Review Article

Unleashing the most effective oral health education intervention technique for improving the oral hygiene status and oral health knowledge in visually impaired young individuals: A systematic review and meta-analysis

Apurva P Deshpande, Anil V Ankola, Roopali Sankeshwari, Sagar Jalihal, Deepika V Bhat, Abhra Roy Choudhury, Ram Surath Kumar, Atrey Pai Khot

Abstract:

Appropriate oral health education (OHE) plays a vital role in prevention of oral diseases and would bridge the gap between dentists and visually impaired individuals. Hence, this systematic review was planned with an aim to evaluate effectiveness of various OHE techniques on the oral hygiene status and oral health knowledge of visually impaired young individuals. An electronic search extended to September 30, 2020 was conducted on PubMed, Wiley, ProQuest, ScienceDirect, Cochrane library, EBSCO, and Google Scholar. Two independent reviewers assessed the studies using a two-stage process; data were extracted according to PRISMA statement. Risk of bias assessment of selected studies was executed according to the study designs. Meta-analysis using the random-effects model was conducted for the outcomes for all oral health education techniques using STATASE 16.1 software. Hand and electronic search identified 3829 articles. After screening for titles and duplicates, 37 articles were retrieved, which were screened through abstract and full text. Of the 37 articles, 17 articles were included for qualitative synthesis, and out of that, 13 were for meta-analysis. Ten variations in oral health education (OHE) techniques were used in the included 17 studies to impart oral health education to visually impaired young individuals. Overall, all OHE techniques demonstrated a positive impact on oral hygiene status. The pooled overall cumulative mean difference of the oral hygiene status after imparting education in ATP, Audio, and Braille was 1.33 [1.06, 1.59], 1.76 [1.11, 2.42], and 1.96 [1.40, 2.55], respectively. An appropriate OHE technique boosts confidence in visually impaired young individuals, making the learning process an enjoyable experience. Use of either Braille or the ATP OHE technique was found to be a reliable and useful method to improve oral hygiene of visually impaired young individuals.

Keywords:

Audio, audio tactile performance, Braille, oral health education, oral hygiene status, visually impaired

Department of Public Health Dentistry, KLE VK Institute of Dental Sciences, KLE Academy of Higher Education and Research, Belagavi, Karnataka, India

Address for correspondence:
Dr. Ram Surath Kumar, Department of Public Health Dentistry, KLE VK Institute of Dental Sciences, KLE Academy of Higher Education and Research, Belagavi, Karnataka, India.
E-mail: ramsurathkumar1996@gmail.com

Introduction

"The best and the most beautiful things in the world cannot be seen or even touched. They must be felt with the heart."   – Hellen Keller

The most important sense for perceiving the world is "vision". When it is impaired, it has a detrimental impact on the physical and psychological development of an individual.[1,2] The World health

organization (WHO) estimates that there are 36 million individuals who suffer from from visual impairment or blindness.[3]

One of the major public health concerns is childhood blindness. There are around 1.42 million and 17.52 million children suffering from blindness and moderate to severe visual impairment, respectively.[4] The most common impact of loss of vision is the inability of the people to maintain oral health as they are not in a position to identify oral disease and may be unable to take immediate action unless informed of the situation.[5]

Oral health care needs of visually impaired children remain largely neglected. It was found that only 29.4% of visually impaired children had good oral hygiene in a study conducted by Al – Qahtani *et al*.[6] High caries prevalence and poor oral hygiene were also reported in other studies that were conducted worldwide. Maintenance of proper oral hygiene is a matter of concern in visually impaired children.[7,8]

Visually impaired children find it challenging to learn basic life skills as they cannot perceive the world like normal children. They rely on their care-givers or parents for performing routine activities including oral hygiene practices, negligence of which can lead to poor oral hygiene. Appropriate oral health education plays a vital role in prevention of oral diseases and would bridge the gap between dentists and visually impaired individuals.[9,10]

The literature quotes various oral health intervention techniques [Braille text, verbal method, audio tactile performance (ATP) technique, and their combinations] which are practiced to deliver oral health education in visually impaired children. Of the many OHE techniques, the most trending oral health education technique is the ATP technique, which was developed by Hebbal and Ankola.[11-14]

In spite of availability of various oral health education techniques, there is always a dilemma to select an appropriate technique to impart knowledge to visually impaired children. Hence, this systematic review was planned with an aim to assess the most effective OHE technique in visually impaired young individuals for prevention of oral diseases and maintenance of good oral hygiene with the following objective: to assess the effect of various OHE techniques on oral health knowledge of visually impaired young individuals. To the best of our knowledge, this systematic review is the first of its kind where effectiveness of ten kinds of OHE techniques on oral hygiene status and oral health knowledge is evaluated among visually impaired children.

Material and Methods

Protocol development and registration
This systematic review and meta-analysis was conducted according to the preferred reporting items for the systematic review and meta-analysis (PRISMA) statement and registered in PROSPERO under number CRD42020200286. The following focused question in the patient, intervention, and outcome (PIO) format was proposed: "How do different OHE techniques (ATP, ATP combined with Braille or verbal, Braille, verbal, tactile, and a combination of verbal, tactile, and braille) influence the oral hygiene status and oral health knowledge of 5–20 years old visually impaired young individuals?"

Search strategy
The electronic search was performed with the databases PubMed, ProQuest, Wiley, ScienceDirect, EBSCO, Cochrane Library, and Google Scholar with a platform-specific search strategy consisting of combinations of controlled terms (MeSH) and text words. Additional hand searching of the literature was also performed with Special Care in Dentistry Journal, Journal of Education and Health Promotion, and International Journal of Pediatric Dentistry. No language restrictions were put, although studies included were in English language. The keywords for search were selected by reviewing the literature. MeSH terms, keywords, and other free terms related to PIO questions were used with Boolean operators (OR, AND) to combine searches. The search strategy terms included "Visually impaired", "Oral health education", "Oral hygiene status", "Audio-tactile performance technique", "Braille", "Audio", "Tactile", "Children", and "Young" with no additional filters.

Eligibility criteria
Inclusion criteria (PIOS format)
P (Population): Visually impaired children/young individuals in the age group of 5–20 years.

I (Intervention): The ATP technique alone or the ATP technique combined with the Braille technique, the verbal technique, the tactile technique, and the combination of Braille, tactile, and verbal techniques.

O (Outcome):
- Primary outcome: Oral hygiene status
- Secondary outcome: Oral health knowledge.

S (Studies): Clinical trials, randomized controlled trials (RCTs), cluster randomized trials, quasi-experimental studies, and non-randomized studies.

Exclusion criteria
Observational study designs, case reports, case series, cross-sectional studies, and reviews were not

considered. Articles reporting only abstracts were also excluded.

Screening process

The search and screening process were carried out by two independent reviewing authors, AD and AA. Title and abstract screening was done at the first stage. The second stage involved complete careful reading of the selected articles and was analyzed per eligibility criteria (inclusion/exclusion) for future data extraction. Discrepancies among authors/reviewers were resolved by the third author, RS through careful discussion. The level of agreement was calculated through Cohen's kappa between the two reviewers and was 0.92 for titles and abstracts and 0.94 for full texts. Finally, the search yielded 17 studies which were included in the systematic review.

Data extraction

A standardized data extraction form was prepared by AD in Microsoft Excel and assessed by another author, AA. The data were extracted independently from the full-text articles selected for inclusion using a standardized pre-designed format. The following items were assessed during data extraction of the individual studies: article details such as author names, country and the year of study, study setting and design, aim of the study, age groups, sample size, type of OHE technique used, indices used to assess oral hygiene status, knowledge assessment, and author conclusion. Any discrepancies within the studies were discussed and resolved between the two authors.

Assessments of the risk of bias and quality

Quality assessment of the selected studies was executed by using the Cochrane Collaboration Tool (http://ohg.-cochrane.org) for RCTs including random sequence generation, allocation concealment, blinding of participants, incomplete outcome data, and selective reporting, and other bias and quality assessments of non-randomized studies were performed using ROBINS - I tool. "Traffic light" plots of the domain-level judgments for each individual result and weighted bar plots of the distribution of risk-of-bias judgments within each bias domain were created using "robvis tool".[15-17]

Statistical analysis

STATASE 16.1 software was used for statistical analysis. Differences in means and effect size were used as principal summary measures. Forest plots and funnel plots were generated to visualize the difference between various intervention groups and publication bias. The overall estimated effect was categorized as significant, where $P < 0.05$. Statistical heterogeneity was tested using I2 statistics (0–40%, not important; 30–60%, moderate heterogeneity; 50–90%, representing substantial heterogeneity; 75–100%, considerable heterogeneity) as described by the PRISMA protocol for writing systematic review.

## Results

Literature search

In the systematic review for evaluation of various oral health education techniques in management of the oral hygiene status in visually impaired children, the process of selection was initiated by stepwise screening of the articles. A total of 419 records were identified through data search using the search strategy in PubMed and Cochrane. A total of 963 records were identified through data search using the search strategy in Proquest, Wiley, and Science direct. A total of 933 and 1512 records were identified through Ebsco and Google Scholar, respectively. Two articles were identified through the Gray literature. The total article number arrived to be 3829. The second step was screening through titles, and after screening through titles, 3,277 articles were excluded because they were not related to the objectives of the systematic review. A total of 552 articles which remained were screened for duplicates through Endnote Software VersionX7. Out of 552 articles, 515 articles were found to be duplicates.

