Community Dental Health (2024) **41,** 14–19
Received 3 June 2023; Accepted 14 August 2023

doi:10.1922/CDH_00109Bhadauria06

Sign language based educational interventions vs. other educational interventions to improve the oral health of hearing-impaired individuals: A systematic review and meta-analysis

Upendra S. Bhadauria, Bharathi Purohit, Harsh Priya

Department of Public Health Dentistry, All India Institute of Medical Sciences, India

Objective: Individuals with special needs requiring special care are more vulnerable to oral health problems. Sign language is a communication medium and language of instruction for individuals with hearing impairments. The purpose of this systematic review and meta-analysis was to assess the effectiveness of sign language-based educational interventions compared to other educational interventions in improving the oral health of hearing-impaired individuals. ***Methods***: PubMed, Scopus, Embase, and Cochrane Central Register of Controlled Trials databases were searched without any restriction on the publication date. Analytical and experimental studies that evaluated and compared the effectiveness of sign language with other educational intervention groups such as videos, posters etc were included. ***Results***: Initially, 5568 records were identified. Three relevant publications from India were eligible and included in the systematic review and meta-analysis. Differences were reported in favour of sign language over other interventions concerning plaque status, gingival health, and oral hygiene status. ***Conclusion***: Sign language-based interventions were found to be effective. However, further studies in different locations and populations are required to support their effectiveness.

Keywords*: Oral Health, Oral Hygiene, Persons with hearing impairments*

Introduction

World Health Organization trends estimate that by 2050, approximately 2.5 billion people (1in every 4) will experience hearing loss, with nearly 700 million (1 in every 14) living with moderate or higher levels of hearing loss in their better hearing ear (World Health Organization, 2021). The main areas of the world affected by disabling hearing loss are the South Asian, Asia Pacific and Sub-Saharan African regions, with prevalence almost four times greater than high income regions (World Health Organization, 2018). Hearing disorders impact general behaviour and impair social functioning, often leading to the neglect of affected individuals due to ignorance, fear, stigma, misconceptions, and negative attitudes (Pareek *et al*., 2015).

Individuals requiring special care are particularly vulnerable to oral health problems (Moin *et al.*, 2021). Their potential motor, sensory, and intellectual disabilities limit their ability to maintain proper oral hygiene, making them more susceptible to oral health issues. Previous studies have reported communication challenges with hearing-impaired individuals, resulting in poor patient adherence to treatment. Additionally, this population has a higher prevalence of dental caries and periodontal diseases (Hashmi *et al*., 2016).

Sign language is used in some countries as a communication medium and language of instruction for individuals with hearing impairments (Jameel *et al*., 2016). People with hearing impairments have the potential to master sign language, and its extensive use has been beneficial in improving their understanding and communication skills. Additionally, sign language has been used in educational interventions to enhance overall development in students (Staden *et al*., 2009).

Sign language has also been used in educational interventions to improve the oral health of hearing-impaired individuals. Studies evaluating the effectiveness of sign language-based interventions compared to other interventions have yielded varying findings, with some reporting no differences and others indicating sign language to be more effective (Hashmi *et al*., 2019; Saikiran *et al*., 2019; Sudhindra *et al*., 2020). However, a comprehensive assessment of sign language in educational interventions for the oral health of hearing-impaired individuals has not been conducted. Therefore, this systematic review aimed to compare the effectiveness of educational interventions delivered through sign language with other educational interventions on the oral health of hearing-impaired individuals.

Methods

This systematic review and meta-analysis were conducted following the Preferred Reporting Items for Systematic Review and Meta-Analysis (PRISMA) guidelines and registered in PROSPERO (CRD42022363401). The focused question, within the population, intervention, comparison, and outcome (PICO) format, was: Are sign language-based educational interventions compared to other educational interventions effective in improving oral hygiene, plaque, and gingival status among hearing-impaired children and adolescents?

Correspondence to: Harsh Priya Email: drharshpriya@gmail.com

Thus, the included population was hearing-impaired children and adolescents, the intervention was sign language-based educational interventions, the comparison group was other educational interventions and the outcome oral hygiene, plaque or gingival status. Studies conducted or translated into English were included, while editorials, review articles, observational studies, and non-English language studies were excluded.

