Effectiveness of Audio and Audio-Visual Distraction Aids for Management of Pain and Anxiety in Children and Adults Undergoing Dental Treatment- A Systematic Review And Meta-Analysis

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Dentists have a wide variety of techniques available to them such as tell -show-do, relaxation, distraction, systematic desensitisation, modelling, audio analgesia, hypnosis, and behaviour rehearsal. There is no concrete research as systematic review and meta-analysis indicating which explains the most effective distraction technique. ***Aim:*** *To summarize effectiveness of audio and audio-visual (AV) distraction aids for management of pain and anxiety in children undergoing dental treatment.* ***Study design:*** *Literature search: PubMed/ MEDLINE, DOAJ, Science Direct from June – July 2020 with randomized control clinical trials conducted on children with audio and AV distraction aids as intervention and those which had anxiety and pain as outcomes were searched. Fifty articles were identified and relevance was determined. 14 studies were included for qualitative synthesis and 05 were eligible for meta-analysis. Cochrane handbook used to assess the risk of bias. The meta analysis conducted using review manager 5.3 software.* ***Results:*** *Meta-analysis, cumulative mean difference for audio and AV distraction techniques was calculated with main outcomes as pulse rate, O_2 level, Vehman's picture and clinical test. These findings showed significant difference favoring the intervention (audio and AV) group when compared with control but indicating more effectiveness of AV distractions.* ***Conclusion:*** *Different audio-visual aids assist in reducing pain and anxiety in children but using audio distraction aids when audio-visual aids are not available could be acceptable way for distracting and treating children*

Keywords*: Audio-visual distraction aids, Anxiety, meta-analysis, Venham's picture test.*

ABBREVIATION

CI: Confidence Interval

DOAJ: Directory of Open Access Journal

IAN BLOCK: Inferior Alveolar Nerve Block

MCDAS: Modified Corah Dental Anxiety Scale

SD: Standard Deviation

VAS: Visual Analog Scale

VEES: Video Eyeglasses/Earphones System

W-B FACES: Wong Baker's Faces

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INTRODUCTION

Pain is an unpleasant sensory and emotional experience associated with actual or potential tissue damage or described regarding such damage, according to the International Association for the Study of Pain[1]. Dental anxiety is a multi-dimensional model that contains social, perceptive, and physiological components. Anxiety and fear of dental procedures develop in early childhood[1]. It is a feeling of apprehension, worry, uneasiness, or dread, the source of which may be unknown. Corah *et al* [1] stated that dental anxiety is the patient's response to anxiety which is very much related to the dental appointments

During dental treatment children are usually very much anxious and it's very normal for the children to be anxious of new and potentially threatening conditions. There is a strong relationship between a child's dental anxiety and successful dental treatment, and also between anxiety and pain[2]. Fear of pain influences a child during the procedure, which may result in nervousness, sensitization, and uncooperative behavior during the present and future dental appointments[1].

Distraction is the technique of diverting the patient's attention from what may be perceived as an unpleasant procedure[3]. Mc Caul and Mallet developed the theory of distraction by giving importance to the fact that the capacity of humans to pay attention is limited. They demonstrated that an individual should concentrate on the painful stimulus so as to perceive pain; therefore, perception of pain decreases when a person's attention is distracted away from the stimulus[3].

In children, dentists have a wide variety of techniques available to them such as tell-show-do, relaxation, distraction, systematic desensitization, modeling, audio analgesia, hypnosis, and behavior rehearsal[4].

Pharmacological management of patients with dental anxiety, though is used commonly in previous days not far from today, but disadvantages are felt by both the patients and the doctor. Among all variety of pharmacological techniques (nitrous oxide usually is matched with oral drugs), general anesthesia, and other agents (chloral hydrate and hydroxyzine), papoose board and hand over mouth technique can be successful, but the attitude of parents and dental professional towards these techniques is changing and now non-aversive techniques like distraction are becoming more popular[4]. Hence, the non-pharmacological interventions have gained the fame especially in dentists. In distraction technique, distracters can be either in active or passive form. Audiovisual distraction is a method of passively distracting two types of sensations—hearing and seeing[3]. Audiovisual virtual reality is an altered three-dimensional (3D) world generated by a computer[5].