The remaining 37 articles were screened through abstracts and full text screening as the next step. Out of 37 articles, 20 were excluded for various reasons, with one being systematic review, two being conference proceedings, 11 not meeting the inclusion criteria (age range of the participants, inclusion of SHCN children other than visual impairment), and six denoting themselves as descriptive studies [Figure 1]. Finally, 17 articles were qualitatively analyzed, after which they were included in the systematic review [Table 1]. Ten different oral health education techniques were used in the included 17 studies to impart oral health education to visually impaired children.

Study characteristics

There are 17 studies[10-14,18-29] included in this systematic review. The general characteristics of each study are presented in Table 1. The majority of the included studies are of Indian origin,[10,11-14,18-24,25,28,29] with one study each being conducted in Iran[27] and Indonesia.[26] There are six randomized controlled trials[10,11,14,24,27,28] and 11 non-randomized controlled trials[12,13,18-23,25,26,29] included in this systematic review.

The age of the participants ranged from 5 to 20 years old with complete visual impairment. They did not have any other systemic condition and were not using any chemical mode of plaque control or were on any medication during the entire study period.
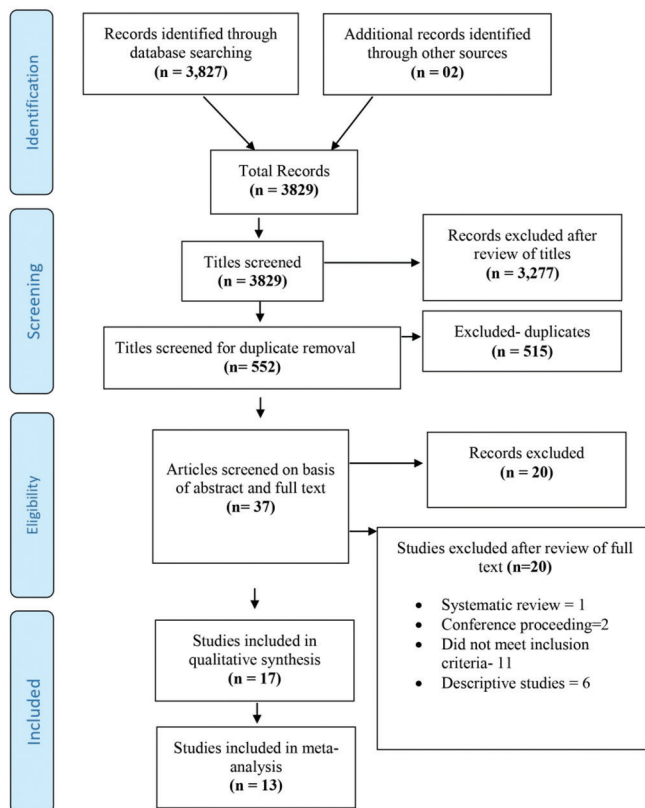
Figure 1: Flowchart diagram depicting the process of selection and exclusion of articles at each step

All the studies had procured informed consent from the parents and guardians prior to the conduct of the study. A total of 1,663 visually impaired children were part of study analysis with 330 in the Braille group,[11,18,20,24,28,29] 183 in the Audio group,[12,23,24,26,28] 247 in the Braille + Audio group,[14,21,22,10,29] 393 in the ATP group,[10-13,20,25,27] 60 in the ATP + Braille group,[11,20] 140 in the Audio + Tactile + Braille group,[14,19,22,24] 60 in the Audio + Tactile group,[14,22] 74 in the Braille + Tactile group,[23] 66 in the ATP + Audio group,[27] and 40 in the Tactile group.[24]

Significant methodological variability was found in the included studies; thus, studies were categorized as follows:
(a) Effect of ten different forms of OHE techniques on the oral hygiene status of visually impaired children.
(b) Effect of different forms of OHE techniques assessed by different oral hygiene indices.
(c) Effect of various OHE techniques on oral health knowledge of visually impaired children.

OHE was given by dental professionals in all the included studies. Overall, there was no attrition observed at the end of the follow-up period. Different follow-up periods were observed in all the included studies. Three of the studies had a follow-up duration of up to 4 weeks,[11,26,29] five studies had a 3-month follow-up period,[10,12,25,27,28]

and nine studies[13,14,18-24] had a follow-up period of more than 3 months.

Risk of bias in included studies
Eleven NRCTs and six RCTs were assessed for risk of bias. All six RCTs included in the systematic review had a low risk of bias. Four studies had unclear or no information bias with respect to the blinding of the participants. Three studies had no information with regard to blinding of the outcome assessment. One study reported incomplete outcome data [Figure 2a and 2b].

Out of 11 NRCTs, five studies demonstrated a low risk of bias, five studies showed a moderate risk of bias, and one study had a high or serious risk of bias. Four studies had a moderate risk of bias, and two studies had a serious risk of bias with regard to bias because of confounding. Two studies had moderate and serious risks of bias, respectively, in bias because of selection of the participants category. Two studies demonstrated a moderate risk of bias in classification of interventions. All three studies had a moderate risk of bias with respect to bias because of deviation from the intended interventions. All 11 studies demonstrated no information or were unclear with respect to bias because of missing data. One study showed a high risk, and two studies showed a moderate risk of bias in bias in the measurement of outcomes. Four studies demonstrated a moderate risk of bias in selection of the reported result category [Figure 2a and 2b].

Considering the overall risk of bias for both the study designs, all the randomized controlled trial studies reported a low risk of bias. More than 25% of non-randomized controlled trials reported low and moderate risks of bias, respectively, whereas less than 25% of non-randomized controlled trials reported a high risk of bias [Figure 3a and 3b].

Effects of oral health education intervention techniques
Meta-analysis was performed to assess the impact of all oral health education techniques on the oral hygiene status and oral health knowledge of visually impaired children. The main interest was to assess the best OHE intervention technique among the ten oral health education techniques which were used in the studies. Thirteen studies were included for meta-analysis to assess the oral hygiene status post various oral health education interventions.[10,12-14,20-25,27-29]

Out of these 13 studies, four studies pooled the mean effect of six different oral health education interventions on oral health knowledge of visually impaired children.[10,24,25,29] The gingival index, plaque

Table 1: Qualitative extraction of the studies selected for the systematic review

Author Country, Year	Study design	Aim	Age	Follow-up	Sample Size
Charu Khurana *et al.*, India 2019[18]	Non - RCT	To evaluate the impact of Braille text and verbal, oral hygiene instructions on the oral health status of visually impaired children.	7-19	Baseline, 1 month, 3 months, and 5 months	165
Arpan Debnath. *et al.*, India 2017[19]	Non-RCT	To assess the effectiveness of the oral health innovative educative method among visually impaired children of Bengaluru city of India	8-18	Baseline and 6 months	40
Tiwari BS *et al.*, India 2019[20]	Non-RCT	To assess the oral hygiene status, knowledge, attitude, and practices (KAPs) in visually impaired children before and after imparting three different modes of oral health education.	12-15	21 days, 1, 6, and 9 months	90
Aggarwal T. *et al.*, India 2019[21]	Non-RCT	To assess the effectiveness of the oral health education program on the oral health status of visually impaired children in New Delhi.	5-15	Baseline and 9 months	120
Chowdary PB. *et al.*, India 2016[22]	Non-RCT	To evaluate the impact of verbal, Braille text, and tactile oral hygiene awareness instructions on the oral health status of visually impaired children	6-16	Baseline, 1 month, 3 months, and 6 months.	120
Hebbal M *et al.*, India 2012[13]	Non-RCT	To develop a special oral health education technique and compare plaque scores before and after health education.	6-18	Baseline and 18 months.	96
Sardana D.*et al.*, China 2019[23]	Non-RCT	To educate and motivate visually impaired children to maintain their oral health by using methods that are easy for them to understand and to evaluate their effectiveness over a 6-month period.	11-18	Baseline, 3 months, 6 months	148
Deolia S. *et al.*, India 2019[25]	Non-RCT	To investigate the effectiveness of "ATP" designed for children with visual impairment using Quigley-Hein Index (Modified by Turesky *et al.*, 1970	9-13	Base line and 3 months.	92
Krishnakumar R *et al.*, India 2016[12]	Non-RCT	To evaluate and compare the effectiveness of audio and audio-tactile methods in improving the oral hygiene status of visually impaired school children.	6-18	Baseline and 2 months	48
Bhor K. *et al.*, India 2016[29]	Non-RCT	To assess the effect of oral health education (OHE) in the form of Braille and combination with oral health talk (OHT) on oral hygiene knowledge, practices, and status of 12-17 years old visually impaired school girls in Pune city	12-17	Baseline, 2 weeks, and 4 weeks.	74
Kristiani A *et al.*, Indonesia 2017[26]	Non-RCT	To see the effects of dental health education through audio media on the knowledge and OHI-S of visually impaired students	7-12	Baseline and 3 weeks	40
Deshpande S. *et al.*, India 2017[11]	RCT	To assess and compare the oral hygiene of visually impaired patients before and after oral health education interventions using Braille and ATP techniques.	12-16	Baseline and 1 month	60
Diptajit Das. *et al.*, India 2019[10]	RCT	To assess the effectiveness of a novel health education method-Audio Tactile Performance (ATP) technique-in maintenance of gingival health and plaque removal efficacy among institutionalized visually impaired children of Bhubaneswar city.	10-15	Baseline, 30 days interval, and 90 days interval	60
Gautam A. *et al.*, India 2018[14]	RCT	To evaluate the effect of oral health education by Audio aids and Braille and tactile models on the oral health status of visually impaired children of Bhopal city.	5-18	Baseline, 1 month and after 3 months	60
Mahantesha T. *et al.*, India 2015[28]	RCT	To compare the oral hygiene status among institutionalized visually impaired children of age between 6 and 20 years given with Braille and audio instructions in Raichur city of Karnataka.	6-20	Baseline 7 days and 3 months.	50
Sharififard *et al.*, Iran 2020[27]	RCT	To compare the effectiveness of oral health education using the Audio Tactile Performance (ATP) technique alone, ATP combined with oral health education for mothers, and ATP along with art package on the oral health status of visually impaired children.	6-17	Baseline, 1 and 2 months	200
Ganapathi A. K *et al.*, India 2015[24]	RCT	To provide dental health education to blind children through various sensory input methods and compare the effectiveness of each method before and after oral health education.	8-14	Baseline and 6 months	200

Table 1: Contd...

