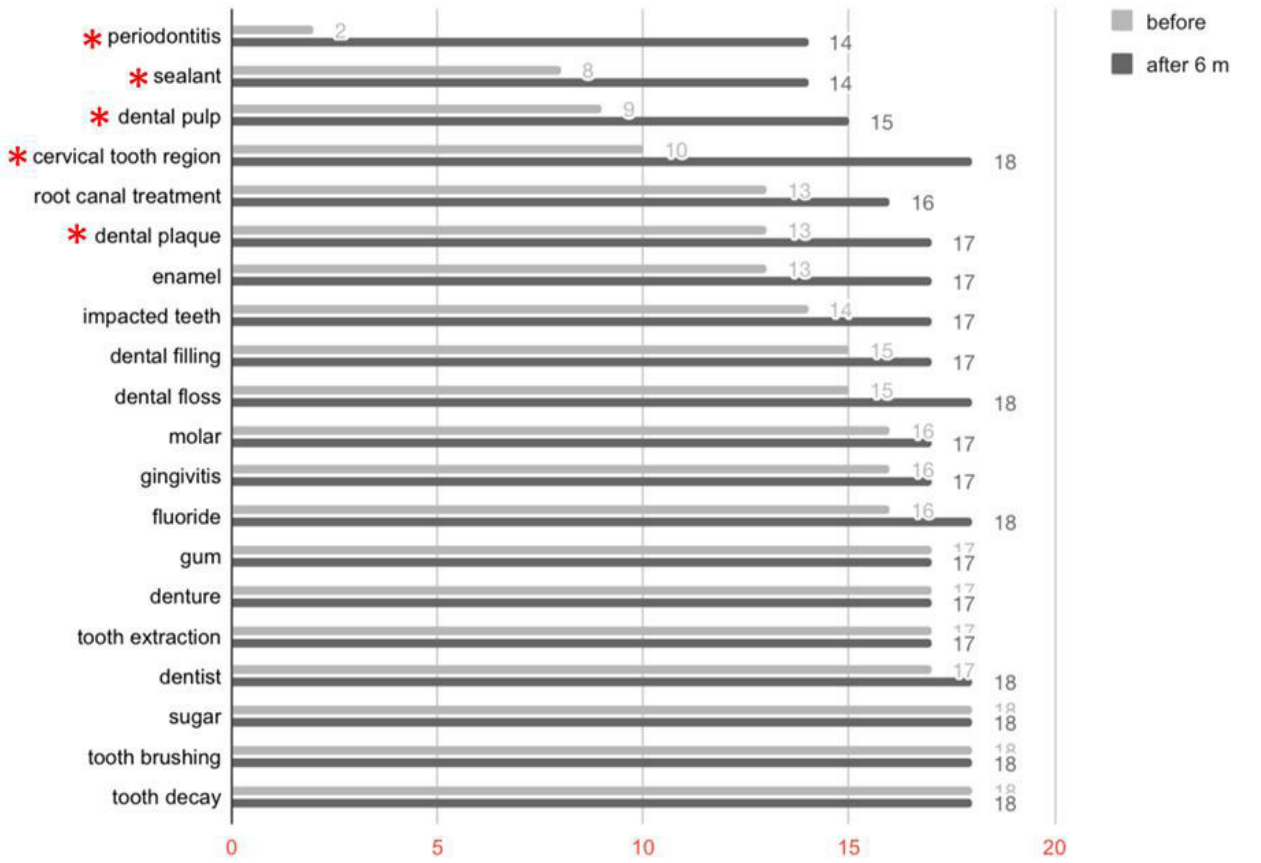

Figure 1 *At baseline and 6 months post-intervention, 18 students understood oral health literacy terms.*

Changes in oral health behaviors were modest. A statistically significant improvement was observed only in the use of fluoride toothpaste, which increased from 38.9% at baseline to 77.8% at six-month follow-up (p = 0.034). Other behaviors, including frequency of tooth brushing, sugar consumption, use of additional oral care products, and dental attendance, showed no statistically significant changes (Table 3).

Table 3 *Oral health behaviors before and after intervention (n=18)*

Oral health behavior		n (%)		*p*-value
		before	after 6 months	
frequency of sugar consumption	in meal	5 (27.8)	11 (61.1)	0.098
	1-2 times/day	9 (50.0)	6 (33.3)	
	>2 times/day	4 (22.2)	1 (5.6)	
frequency of tooth brushing	0-1 time/day	1 (5.6)	3 (16.7)	0.289
	>=2 times/day	17 (94.4)	15 (83.3)	
type of toothbrush	manual	18 (100.0)	17 (94.4)	0.310
	electric	0 (0.0)	1 (5.6)	
toothbrush bristles	soft	11 (61.1)	7 (38.9)	0.138
	medium	7 (38.9)	8 (44.4)	
	hard	0 (0.0)	3 (16.7)	
fluoride in toothpaste	with fluoride	7 (38.9)	14 (77.8)	0.034*
	without fluoride	2 (11.1)	2 (11.1)	
	not sure	9 (50.0)	2 (11.1)	