An electronic search was performed in English-language databases, including PubMed, Scopus, Embase, and the Cochrane Central Register of Controlled Trials, from October 2022 to November 2022. No time frame restriction was applied. Additionally, Google Scholar and Grey literature were searched, and the references of the included studies were examined. The search strategy involved using MeSH keywords (Available at https://www.aiims.edu/index.php?option=com_content&view=article&id=16522&catid=189&lang=en). Two independent reviewers (USB and BP) followed the screened titles and abstracts for inclusion. Duplicates were manually removed. Full articles were then read and analyzed for eligibility, with discrepancies resolved through discussion with the third author (HP). Inter-reliability across the title/abstracts and full-text review stages was measured using Cohen's Kappa, with reported values of 0.82 and 0.84, respectively.

Data were extracted by one reviewer (USB) and cross-checked independently by the second BP. Data were extracted independently from the included full-text articles. Collated information included author details, participant age range, year of study, sample size, country, intervention, indices, study design, and results. Any inconsistencies were discussed and resolved between the two authors, and missing or unclear information was sought from the authors of the selected papers.

Risk of bias in randomized controlled trials was assessed using the Revised Cochrane risk-of-bias tool for randomized trials. (RoB2), with five domains that evaluate the potential bias introduced (Sterne *et al*., 2019). For non-randomized controlled trials, the ROBINS2 ("Risk of Bias in Non-randomised studies – of Interventions") criteria were used (Sterne *et al*., 2016). RoB 2 is structured into a fixed set of domains of bias, focusing on different aspects of trial design, conduct, and reporting.

Statistical analysis was conducted in Review Manager 5.4. Heterogeneity was assessed using the I^2 values, and a confidence interval of 95% was used. The data were summarized differences in means. Oral hygiene, gingival, and plaque status were assessed using the random-effects model. 'Oral hygiene' and 'plaque'were measured with several indices; but all were taken to measure plaque found on and between the teeth.

Results

The initial search yielded 5,568 records. After removing 1365 duplicates, 8 were selected for full-text evaluation for eligibility by the two independent reviewers (Figure 1). The bibliographies of the selected studies were also hand-searched.

Five of the 8 studies were excluded. Two used a single group pre-post-test design (Veriza *et al*., 2021; Kurniawati *et al*., 2022). One study compared the visual performance reinforcement technique (VPR) with sign language, but the VPR group received sign language-based interventions (Kumar *et al*., 2022). One study investigated the knowledge and attitudes of caregivers of children with hearing impairments and another compared knowledge change using booklets and sign language videos (Sneha *et al*., 2022; Fageeh *et al*., 2020).

Three relevant publications were included in the systematic review and meta-analysis. Oral hygiene status was assessed in two studies, whereas plaque and gingival status were reported in all three.

Table 1 summarises the characteristics and chief findings of the included studies. They were published in 2019 or 2020, and were all conducted in India. Two studies were randomized controlled trials, while one did not explicitly define the design but evaluated two interventions. Only one study reported a gender predilection with male predominance. The participants in all studies were aged 5-20 years, and the sample sizes ranged from 64-178. Validated oral hygiene, plaque, and gingival indices were used to assess the oral hygiene, plaque, and gingival status of the participants.

Figures 2 and 3 reports the risk of the bias in the included studies. Two were reported to have high bias, and one had some concerns. The assessment for randomized trials considered bias arising from randomization, deviations from the intended intervention, missing outcome data, measurement of outcome, and selection of the reported result. One study was judged to have an overall high risk of bias due to multiple domains of concern, while the other study was interpreted to have some concerns in two of the five domains. The ROBINS assessment for non-randomized trials revealed serious bias in two domains and low bias in five domains, resulting in an overall judgment of high bias.

The results of the meta-analysis are depicted in Figures 4, 5, and 6. A difference was reported favouring sign language over visual interventions with respect to plaque status (p = 0.002, I^2=84%, mean difference -0.07, 95%CI = -0.20,-0.06), gingival status (p =<0.001, I^2=94%, mean difference -0.05, 95%CI = -0.08,-0.01), and oral hygiene status (p =<0.001, I^2=100%, mean difference -17.68, 95%CI = -51.10, -15.75).