Author Country, Year	Intervention	Methods of outcome assessment	Author Conclusion
Charu Khurana *et al*., India 2019[18]	Braille	Silness and Loe Plaque indices (1967) and Loe and Silness Gingival indices (1963)	Acceptable level of oral hygiene when taught using Braille text for instructions
Arpan Debnath. *et al*., India 2017[19]	Audio + tactile + Braille	Loe and Silness Plaque indices (1964), Knowledge score by Questionnaire	Statistically significant change in oral hygiene status and oral health knowledge
Tiwari BS *et al*., India 2019[20]	Group I: ATP Group II: Braille Group III: ATP + Braille	Silness and Loe Plaque indices (1964) and Loe and Silness Gingival indices (1963), Knowledge score by Questionnaire	ATP + Braille combination was the most effective.
Aggarwal T. *et al*., India 2019[21]	Audio + Braille	Loe and Silness Plaque indices (1967)	Combination of Audio and Braille was effective in significantly improving the oral hygiene status.
Chowdary PB. *et al*., India 2016[22]	Group I: Verbal + Tactile Group II: Verbal + Braille Group III: Verbal + Braille + Tactile.	Silness and Loe Plaque indices and Loe and Silness Gingival indices	Group III (Verbal + Braille + Tactile) showed the highest reduction in plaque. Group II (Verbal + Braille) showed the highest reduction in gingival scores.
Hebbal M *et al*., India 2012[13]	ATP	Silness and Loe plaque indices (1964)	Significant improvement in the oral hygiene status
Sardana D.*et al*., China 2019[23]	Group I: Braille + Tactile Group II: Audio	Silness and Loe Plaque indices (1964) and Loe and Silness Gingival indices (1963)	Tactile and auditory measures were found to be effective in educating and motivating visually impaired children regarding maintenance of oral hygiene.
Deolia S. *et al*., India 2019[25]	ATP	Quigley-Hein Index (Modified by Turesky *et al*., 1970), Knowledge score by Questionnaire	ATP was an effective tool for improving the oral hygiene status and oral health knowledge.
Krishnakumar R *et al*., India 2016[12]	Group I: ATP Group II: Audio	Silness and Loe Plaque indices	ATP method significantly improved the oral hygiene status
Bhor K. *et al*., India 2016[29]	Group I: Braille Group II: Braille + Audio	Oral Hygiene Index -Simplified (1964), Knowledge score by Questionnaire	Braille + Audio method was found to be superior in improving the oral hygiene status
Kristiani A *et al*., Indonesia 2017[26]	Group I: Audio Group II: Control	Oral Hygiene Index -Simplified (1964), Knowledge score by Questionnaire	Audio was an effective method in improving the oral hygiene status.
Deshpande S. *et al*., India 2017[11]	Group I: Braille Group II: ATP Group III: ATP + Braille	Silness and Loe plaque indices (1967)	Combination of Braille + ATP was the most effective.
Diptajit Das. *et al*., India 2019[10]	Group I: Braille + Audio, Group II: ATP	Quigley-Hein Plaque index (1970) and Loe and Silness Gingival indices 1963, Knowledge score by Questionnaire	Both are efficient
Gautam A. *et al*., India 2018[14]	Group I: Audio + Braille Group II Audio + tactile Group III: Audio + Braille + Tactile	Patient hygiene performance index	Audio + Braille + Tactile is most effective.
Mahantesha T. *et al*., India 2015[28]	Group I: Braille Group II: Audio	Patient hygiene performance index	Both showed significant improvement of the oral hygiene status with Braille being better than Audio.
Sharififard *et al*., Iran 2020[27]	Group I: ATP + Audio Group II: ATP + education of mothers Group III: ATP	Oral Hygiene Index -Simplified (1964)	ATP Technique alone can be an effective method to improve oral hygiene status of visually impaired children.
Ganapathi A. K *et al*., India 2015[24]	Group I: Audio Group II: Braille Group III: Tactile Group IV: Audio + Tactile + Braille Group V: Control (received no oral health education)	Quigley-Hein Plaque index (1970), Knowledge score by Questionnaire	Audio + Braille + Tactile is effective.

Figure 2a: Risk of bias assessment of randomized controlled trials

Figure 2b: Risk of bias assessment of non-randomized controlled trials

index, and oral hygiene index – simplified scores before and after oral health education interventions – were used to construct the forest plots. The results obtained from the analysis showed high precision values while considering 95% confidence interval.

Effect of ten different forms of OHE techniques on oral hygiene status of visually impaired children
ATP + Audio
Sharififard *et al.*, 2020[27] assessed the effect of the combination of ATP + Audio OHE technique on the
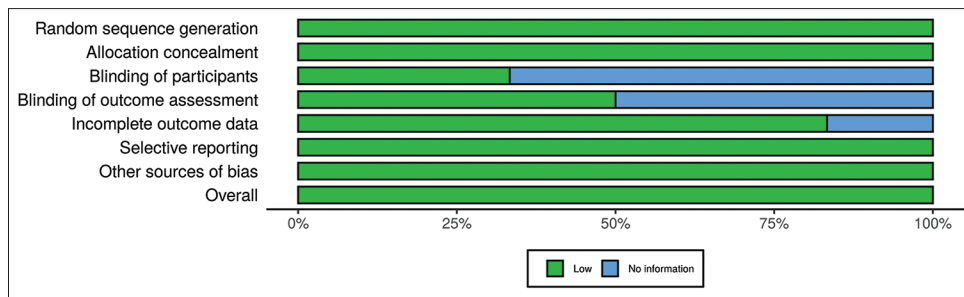
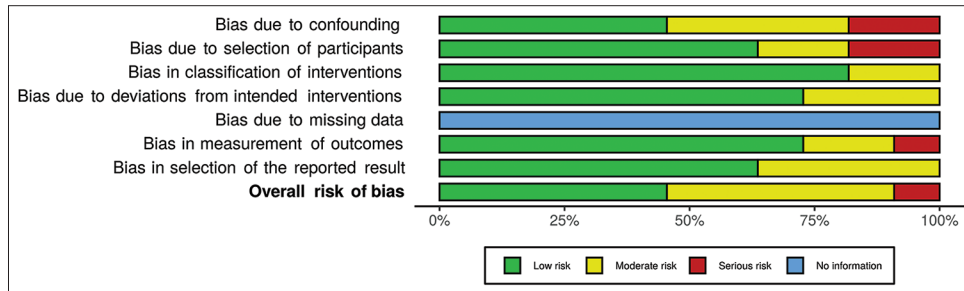**Figure 3a:** Overall Risk of Bias among Randomized controlled trials

Figure 3b: Overall Risk of Bias among Non - Randomized controlled trials

oral hygiene of visually impaired children. The pooled overall mean of the oral hygiene status after imparting education in the ATP + Audio OHE technique was found to be 1.34 [Figure 4c].

ATP + Braille
Tiwari BS *et al*., 2019[20] compared effectiveness of the ATP + Braille OHE technique on the oral hygiene status of visually impaired children. Pre- and post-values of both plaque and gingival indices were used to assess the oral hygiene status. The pooled overall mean of the oral hygiene status after imparting education in the ATP + Braille OHE technique was found to be 1.26 [Figure 4d].

Braille + Tactile
Sardana D.*et al*., 2019[23] assessed the combination of Braille + Tactile OHE technique for improving the oral hygiene status in visually impaired children. The pooled overall mean of the oral hygiene status after imparting education in the Braille + Tactile OHE technique was found to be 1.13 [Figure 4e].

Tactile
Ganapathi A K *et al*., 2015[24] assessed the effect of the tactile OHE technique on the oral hygiene of visually impaired children. The pooled overall mean of the oral hygiene status after imparting education in the tactile OHE technique was found to be 2.07 [Figure 4f].

ATP technique
Six studies (Tiwari BS *et al*., 2019; Hebbal M *et al*., 2012; Krishnakumar R *et al*., 2016; Diptajit Das. *et al*., 2019; Sharififard *et al*., 2020; and Deolia S. *et al*., 2019)[10,12,13,20,25,27]

assessed the effectiveness of the ATP OHE technique on the oral hygiene status of visually impaired children. The pooled overall mean of the oral hygiene status after imparting education in the ATP OHE technique was found to be 1.33 [Figure 4a].

Braille technique
Four studies (Tiwari BS *et al*., 2019; Mahantesha T *et al*., 2015; Bhor K *et al*., 2016 and Ganapathi A K *et al*., 2015)[20,24,28,29] assessed the effect of the Braille OHE technique on the oral hygiene status of visually impaired children. The pooled overall mean of the oral hygiene status after imparting education in Braille was found to be 1.97 [Figure 4b].