Table 3 *Oral health behaviors before and after intervention (n=18) (cont.)*

Oral health behavior		n (%)		*p*-value
		before	after 6 months	
other oral care products	no use	11 (61.1)	13 (72.2)	0.775
	floss	2 (11.1)	2 (11.1)	
	mouthwash	1 (5.6)	2 (11.1)	
	proxabrush	1 (5.6)	1 (5.6)	
	toothpick	1 (5.6)	2 (11.1)	
frequency of dental visit	none	13 (72.2)	14 (77.8)	0.464
	1 time	5 (27.8)	3 (16.7)	
	>=2 times	0 (0.0)	1 (5.6)	

** p value analyzed using Chi-square test with statistically significant difference (p<0.05).*

No statistically significant differences were observed in the mean numbers of decayed teeth (DT), missing teeth (MT), filled teeth (FT), or the overall DMFT scores between baseline and the six-month follow-up assessment. The mean Oral Hygiene Index–Simplified (OHI-S) score showed a slight downward trend at six months compared with baseline; however, this change did not reach statistical significance.

Regarding the healthy public policy, supportive environment component, post-implementation findings indicated incremental but meaningful developments at the institutional level. Although no formal revisions to school regulations concerning food and beverage sales were observed during the study period, oral health considerations began to be incorporated into existing school health practices and service delivery structures. Preventive dental services, including annual dental examinations, topical fluoride application, and fissure sealant placement, were maintained as routine practices within the school dental clinic, reflecting sustained policy support for preventive oral health care for students with visual impairment. In addition, a structured referral policy was operationalized for students requiring advanced dental treatment. Approximately ten students per year were systematically referred to the Faculty of Dentistry, Chulalongkorn University, indicating the presence of an established inter-institutional collaboration and continuity of care beyond the school setting.

Furthermore, the initiation of an oral health education module tailored for visually impaired students was implemented by another research team and integrated into the school curriculum. This suggests growing institutional recognition of oral health as a component of comprehensive student well-being. While this curriculum initiative was not directly generated by the present program, it reflects an enabling policy environment and increased alignment between educational and health objectives within the school system. Overall, these findings demonstrate early-stage policy integration characterized by the maintenance of preventive service provision, formalized referral pathways, and emerging curriculum-level actions. However, broader policy changes affecting the school food environment, particularly regulations governing beverage availability, had not yet been realized during the study period.

Discussion

The findings of this study indicate that visually impaired adolescents had a higher prevalence of dental caries and poorer oral health than sighted counterparts. This observation is consistent with national and international evidence demonstrating oral health disparities among individuals with visual impairment. Data from the report of the 9th Thai National Oral Health Survey in 2023[9] showed that 15-year-old Thai adolescents had a caries prevalence of 61.2%, a mean DMFT of 2.1 whereas caries prevalence of this study was 76.5% with the mean DMFT of 2.41 teeth. Similar to Bunyoo's study in Thailand that found 58.8% of visually impaired adults (ages 21 to 93; mean age 67.45) had dental caries. Moreover, they had less restoration in

due to the lower accessibility of dental treatment.[10] Samnieng *et al.*'s study conducted on 146 visually impaired adults (mean age 48.8–5.9) who live in Phitsanulok, Thailand indicated that visually impaired people had poorer oral hygiene than the sighted ones.[4] In accordance with studies in India (Solanki *et al.*, 2013), which compared 354 visually impaired children (ages 6 to 15 years) to 350 sighted children, the prevalence of dental caries in visually impaired children (60%) was higher than the group of the sighted children (31.5%). These findings reflect persistent structural, informational, and environmental barriers to oral health care among visually impaired adolescents. Such disparities underscore the need for oral health promotion strategies that address not only individual knowledge deficits but also broader social and environmental determinants of health, in line with the Ottawa Charter for Health Promotion. In this context, the outcomes of the present study can be meaningfully interpreted through the framework of developing personal skills and creating supportive environments, which represent two core components of the implemented program.