Although there are several studies about the effect of the Audio, [6-10] and audiovisual[1-5,11-19] techniques on anxiety during dental treatments. With reference to the vast amount of literature available on this topic, some systematic reviews were conducted by Liu *et al* [20] and Prado I *et al* [21] with adequate methodology and concrete findings. However, they did attempt for qualitatively to assess the individual studies nonetheless, there was a missing quantitative (meta-analysis) conclusion to arrive at a holistic conclusion. Neither did we find any literature which tried to compare audio and audio-visual distraction technique, to show an inclination towards one or the other.

Thus, with reference to this paucity that there is no concrete research as systematic review and meta-analysis which explains and is indicative of the most effective distraction technique, we conducted a systematic review and meta-analysis to summarize and evaluate effectiveness of audio and audio-visual distraction aids for management of pain and anxiety in children undergoing dental treatment.

METHOD

Protocol development

This systematic review and meta-analysis were written and conducted according to the Preferred Reporting Items for Systematic Review and Meta-Analyses (PRISMA) statement and registered in PROSPERO under number CRD42020204345. This SR's methodology followed the recommendations of the Cochrane Handbook for Systematic Reviews of Interventions version 5.1.0 [22]. The following focused question in the Patient, Intervention, Comparison and Outcome (PICO) format was posed "Is there any effect of audio and audio-visual distractions aids on pain and anxiety levels in children undergoing dental treatment?"

Search Strategy

An electronic search without restriction of language in June – July 2020 was conducted on PubMed/ MEDLINE, Google Scholar, DOAJ, Science Direct. In addition, a specific electronic search in the following journals was also conducted: International Journal of Paediatric Dentistry, International Journal of Clinical Pediatric Dentistry, European Journal of Paediatric Dentistry, Journal of Indian Society of Pedodontics and Preventive Dentistry, Journal of Pediatric Dentistry and The Journal of Clinical Pediatric Dentistry.

MeSH terms, keywords, and other free terms related to PICO question were used with Boolean operators (OR, AND) to combine searches. The similar keywords were used for all search platforms followed the syntax rules of each database. The search strategy and PICOS tool are given in Table 1.

Inclusion criteria guidelines according to the population, interventions, comparisons, outcomes, and study design (PICOS strategy)

- Population (P): Children undergoing dental treatment
- Interventions (I): Various audio distraction aids- music or audio presentation through earphones. (which included instrumental, songs, rhymes) audio-visual distraction aids (VR, presentations, videos, cartoons, story) using (earphones, headphones, laptops, MP3 players, mobile phones, chair mounted devices, ceiling mounted devices).
- Comparison (C): No intervention methods given to the control group.
- Outcome (O): **Anxiety level**: (pulse rate, oxygen level, pulse rate, Vehman's picture, Vehman's clinical anxiety and picture test scale, Facial Image scale(FIS), face, Legs, Activity, Cry, Consolability' scale (FLACC)
- **Pain level Vehman's:** Vehman's anxiety scale), Wong baker's scale, State Trait Anxiety Inventory (STAI), Blood pressure (BP

Table 1: Search strategy and PICOS tool

Focused question	Is there any effect of audio and audio-visual distractions aids on pain and anxiety levels in children and adults undergoing dental treatment?
Search strategy	
Population	(Adolescent [MeSH] OR Teenagers [Text Word] OR Teens [Text Word] OR Kids [Text Word] OR School children [Text Word] OR children [Text Word]
Intervention	audio aids (songs, music, videos) OR audio-visual distraction aids (VR, music instruments) OR visual aids (cartoons, story) using earphones OR headphones OR laptops OR MP3 players OR mobile phones OR chair mounted devices OR ceiling mounted devices)
Comparisons	No intervention methods given to the control group
Outcomes	For dental anxiety Pulse rate [Text Word] OR oxygen level [Text Word] OR Heart rate [Text Word] OR Vehman's picture [Text Word] OR Vehman's clinical anxiety and picture test scale [Text Word] OR FIS[Text Word] OR FLACC[Text Word] OR COARH[-Text word] OR Frankel's behaviour rating scale [Text word] For pain Blood pressure [Text Word] OR STAI [Text Word] OR VAS [Text Word] OR Wong baker's scale [Text Word]
Study design	Experimental trials and Randomized controlled trials (RCTs)
Search combination	#1 AND #2 AND #3 AND #4
Database search	
Language	No restriction
Electronic Databases	PubMed, Google Scholar, DOAJ (Directory of Open Access Journal), Science Direct.
Journals	International Journal of Paediatric Dentistry, International Journal of Clinical Pediatric Dentistry, European Journal of Paediatric Dentistry, Journal of Indian Society of Pedodontics and Preventive Dentistry, Journal of Pediatric Dentistry