Braille + Audio technique
The effect of the Braille + Audio technique on the oral hygiene status of visually impaired children was evaluated by Aggarwal T. *et al*., 2019; Chowdary PB. *et al*., 2016; Bhor K *et al*., 2016; Diptajit Das *et al*., 2019; and Gautam A. *et al*., 2018.[10,14,21,22,29] The pooled overall mean of the oral hygiene status after imparting education in the Braille + Audio OHE technique was found to be 0.71 [Figure 4g].

Audio technique
Krishnakumar R *et al*., 2016; Sardana D.*et al*., 2019; Mahantesha T *et al*., 2015; and Ganapathi A K *et al*., 2015[12,23,24,28] evaluated the effect of the Audio OHE technique on the oral hygiene status of visually impaired children. The pooled overall mean of the oral hygiene status after imparting education in Audio was found to be 1.76 [Figure 4h].
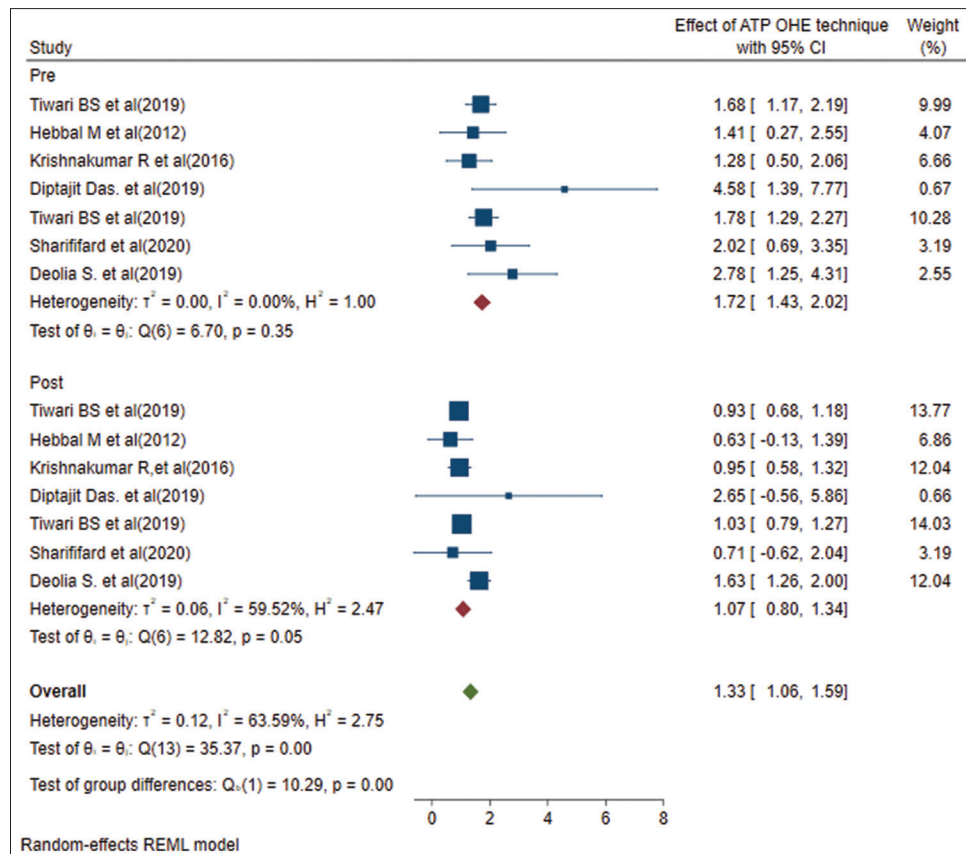
Figure 4a: Effect of the ATP OHE technique on the oral hygiene status of visually impaired children

Audio + Tactile + Braille

Ganapathi A K *et al*., 2015; Chowdary PB. *et al*., 2016; and Gautam A. *et al*., 2018[14,22,24] evaluated the combination of Audio + Tactile + Braille for improving the oral hygiene status in visually impaired children. The pooled overall mean of the oral hygiene status after imparting education in the Audio + Tactile + Braille OHE technique was found to be 0.76 [Figure 4i].

Audio + Tactile

Chowdary PB *et al*., 2016 and Gautam A. *et al*., 2018[14,22] assessed the combination of Audio + Tactile OHE technique for improving the oral hygiene status in visually impaired children. The pooled overall mean of the oral hygiene status after imparting education in the Audio + Tactile OHE technique was found to be 0.42 [Figure 4j].

Effect of different forms of OHE techniques assessed by different oral hygiene indices
Effect of OHE techniques on gingival scores assessed by Loe and Silness Gingival indices

The impact of various OHE techniques on gingival scores in four different studies[10,20,22,23] assessed by Loe and Silness gingival indices is portrayed in Figure 5b. The highest mean gingival score reduction was obtained in the combination of Braille + Audio OHE technique being [2.15 (1.35, 2.95)]. The pooled overall mean of the

oral hygiene status using Loe and Silness gingival indices after imparting education in different OHE techniques was found to be 0.72 [Figure 5b].

Effect of OHE techniques on plaque scores assessed by Silness and Loe Plaque indices

There was substantial evidence of mean plaque reduction observed in six studies[12,13,20-23] that included different OHE techniques to assess plaque scores before and after imparting oral health education. The highest mean plaque reduction was observed in the ATP + Braille technique [0.95 (0.83, 1.07)], followed by ATP [0.78 (0.64, 0.92)]. The pooled overall mean of the oral hygiene status using Silness and Loe Plaque indices after imparting education in different OHE techniques was found to be 0.49 [Figure 5a].

Effect of OHE techniques on oral hygiene status assessed by OHI-S index

There was substantial evidence of improvement of oral hygiene status using OHI-S index, which is portrayed in Figure 5c.[27,29] The highest improvement in oral hygiene status was noticed in the ATP OHE technique [1.31 (1.07, 1.55)]. The pooled overall mean of the oral hygiene status using OHI-S index after imparting education in different OHE techniques was found to be 0.80 [Figure 5c].
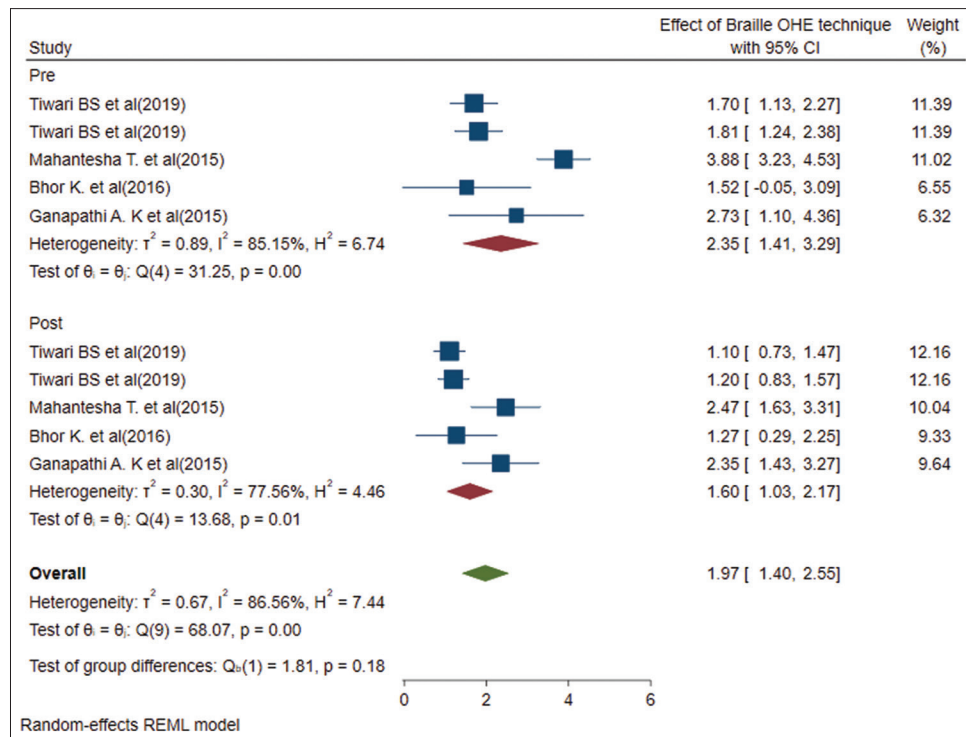
Figure 4b: Effect of the Braille OHE technique on the oral hygiene status of visually impaired children
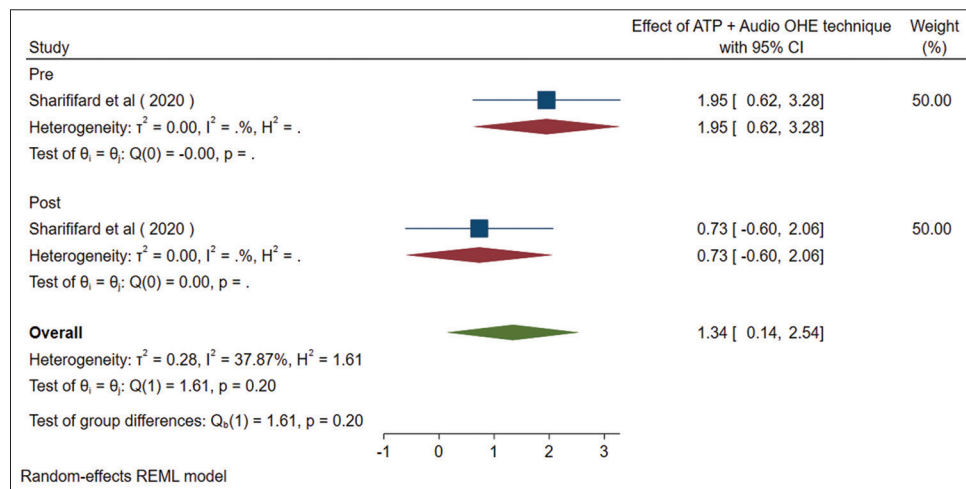

Figure 4c: Effect of ATP + Audio OHE technique on oral hygiene status of visually impaired children

Effect of OHE techniques on oral hygiene status assessed by PHP index

The effect of five different OHE techniques on oral hygiene status was assessed in two studies[14,28] using PHP index. The highest improvement in oral hygiene status was observed in the Braille OHE technique [1.41 (1.20, 1.62)]. The pooled overall mean of the oral hygiene status using PHP index after imparting education in different OHE techniques was found to be 0.75 [Figure 5d].