This finding might be possible that those who are visually impaired have poorer oral hygiene because they have difficulty in locating plaque[4] and cannot identify oral diseases as early as others.[11] Additionally, they lack knowledge of proper oral health care and are less aware of the importance of regular dental checkups, resulting in tooth decay later.[4] Moreover, less access to dental treatment is one of the reasons why visually impaired people have more oral health concerns than sighted people. Other reasons include parents' attitudes that do not recognize the importance of oral care for visually impaired children, dentists' bias against the visually impaired, and environments that are unfriendly to the visually impaired.[4,12] These results are consistent with the study of Yalcinkaya *et al* [13], which found that an effective oral health program could improve the oral health knowledge of visually impaired students. In this context, the present study highlights the potential role of the Audio-Tactile Performance (ATP) technique in enhancing oral health literacy among visually impaired adolescents. By integrating auditory instruction, tactile exploration, and hands-on practice, the ATP approach aligns with multisensory learning principles that are particularly relevant for individuals with visual impairment. Evidence from related populations further supports this approach: a systematic review by Shrivastava *et al.*[14] reported improved oral health knowledge and behaviors through visual learning strategies among children and adolescents with hearing impairment, while Khurana *et al.*[15] emphasized the importance of adapting oral health education to the sensory needs of individuals with visual impairment using accessible formats such as Braille-based tools. Collectively, these findings reinforce the rationale for multisensory, sensory-adapted educational approaches, consistent with the significant and sustained improvements in oral health knowledge and word comprehension observed in the present study.

Improvements were particularly evident for technical terms such as "periodontitis", "sealant", "dental pulp", "cervical tooth region" and "dental plaque". These gains are likely attributable to repeated exposure through audio media and tactile engagement during workshops, especially the opportunity to physically explore dental models. Tactile learning enables individuals with visual impairment to better perceive three-dimensional structures and spatial relationships, which may facilitate deeper understanding and retention of oral health concepts. These findings are consistent with previous studies demonstrating the effectiveness of ATP-based oral health education among visually impaired children and adolescents.[16] In contrast, commonly used daily terms such as tooth brushing, sugar, and dentist showed limited change, likely reflecting a ceiling effect, as participants were already familiar with these concepts prior to the intervention. This distinction further supports the role of ATP techniques in strengthening more complex or abstract aspects of oral health literacy rather than basic knowledge alone.

With regard to oral health behaviors, a statistically significant improvement was observed only in the use of fluoride toothpaste. This change may have been influenced by both increased oral health knowledge acquired through the audio-tactile performance (ATP)–based education

and a reduction in access-related barriers, as fluoride toothpaste was provided to all participants as part of the intervention. Visually impaired adolescents may experience difficulty in identifying fluoride content on toothpaste labels, and therefore the combination of targeted education and material support likely facilitated this behavioral change. However, due to the one-group before–after study design, the independent effects of knowledge improvement and resource provision cannot be clearly disentangled.

In contrast, other oral health behaviors, including tooth brushing frequency, sugar consumption, and dental attendance, did not show statistically significant changes. Although tooth brushing skills were addressed through hands-on ATP training, a single session may have been insufficient to produce sustained behavioral change. Difficulties in brushing posterior and lingual surfaces were observed, suggesting that repeated practice and reinforcement may be necessary to translate skill acquisition into habitual behavior. Previous studies have similarly emphasized the importance of repeated and longitudinal training sessions for improving oral hygiene practices among visually impaired individuals.[17]

Sugar consumption also remained largely unchanged, likely due to environmental influences beyond individual control, such as the availability of sugary foods and beverages in and around school settings. This finding aligns with existing literature demonstrating that dietary behaviors among children and adolescents are strongly shaped by physical and social environments.[18,19] In the absence of substantial environmental or policy-level modifications, individual-level education alone may have limited impact on such behaviors. Consequently, the lack of significant improvement in clinical outcomes, including DMFT and OHI-S scores, is not unexpected within the relatively short follow-up period.

With respect to creating supportive environments and policy-related actions, a descriptive follow-up conducted after program implementation indicated that changes in the physical school environment remained limited, particularly regarding beverage options available through vending machines. This finding highlights the challenges of modifying environmental determinants of health within school settings, which often require sustained policy commitment beyond short-term interventions. Nevertheless, progress was observed in other supportive domains, including the initiation of an oral health education module tailored as part of the school curriculum by another research team, and the establishment of a referral pathway enabling students to access comprehensive dental care. Although these developments were not quantitatively evaluated, they represent early steps toward strengthening supportive environments and reorienting oral health services in alignment with the Ottawa Charter framework.

Several limitations need to be acknowledged. The one-group before–after study design limits causal inference and does not allow clear separation of the effects of individual skill development and environmental support. In addition, the relatively high loss to follow-up may have reduced statistical power to detect changes in behaviors and clinical outcomes. Finally, longer follow-up periods are likely required to observe meaningful changes in oral health behaviors and clinical indicators. Despite these limitations, the present study provides valuable evidence supporting the application of ATP-based strategies within an Ottawa Charter–informed framework to improve oral health literacy among visually impaired adolescents.

Conclusion

A school-based oral health promotion program can effectively enhance oral health literacy and improve specific oral health behaviors, particularly the use of fluoride toothpaste, among visually impaired adolescents.

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