Discussion

Sign language is recognized as a natural language for many deaf and hearing-impaired individuals, with some countries even considering it the first language for deaf people (Jameel *et al*., 2016). Sign languages are not only linguistically important but also possess complex structures and independent grammar. Therefore, using sign language in interventions to improve the oral health of hearing-impaired individuals is justifiable. However, our findings highlight gaps in the literature regarding the use of sign language in dental health education in this special population. Other interventions, such as posters and videos, primarily rely on the participants' ability to communicate and learn new activities and behaviours (Balian *et al*., 2021; Shrivastava *et al*., 2022).

The studies included in this review compared sign language with other interventions, but variations were observed in the sign language-based interventions. The

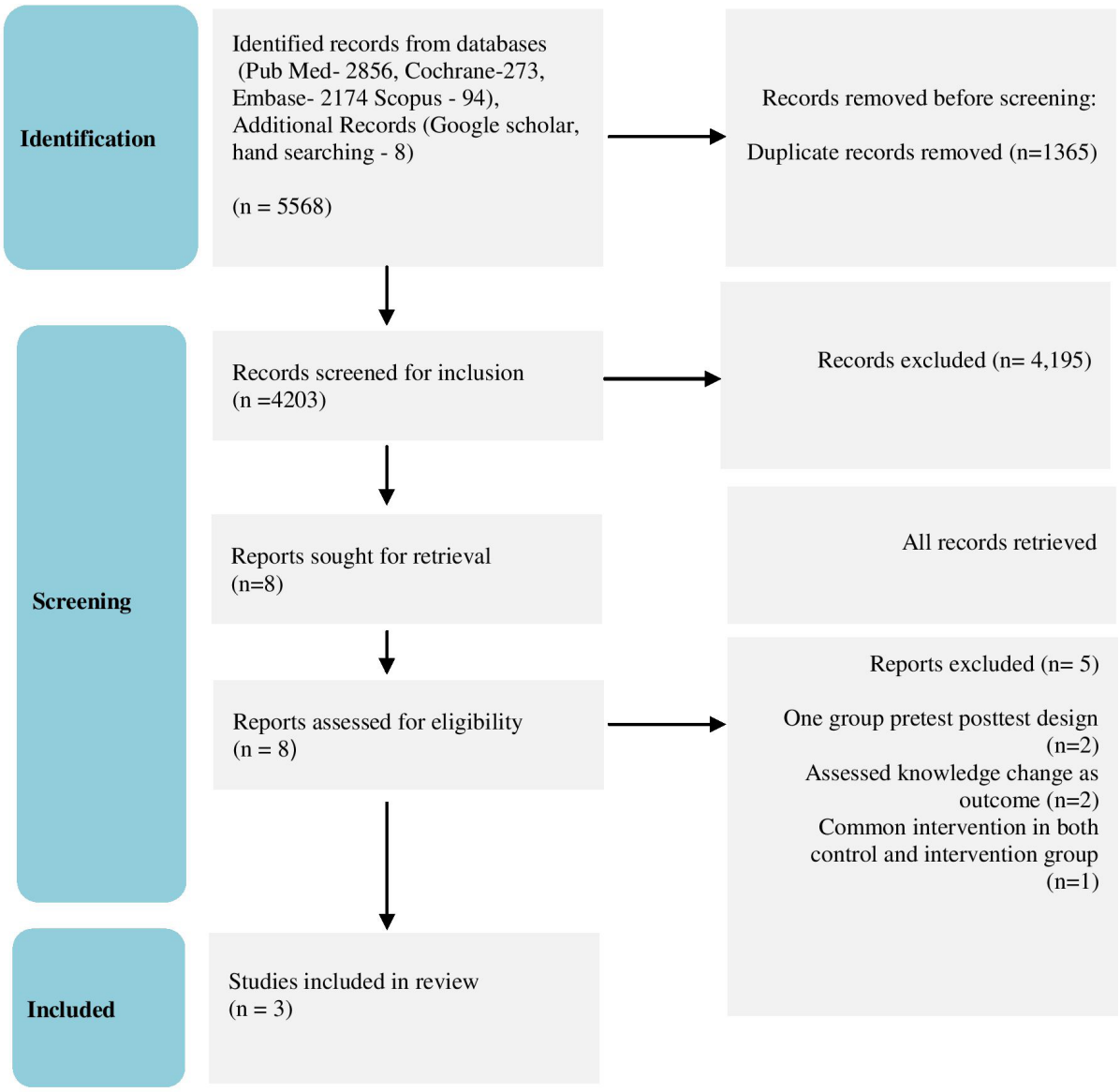

Figure 1. *Flowchart of records screening through review process.*

Table 1. Characteristics of three included studies.