Effect of OHE techniques on plaque scores assessed by Quigley Hein plaque index

There was substantial evidence of improvement of plaque status in visually impaired children after imparting oral health education through various OHE techniques.[24,25] The highest mean plaque reduction was observed in the ATP technique [1.15 (0.56, 1.08)]. The pooled overall mean of the oral hygiene status using Quigley Hein Plaque index after imparting education in different OHE techniques was found to be 0.82 [Figure 5e].

Effect of various OHE techniques on oral health knowledge of visually impaired children
Oral health education

Figure 6a and 6b show individual and overall effects of six different OHE techniques on oral health knowledge before and after imparting oral health education in
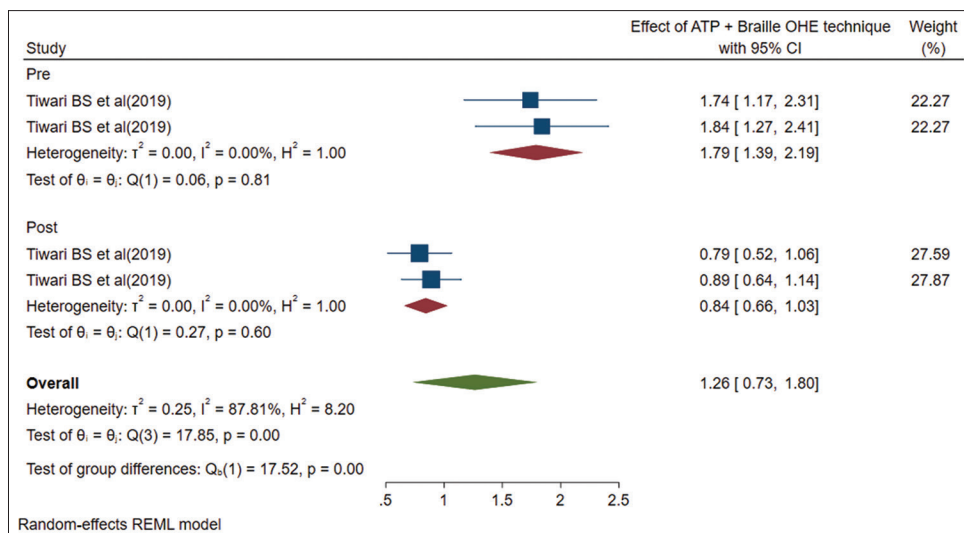
Figure 4d: Effect of ATP + Braille OHE technique on oral hygiene status of visually impaired children
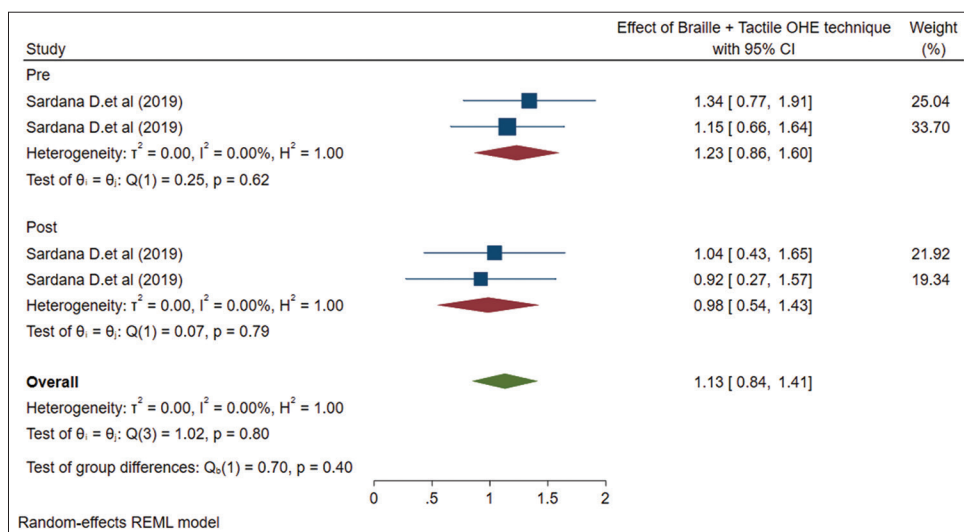

Figure 4e: Effect of Braille + Tactile OHE technique on oral hygiene status of visually impaired children
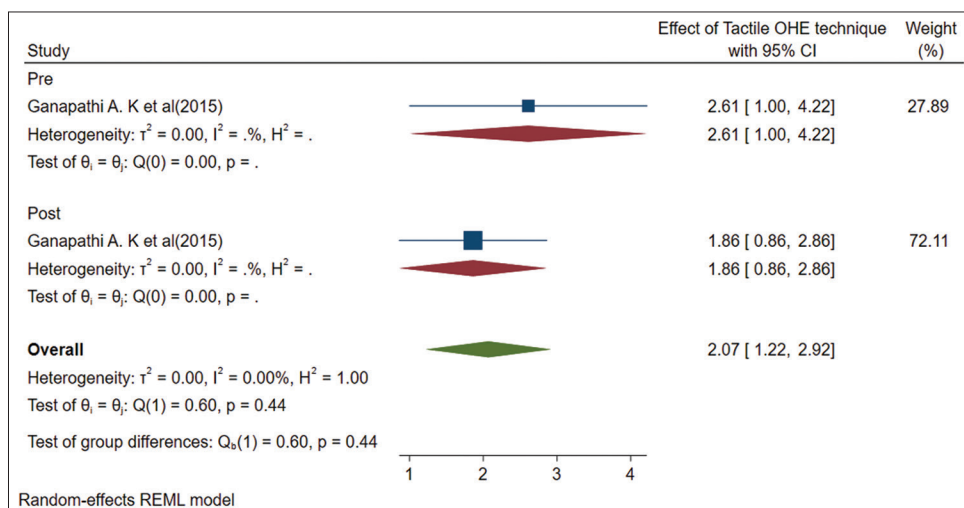

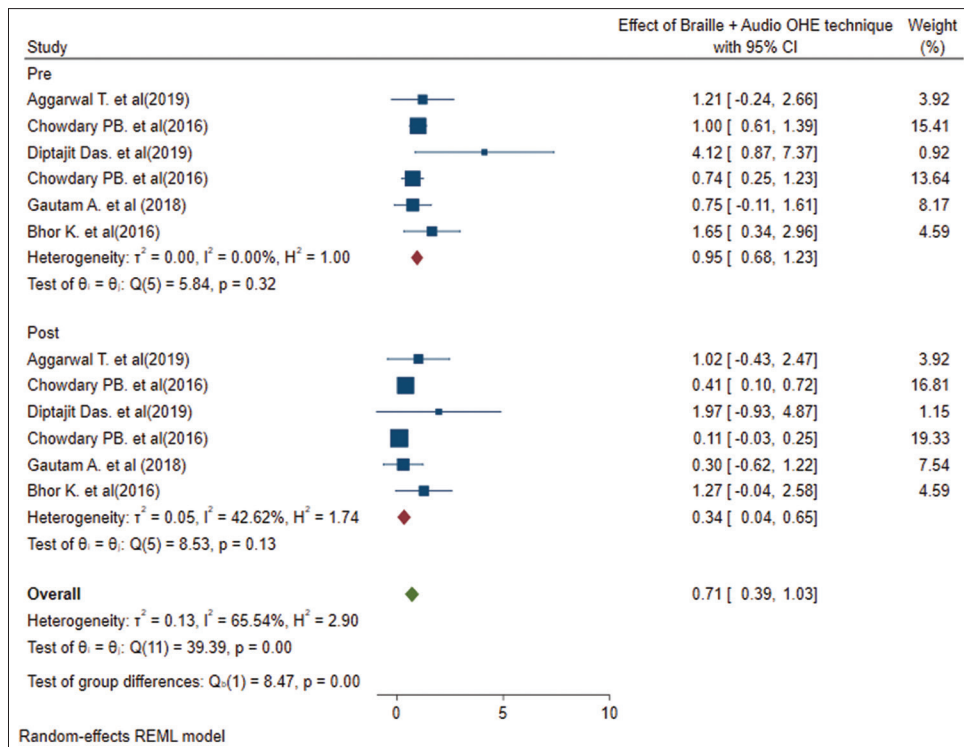**Figure 4f:** Effect of Tactile OHE technique on oral hygiene status of visually impaired children