- Study design (S): Experimental trials and Randomized controlled trials (RCTs)
- Time (T): follow-up period kept at 1 month and 24 months

Exclusion criteria

Animal studies, *in vitro* studies, observational study designs, case reports, and reviews. In addition, studies reporting about a single intervention were excluded. Also only those studies which had ethical approval were included.

Selection criteria

This review included randomized controlled trial that evaluated the primary outcomes and were free full text which could be translated in English language.

Screening process

The search and screening process were carried out by two independent reviewing authors, following the previously established protocol, first analysing titles and abstracts. In a second phase, complete free full text articles were selected for careful reading and analysed per eligibility criteria (inclusion/exclusion) for future data extraction. Disagreements among authors/reviewers were resolved through careful discussion. The search agreement between the two reviewers was evaluated by the Cohen's Kappa (k) test (0.82). If required, the authors of the included studies were contacted by e-mail for clarification of any doubts.

Data extraction

The following data were extracted from the included studies (when available) by two independent reviewing authors: study identification number, authors, study design, follow-up, number of subjects, age, gender, sample size, type of distraction aid, dental treatment, type of outcome and author's conclusions. The data was recorded in mean and standard deviation format as principal summary measures which was further analysed in quantitative analysis. The post intervention, last follow-up visit scores were recorded and used from the individual relevant studies. Based on the three comparisons (audio vs control; audio-visual vs control; audio vs audio-visual) there was subgroup analysis performed for the outcome parameters/tools.

Assessment of the risk of bias and quality

Quality assessment of the selected studies was executed by using the Cochrane Collaboration Tool[23] for randomized controlled trials (RCTs) including random sequence generation, allocation concealment, blinding of participants, incomplete outcome data, selective reporting, and other bias.

Statistical analysis

Review Manager 5.3 was used for statistical analysis. The heterogeneity for the studies in meta-analysis were checked by I^2 values along with Cochran's Chi-Square Q. Depending on the same, we applied the fixed or random effect model accordingly. Differences in means and effect size were used as principal summary measures (post-intervention/last follow-up visit). Forest plots and funnel plots were created to visualize the differences between groups and publication bias. The overall calculated effect was categorized as significant where $p < 0.05$.

RESULTS

We followed the PRISMA guidelines for the methodology. The study selection process is given in Figure 1 (PRISMA flow Chart-Supplementary file). All the titles and abstracts were screened based on the stringent selection criteria. Subsequently the full texts the assessed independently by the two reviewers. A total of 14 studies over the past fifteen years met the inclusion criteria for full text reading and all 05 were included for further analysis.

Literature search

The electronic searches yielded 17400 references, with title/ abstract availed. After removal of duplicates and initial screening 3310 paper was assessed based on titles and abstract relevant to topic. A total of 50 full text articles were assessed for eligibility based on the inclusion and exclusion criteria. Fourteen studies were finally involved for qualitative synthesis in this review. A total of 05 were further selected for quantitative analysis. No study was