Author	*Age (Years)*	*Year*	*Sample size*	*Country*	*Intervention vs. Comparison*	*Indices*	*Study Design*	*Results*
Hashmi	11-20	2019	178	India	Sign language vs Poster (Visual)	OHI-S, Plaque, Gingival	Randomized Double Blind Control Trial	Post-intervention oral hygiene, plaque and gingival index scores were 1.72 & 2.31 (p=0.01), 0.77 & 0.80 (p=0.61), 0.61 & 0.82 (p=0.01) respectively.
Saikiran	5-15	2019	93	India	Sign language vs Video	Oral Hygiene Status, Plaque Status, Calculus Status	Randomized Controlled Trial	Similar post-intervention debris, calculus, OHI-S, plaque & gingival indices in both groups.
Baliga	6-13	2020	64	India	Sign language vs Video	Plaque and Gingival Scores	_	Similar post-intervention plaque and gingival scores in both groups.

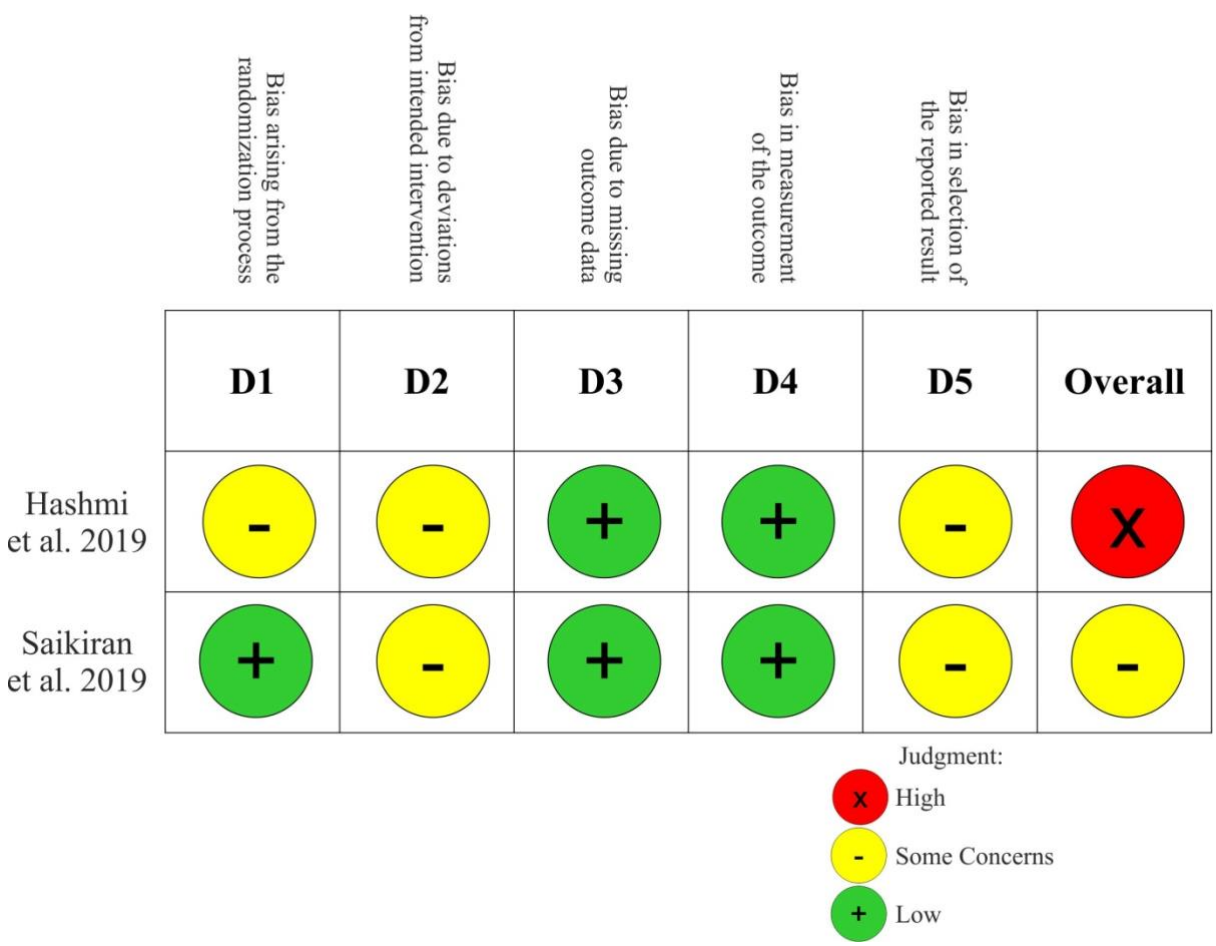