Figure 4g: Effect of Braille + Audio OHE technique on oral hygiene status of visually impaired children
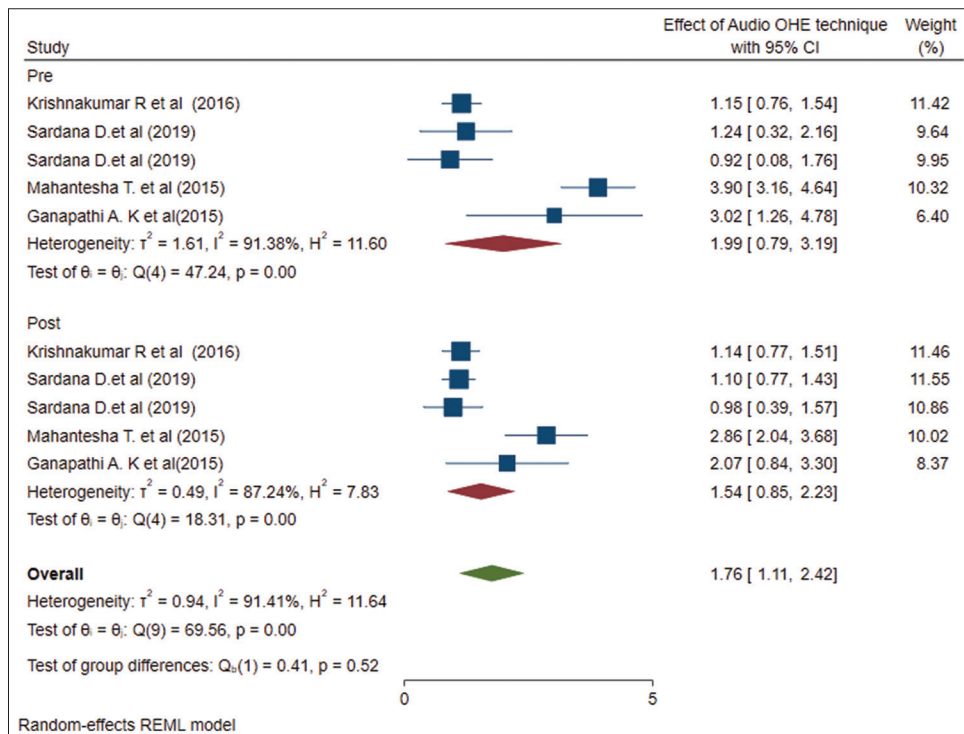

Figure 4h: Effect of Audio OHE technique on oral hygiene status of visually impaired children

visually impaired children. The overall pooled mean before imparting oral health education was estimated to be 2.29. The overall pooled mean increased to 8.63 after imparting oral health education in visually impaired children[10,24,25,29] [Figure 6a and 6b].

Discussion

One of the most widely accepted approaches in prevention of oral diseases and enhancing the oral hygiene status is appropriate oral health education. Oral
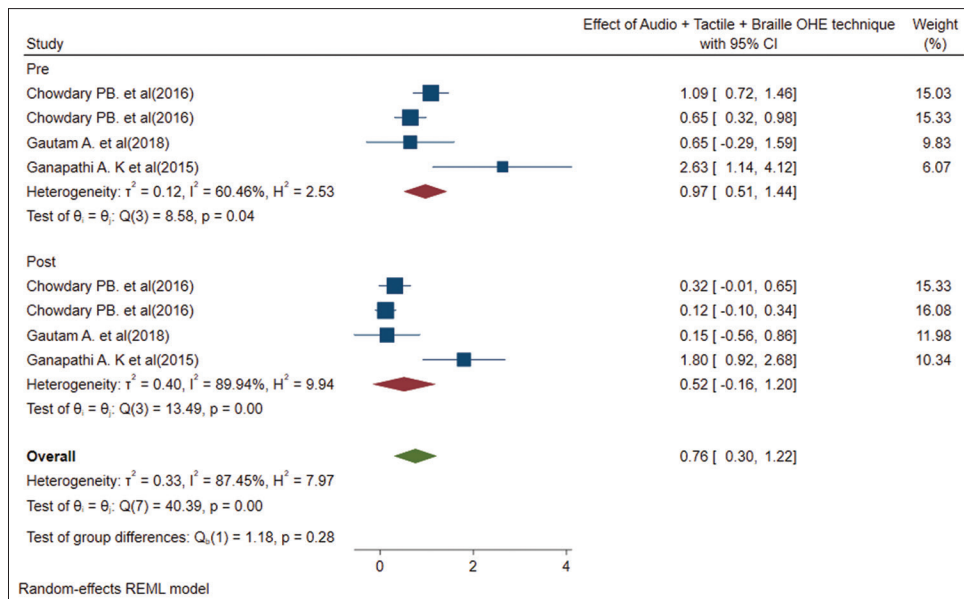
Figure 4i: Effect of Audio + Tactile + Braille OHE technique on oral hygiene status of visually impaired children
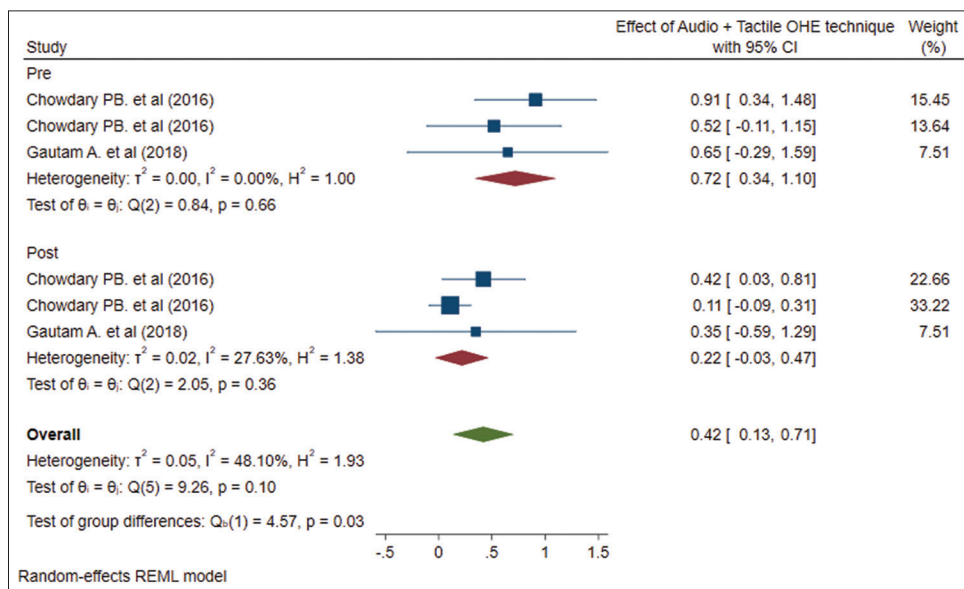

Figure 4j: Effect of Audio + Tactile OHE technique on oral hygiene status of visually impaired children

health education has an upper hand when compared to any other preventive strategy as it not only helps in reduction of the incidence of oral ailments but also is easy to implement and cost-effective. An appropriate OHE technique will help the beneficiary to inculcate and reinforce new behavior. It will help to maintain a healthy lifestyle that will promote and improve an individual's general and oral health.[11,30] A distinctive approach with time and patience is essential for teaching good oral hygiene practices to visually impaired children.

For oral hygiene status outcome, 13 studies were included in meta-analysis. Six studies assessed Loe and Silness plaque index,[12,13,20-23] four studies assessed

Loe and Silness gingival indices,[10,20,22,23] two studies assessed PHP index,[14,28] two studies assessed Quigley Hein Plaque index,[24,25] and two studies assessed oral hygiene index – simplified (OHI-S).[27,29] The majority of the studies suggest a positive effect of different OHE techniques on plaque level reduction, improvement of gingival scores, and improvement of the oral hygiene status calculated through PHP index and OHI-S. For plaque reduction, which was assessed by Loe and Silness plaque indices and Quigley Hein plaque index, the "ATP" OHE technique was found to be superior to other OHE techniques. The combination of "Braille + Audio" was the most effective as compared to other OHE techniques in improving gingival scores which were
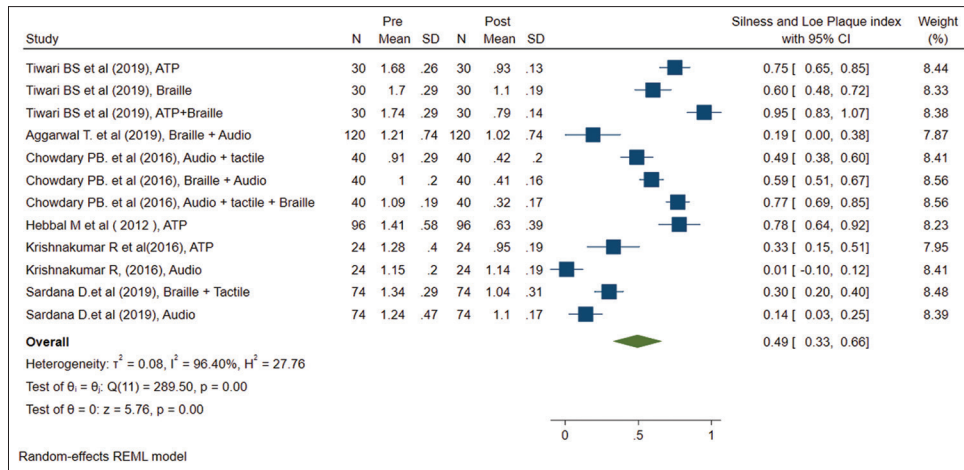
Figure 5a: Effect of different OHE techniques on the oral hygiene status of visually impaired children assessed by Silness and Loe Plague indices
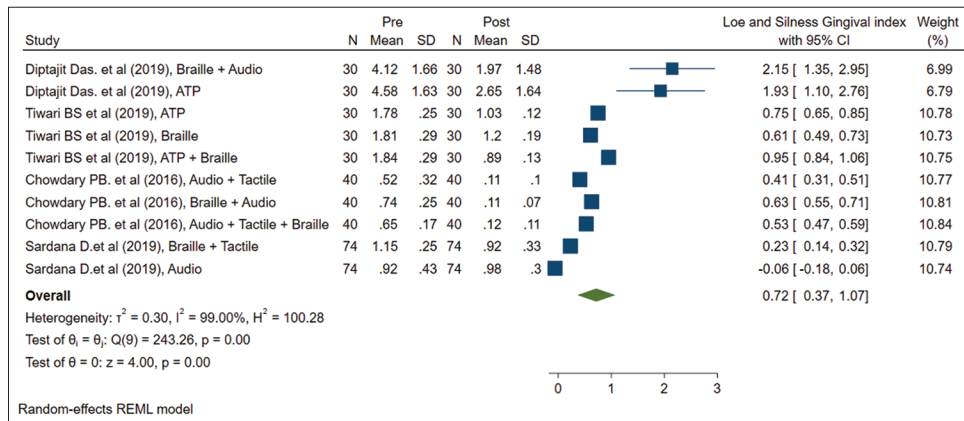