Figure 2. *Risk of bias - ROB-2 assessment of randomized controlled trials.*

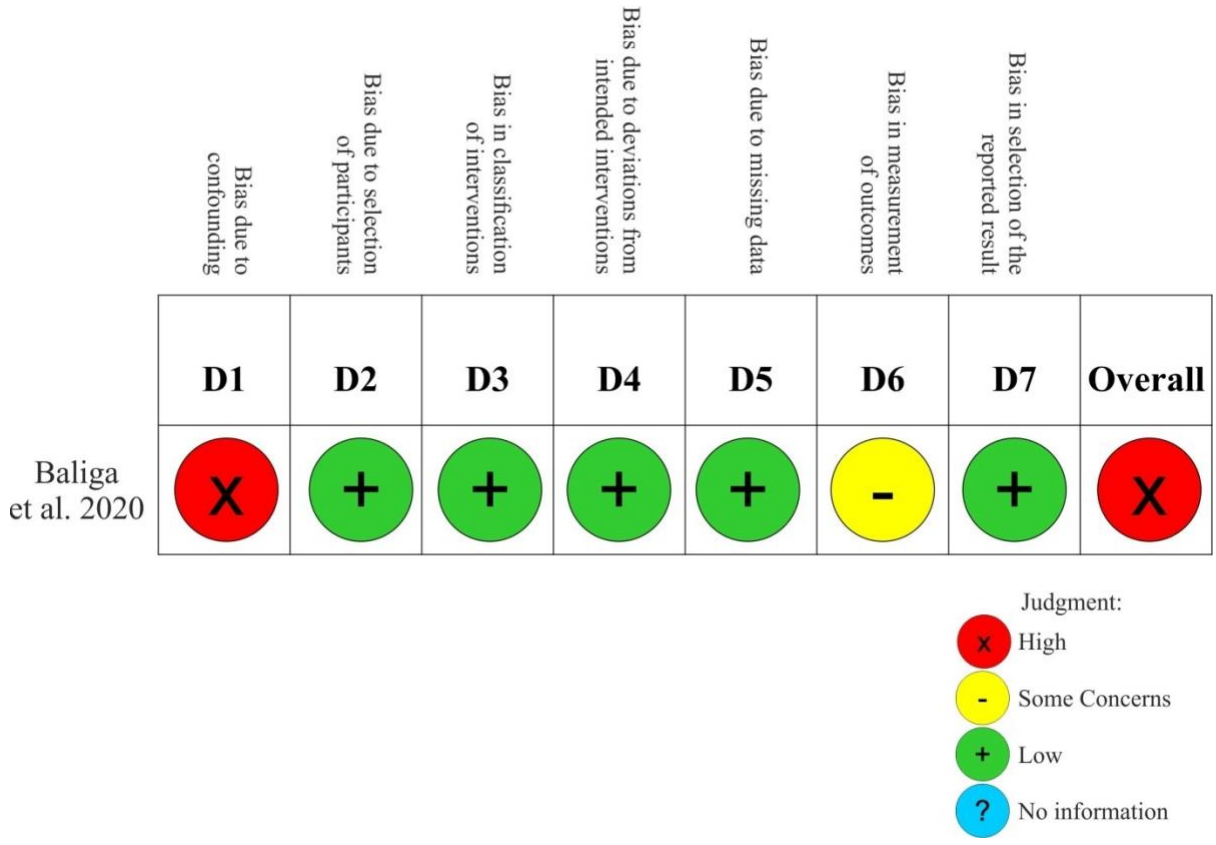

Figure 3. *Risk of bias - ROBINS assessment of non-randomized trials.*

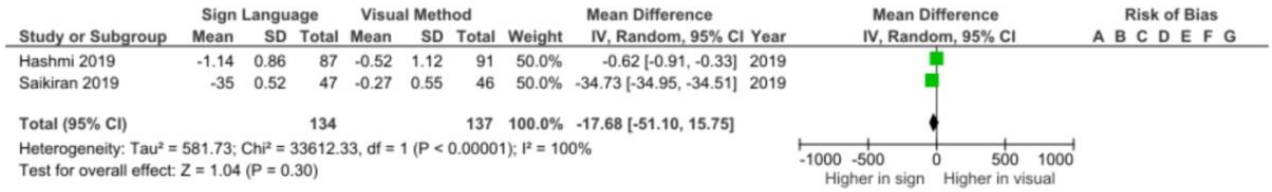

Figure 4. *Oral hygiene status.*

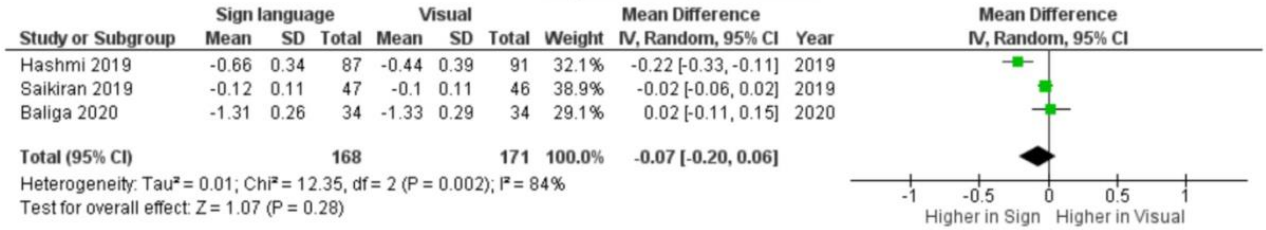

Figure 5. *Plaque status.*

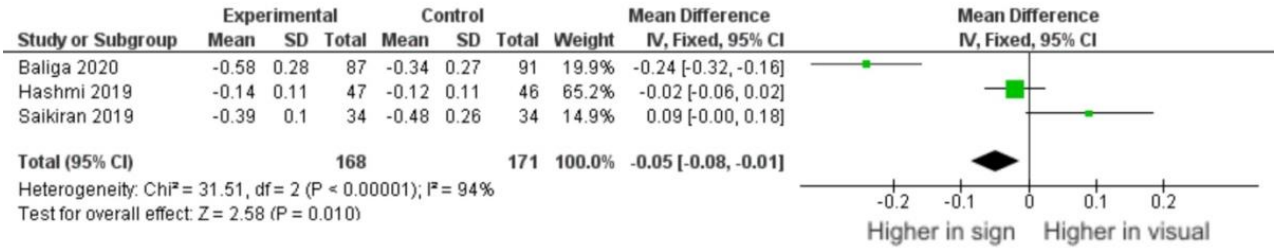

Figure 6. *Gingival status.*

frequency of reinforcement and the coupling with other educational materials varied. Reinforcement was daily in one study (Sudhindra *et al*., 2020), was weekly in another (Saikiran *et al*., 2019) and monthly (Hashmi *et al*., 2019) in the remaining study. Additionally, Hashmi et al. (2019) coupled their intervention with a PowerPoint presentation. The interventions were delivered by school caregivers in one study (Sudhindra *et al*., 2020). Despite these differences, sign language-based interventions were similarly or more effective than visual interventions, such as posters and videos (Hashmi *et al*., 2019, Sudhindra *et al*., 2020, Fageeh *et al*., 2020)

Our meta-analysis supported the effectiveness of sign language in improving oral hygiene, plaque, gingival status, and knowledge levels among hearing-impaired individuals compared to visual interventions. Regarding gender predilection, previous evidence-based literature has shown a higher male prevalence in this special population (Bhadauria *et al*., 2023). Similar findings were observed in this study, where the only study reporting gender predilection also reported a higher prevalence among males (Hashmi *et al*., 2019).