Figure 5b: Effect of different OHE technique on oral hygiene status of visually impaired children assessed by Loe and Silness Gingival Index
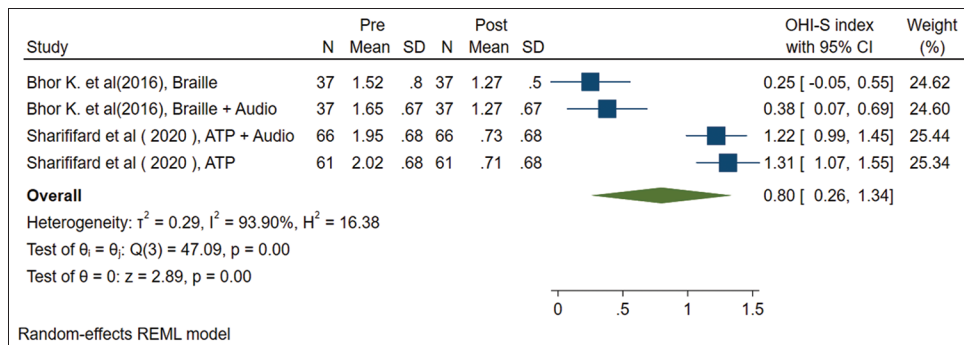

Figure 5c: Effect of different OHE technique on oral hygiene status of visually impaired children assessed by Oral Hygiene Index – Simplified (OHI-S) Index

assessed using Loe and Silness gingival indices. "Braille" and "ATP" were superior in improving the oral hygiene status, which were assessed with the help of PHP index and OHI-S Index, respectively.

We conducted meta-analysis separately for assessing the independent effect of ten different OHE intervention techniques to see the overall improvement of the oral hygiene status. Among the different OHE techniques, it can be suggested that conventional "Braille" is the best OHE technique for improving the oral hygiene status in visually impaired children, followed by "Audio" and "ATP". The least improvement in the oral hygiene status post the OHE technique was seen with "Audio + Tactile".[10,12-14,20-25,27-29]

Meta-analysis was also conducted to assess the oral health knowledge of visually impaired children. Four studies which were composed of six different OHE techniques were assessed. All four studies showed a positive effect of six different OHE techniques on the oral health
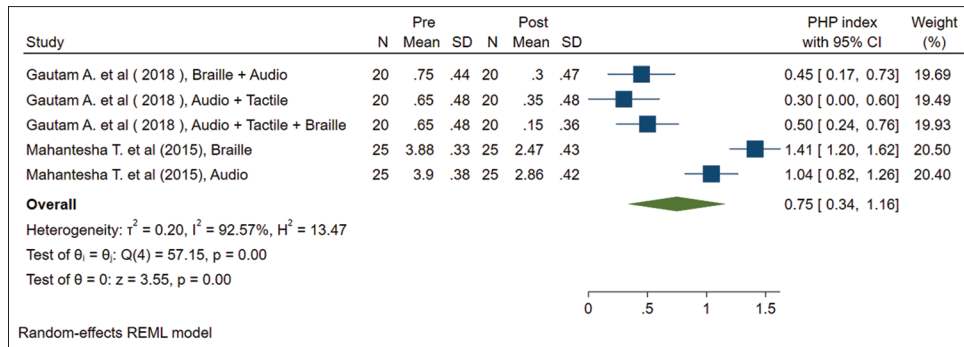
Figure 5d: Effect of different OHE technique on oral hygiene status of visually impaired children assessed by Patient Hygiene Performance (PHP) Index
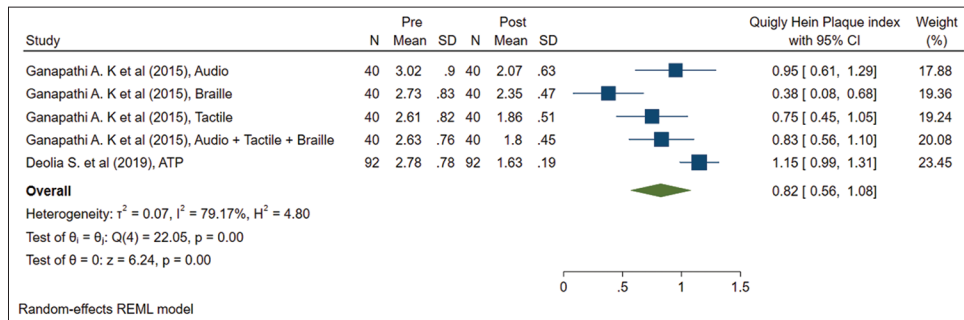

Figure 5e: Effect of different OHE technique on oral hygiene status of visually impaired children assessed by Quigley Hein Plaque Index
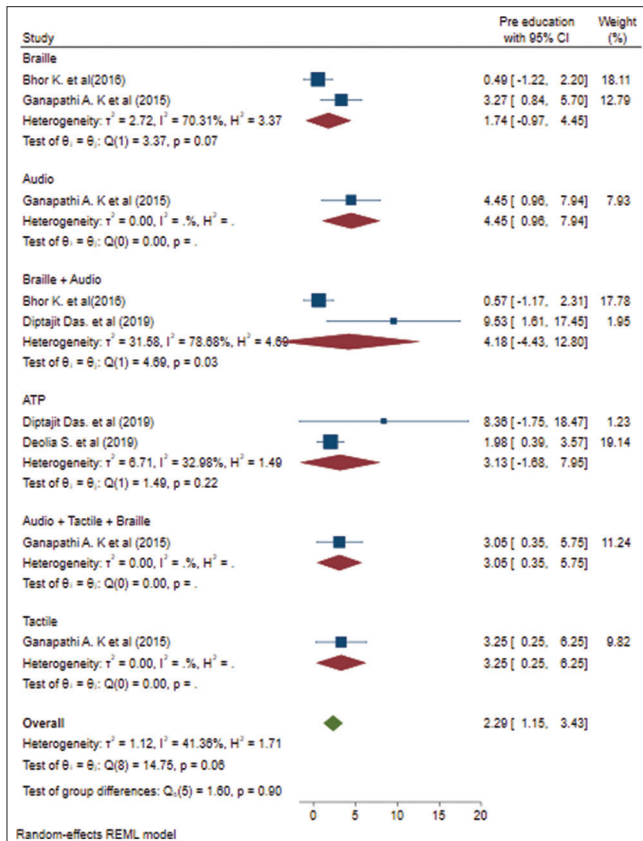

Figure 6a: Oral health knowledge of visually impaired children before OHE

knowledge of visually impaired children.[10,24,25,29] The pooled pre-OHE mean of the "Audio + Tactile + Braille"

OHE technique was found to be the most effective in improving oral health knowledge, followed by the "ATP" OHE technique. This may be attributed to the fact that visually impaired children would grasp more knowledge when it is imparted with a multi-sensory approach which includes verbal interaction, tactile experience, and the help of Braille.

A meta-analysis performed by Niloufar Abedi in 2018 to investigate the effective educational interventions on improving oral and dental health improvement in Iran by following the metaanalysis model concluded that educational interventions are beneficial in improving dental health in Iran. Our results also highlight improvement in the oral hygiene status and oral health knowledge post educational interventions.[31]

Systematic review conducted by Bhor K *et al*. (2020)[32] concluded that newer OHE methods (Braille, ATP) showed short-term improvement in oral hygiene behavior. However, evidence of this review is limited because OHE methods were evaluated over a short period of time. Also, findings of this systematic review did not explicitly mention the best OHE technique. It also highlighted the fact that all the studies were conducted while the students were not sensitized to the newer methods, which might have an added influence on their level of grasping of knowledge that was imparted.