It is relevant that most studies on oral health structures in hearing-impaired individuals have been conducted in the South Asia, particularly in India, due to the higher prevalence of hearing impairment in that region (World Health Organization, 2018). The inclusion of studies solely from India might limit the generalizability of the findings globally, underscoring the need for more diverse research on this topic.

The risk of bias tool included for both randomized and non-randomized trials is based on multiple domains. In all the studies, most of the domains were of either of low risk of bias or showed some concerns as judgment. The studies were thus included in the meta-analysis even after questionable overall judgement. Bias due to deviations from the intended intervention, in the selection of the reported results and due to confounding and measurement of outcome were the biases in the included non-randomized studies.

Interventions tailored for special groups of populations may support oral health promotion.Various media, such as Braille, audio tactile performances, and other educational strategies, have shown effectiveness in visually impaired individuals (Bhor *et al*., 2021). Therapy and skill-based interventions have been utilized for disabled children and adolescents, focusing predominantly on tooth brushing skills (Waldron *et al*., 2016). Similarly, different visual learning strategies have been found to improve oral hygiene status, oral health-related knowledge and attitudes, and dental anxiety among hearing-impaired individuals (Shrivastava *et al*., 2022). These interventions and learning strategies equip special populations with essential skills to improve their overall and oral health and require regular updates to align with current skill sets.

While this study strengthens the case for using sign language in educational interventions to improve the gingival, plaque, and oral hygiene status of hearing-impaired individuals, it also highlights the limited number of comparative studies in the past. Additionally, the inclusion of studies only in English and variations in

interventions limit the generalizability of the findings. Another point to consider is that the number of dentists or dental nurses who are proficient in sign language is likely to be very low in many countries, potentially affecting the implementation of sign language-based interventions.

In conclusion, while sign language-based interventions were found to be effective in improving the oral health of hearing-impaired individuals, the presence of high and concerning bias in the included studies restricts the ability to favor one type of intervention over another. Further studies in diverse geographical locations and populations are necessary to establish the broader effectiveness of sign language-based educational interventions. Efforts should be made to increase the availability of dental professionals proficient in sign language to facilitate the implementation of such interventions effectively.

References

Balian, A., Cirio, S., Salerno, C., Wolf, T.G., Campus, G. and Cagetti, M.G. (2021): Is visual pedagogy effective in improving cooperation towards oral hygiene and dental care in children with autism spectrum disorder? A systematic review and meta-analysis. *International Journal of Environmental Research and Public Health* **18**, 789.

Bhadauria, U.S., Purohit, B., Agarwal, D. and Priya, H. (2023): Dental caries status in individuals with hearing difficulties: a systematic review and meta-analysis. *Special Care in Dentistry* **43**, 9-16.

Bhadauria, U.S., Purohit, B., Agarwal, D., Priya, H. and Upadhyay, A. (2023): Oral hygiene status in individuals with hearing difficulties: A systematic review and meta-analysis. *Special Care in Dentistry*, 1-14.

Bhor, K.B., Vinay, V., Ambildhok, K. and Shetty, V. (2021): Effectiveness of oral health educational interventions on oral health of visually impaired school children: A systematic review and meta-analysis. *Special Care in Dentistry* **41**, 291-308.

Fageeh, H.N. and Mansoor, M.A. (2020): The effectiveness of oral hygiene instructions in sign language among hearing impaired adults in Saudi Arabia. *Special Care in Dentistry* **40**, 41-48.

Hashmi, S., Mohanty, V.R., Balappanavar, A.Y., Yadav, V., Kapoor, S. andRijhwani, K. (2019): Effectiveness of dental health education on oral hygiene among hearing impaired adolescents in India: a randomized control trial. *Special Care in Dentistry* **39**, 274-280.