The prime objective of our systematic review was to assess the best OHE technique to impart oral health
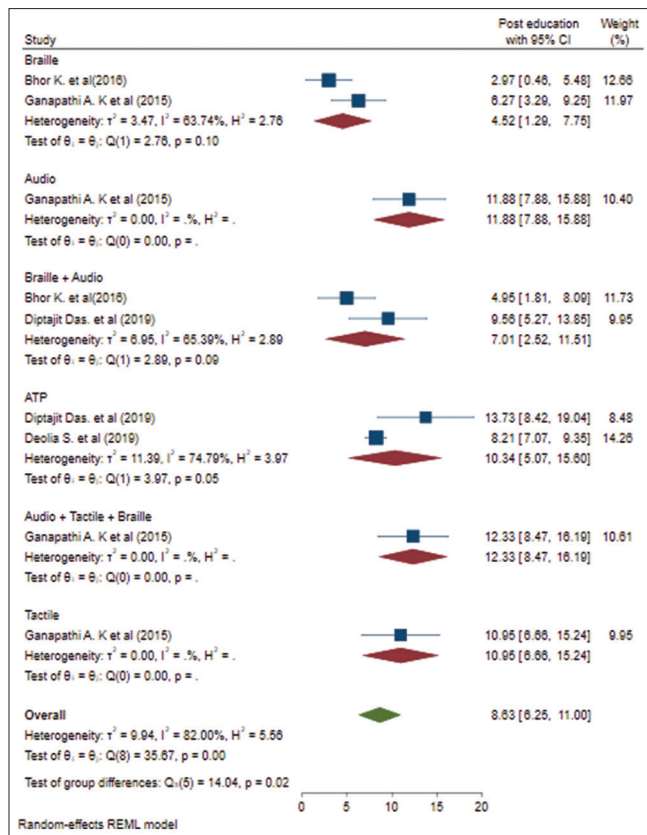
Figure 6b: Oral health knowledge of visually impaired children after OHE

education in visually impaired children. Hence, ten different combinations of OHE techniques were assessed in this systematic review. We found that all the oral health education interventions were imparted by oral health professionals. Visually impaired children are dependent on their parents or guardians for their daily activities. Hence, use of an appropriate OHE technique to enlighten visually impaired children would make them more independent and confident in maintaining their oral hygiene. These techniques can also be taught to parents and guardians to reinforce oral health education knowledge in these children periodically.

Limitation of the systematic review

Large heterogeneity was observed among the studies. Also, future studies should focus more on a larger sample size and longer follow-up periods. Sensitization to OHE techniques prior to the conduct of the study should be taken into consideration in any upcoming future studies.

Conclusion

Regular motivation and reinforcement from dental professionals, teachers, parents, and guardians play a significant role in promoting the oral health of visually impaired children.

Use of an appropriate OHE technique would boost their confidence and would make the learning process an enjoyable experience. Braille was the most effective OHE technique to improve oral hygiene of visually impaired children, followed by the Audio OHE technique and ATP OHE technique. "ATP" and "ATP + Braille" OHE techniques were the most effective in plaque reduction and oral hygiene status improvement. Based on our overall observation, it can be concluded that use of either the conventional Braille or ATP OHE technique alone without any combinations to impart OHE is the most reliable and useful method to improve the oral hygiene of visually impaired children and young individuals.

Abbreviations

Oral health education (OHE), World Health Organization (WHO), audio tactile performance (ATP), Apurva Deshpande (AD), Anil Ankola (AA), Roopali Sankeshwari (RS).

Conflicts of interest

There are no conflicts of interest.

References

1. Chang CH, Shih YH. Knowledge of dental health and oral hygiene practices of Taiwanese visually impaired and sighted students. J Vis Impair Blind 2004;98:289-303.
2. Kumar RK, Fareed N, Shanthi M. The effectiveness of oral health education program with and without involving self-maintainable oral hygiene skills among the visually impaired children. Int J Sci Study 2013;1:51-9.
3. Bourne RRA, Flaxman SR, Braithwaite T, Cicinelli MV, Das A, Jonas JB, *et al*. Magnitude, temporal trends, and projections of the global prevalence of blindness and distance and near vision impairment: A systematic review and meta-analysis. Lancet Glob Health 2017;5:e888-97.
4. Wadhwani M, Vashist P, Singh SS, Gupta V, Gupta N, Saxena R. Prevalence and causes of childhood blindness in India: A systematic review. Indian J Ophthalmol 2020;68:311-5.
5. Al-Alousi JMR. Oral health status and treatment needs among blind children in Iraq. MDJ 2009;6:313-24.
6. Al-Qahtani C, Wyne AH. Caries experience and oral hygiene status of blind, deaf and mentally retarded female children in Riyadh, Saudi Arabia. Odontostomatol Trop 2004;27:37-40.
7. Shetty V, Hegde AM, Bhandary S, Rai K. Oral health status of the visually impaired children–a south Indian study. J Clin Pediatr Dent 2010;34:213-6.
8. Tagelsir A, Khogli AE, Nurelhuda NM. Oral health of visually impaired schoolchildren in Khartoum State, Sudan. BMC Oral Health 2013;13:33.
9. Singh N, Kaur G, Gumber PK, Kaur N. Oral health status of 6 to 15-year-old deaf and blind children of Sriganganagar. Int J Oral Health Res Rev 2014;19:47-55.

10. Das D, Suresan V, Jnaneswar A, Pathi J, Bala Subramaniam G. Effectiveness of a novel oral health education technique in maintenance of gingival health and plaque removal efficacy among institutionalized visually impaired children of Bhubaneswar city: A randomized controlled trial. Spec Care Dentist 2019;39:125-34.

11. Deshpande S, Rajpurohit L, Kokka VV. Effectiveness of braille and audio-tactile performance technique for improving oral hygiene status of visually impaired adolescents. J Indian Soc Periodontol 2017;21:27–31.

12. Krishnakumar R, Silla SS, Durai SK, Govindarajan M, Ahamed SS, Mathivanan L. Comparative evaluation of audio and audio-tactile methods to improve oral hygiene status of visually impaired school children. CHRISMED J Health Res 2016;3:55–9.

13. Hebbal M, Ankola AV. Development of a new technique (ATP) for training visually impaired children in oral hygiene maintenance. Eur Arch Paediatr Dent 2012;13:244–7.

14. Gautam A, Bhambal A, Moghe S. Impact of oral health education by audio aids, braille and tactile models on the oral health status of visually impaired children of Bhopal City. J Indian Soc Pedod Prev Dent 2018;36:82–5.

15. Higgins JP, Thomas J, Chandler J, Cumpston M, Li T, Page MJ, *et al.* editors. Cochrane Handbook for Systematic Reviews of Interventions. John Wiley & Sons; 2019.

16. Sterne JA, Hernán MA, Reeves BC, Savović J, Berkman ND, Viswanathan M, *et al.* ROBINS-I: A tool for assessing risk of bias in non-randomised studies of interventions. BMJ 2016;355:i4919.

17. McGuinness LA, Higgins JPT. Risk-of-bias VISualization (robvis): An R package and Shiny web app for visualizing risk-of-bias assessments. Res Synth Methods 2021;12:55-61.

18. Khurana C, Tandon S, Chand S, Chinmaya BR. Effectiveness of oral health education program using braille text in a group of visually impaired children-before and after comparison trial. J Educ Health Promot 2019;8:50.

19. Debnath A, Srivastava BK, Shetty P, Eshwar S. New vision for improving the oral health education of visually impaired children-a non randomized control trial. J Clin Diagn Res 2017;11:ZC29-32.

20. Tiwari BS, Ankola AV, Jalihal S, Patil P, Sankeshwari RM, Kashyap BR. Effectiveness of different oral health education interventions in visually impaired school children. Spec Care Dentist 2019;39:97-107.

21. Aggarwal T, Goswami M, Dhillon JK. Assessment of Oral Health Educational Program on oral health status of visually impaired children in New Delhi. Spec Care Dentist 2019;39:140-6.

22. Chowdary PB, Uloopi KS, Vinay C, Rao VV, Rayala C. Impact of verbal, braille text, and tactile oral hygiene awareness instructions on oral health status of visually impaired children. J Indian Soc Pedod Prev Dent 2016;34:43.

23. Sardana D, Goyal A, Gauba K, Kapur A, Manchanda S. Effect of specially designed oral health preventive programme on oral health of visually impaired children: Use of audio and tactile aids. Int Dent J 2019;69:98-106.

24. Ganapathi AK, Namineni S, Vaaka PH, K V, Das R, Devi M, *et al.* Effectiveness of various sensory input methods in dental health education among blind children-A comparative study. J Clin Diagn Res 2015;9:ZC75-8.

25. Deolia S, Johny J, Patil MS, Lanje NR, Patil AV. Effectiveness of "Audio-tactile Performance Technique" to improve the oral hygiene status of visually impaired schoolchildren. J Indian Soc Pedod Prev Dent 2019;37:172.

26. Kristiani A, Nugroho C. The effect of dental health education audio media toward the knowledge and ohi-s in visually impaired students of Tasikmalaya Special Extraordinary School (SLB) year 2016. In Prosiding Seminar Bakti Tunas Husada 2017. Vol. 1.

27. Sharififard N, Sargeran K, Gholami M, Zayeri F. A music-and game-based oral health education for visually impaired school children; Multilevel analysis of a cluster randomized controlled trial. BMC Oral Health 2020;20:1-9.

28. Mahantesha T, Nara A, Kumari PR, Halemani PK, Buddiga V, Mythri S. A comparative evaluation of oral hygiene using Braille and audio instructions among institutionalized visually impaired children aged between 6 years and 20 years: A 3-monthfollow-up study. J Int Soc Prev Community Dent 2015;5(Suppl 2):S129-32.

29. Bhor K, Shetty V, Garcha V, Nimbulkar GC. Effect of oral health education in the form of Braille and oral health talk on oral hygiene knowledge, practices, and status of 12–17 years old visually impaired school girls in Pune city: A comparative study. J Int Soc Prev Community Dent 2016;6:459-64.

30. Pine CM. Community Oral Health. 2nd ed. Oxford: Wright; 1997. p. 188–205.

31. Abedi N. Meta-analysis of the effectiveness of educational interventions on dental and oral health promotion in Iran. J Educ Health Promot 2019;8:29.

32. Bhor KB, Vinay V, Ambildhok K, Shetty V. Effectiveness of oral health educational interventions on oral health of visually impaired school children: A systematic review and meta-analysis. Spec Care Dentist 2021;41:291-308.