Jameel, H.T. and Bibi, S. (2016): Benefits of sign language for the deaf students in classroom learning. *International Journal of Advanced and Applied Sciences* **3**, 24-26.

Kumar, R.S., Deshpande, A.P., Ankola, A.V., Sankeshwari, R. M., Hampiholi, V., Hebbal, M., et al. (2022): Impact of the Visual Performance Reinforcement Technique on Oral Hygiene Knowledge and Practices, Gingival Health, and Plaque Control in Hearing- and Speech-Impaired Adolescents: A Randomized Controlled Trial. *Children* **9**, 1905.

Kurniawati, D., Bernice, S.F. and Pasha, F.R.A. (2022): The effectiveness of dental and oral health promotion with audiovisual media on knowledge level and oral hygiene status of deaf children. *Revista Latinoamericana de Hipertension* **17**, 75-81.

Moin, M., Saadat, S., Rafique, S., Maqsood, A., Lal, A., Vohra, F., et al. (2021): Impact of oral health educational interventions on oral hygiene status of children with hearing loss: a randomized controlled trial. *BioMed Research International* 5185613.

Pareek, S., Nagaraj, A., Yousuf, A., Ganta, S., Atri, M. and Singh, K. (2015): Effectiveness of supervised oral health maintenance in hearing impaired and mute children - A parallel randomized controlled trial. *Journal of the International Society of Preventive & Community Dentistry* **5**, 176-182.

Saikiran, K.V., Kamatham, R., Sahiti, P.S. and Nuvvula, S. (2019): Impact of educational (sign language/video modeling) and therapeutic (Glycyrrhiza glabra–liquorice mouth wash) interventions on oral health pertaining to children with hearing impairment: a randomized clinical trial. *Special Care in Dentistry* **39**, 505-514.

Shrivastava, R., Gupta, A., Nishant, Sharda, S., Das, D. and Goyal, A. (2022): Visual learning strategies for oral health promotion and treatment interventions in children and adolescents with hearing impairment – A systematic review. *Special Care in Dentistry* **43**,1-14.

Staden, A.V., Badenhorst, G. and Ridge, E. (2009): The benefits of sign language for deaf learners with language challenges. *Per Linguam* **25**, 44-60.

Sterne, J.A.C., Savović, J., Page, M.J., Elbers, R.G., Blencowe, N.S., Boutron, I., et al. (2019): RoB 2: a revised tool for assessing risk of bias in randomized trials. *British Medical Journal* **366**, l4898.

Sterne, J.A.C., Hernan, M.A., Reeves, B.C., Savović, J., Berkman, N.D., Viswanathan, M., et al. (2016): ROBINS-I: a tool for assessing risk of bias in non-randomized studies of interventions. *British Medical Journal* **355**, i4919.

Sneha, K., Praveen, P. and Anantharaj, A. (2022): An assessment of the effectiveness of oral health education on oral health-related knowledge and attitudes of caregivers of children with hearing impairment. *European Journal of Paediatric Dentistry* **23**, 10-14.

Sudhindra, B., Deshpande, M., Thosar, N., Rathi, N., Bane, S. and Deulkar, P. (2020): Comparison of impact of oral hygiene instructions given via sign language and validated customized oral health education skit video on oral hygiene status of children with hearing impairment. *Journal of the Indian Society of Pedodontics and Preventive Dentistry* **38**, 20-25.

Veriza, E., Boy, H., Alhamda, S. and Razi, P. (2021): The effectiveness of the use of sign language videos in improving the behavior of dental and oral health care in children with impairment in SLB Negeri 1 Jambi City, Indonesia. *International Journal of Research Studies in Medical and Health Sciences* **6**, 3-8.

Waldron, C., Phadriag, C.M., Comiskey, C. and Nunn, J. (2016): Oral health interventions for children and adolescents with disabilities: A scoping review. *Journal of Disability and Oral Health* **17**, 144-149.

World Health Organization. (2021): World report on hearing. Geneva. World Health Organization. https://apps.who.int/iris/handle/10665/339913.

World Health Organization (2018): Addressing the rising prevalence of hearing loss. Geneva, World Health Organization. https://apps.who.int/iris/bitstream/handle/10665/260336/9789241550260-eng.pdf