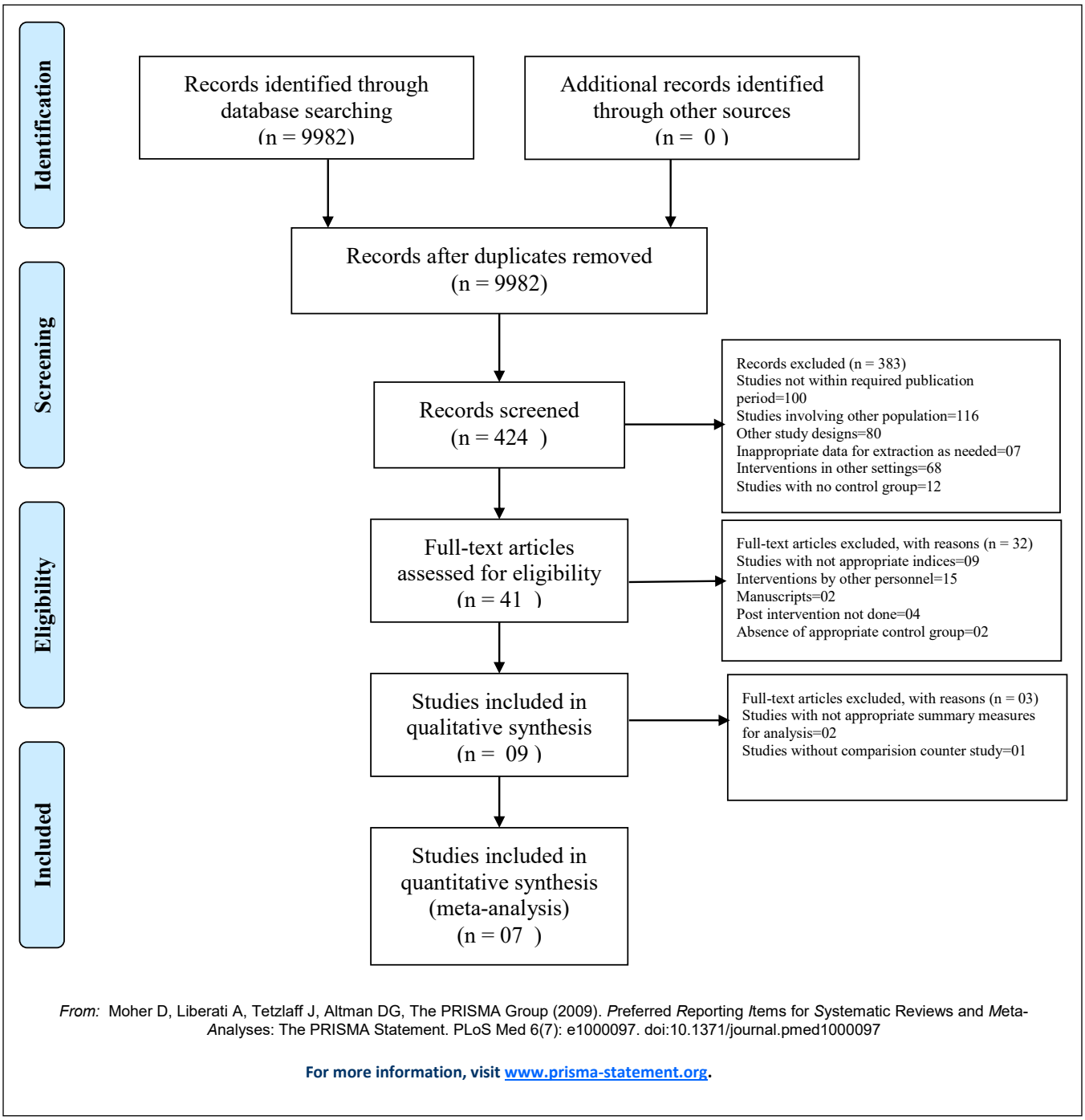

Figure 1. Prisma flow diagram showing the studies exclusion and final inclusion with reasons.

found by manual screening the references list of included studies. Fourteen articles were selected from screening the above mentioned number of articles by two independent reviewers. Following careful examination, discussion was conducted depending on the selection criteria by the reviewers. Any discrepancies in opinion was resolved by third reviewer. Ultimately 14 articles were finalised for qualitative analysis and meta-analysis was conducted for 05 articles from the lot.

Qualitative Analysis

Study characteristics (Table 2 and Table 3)

The study characteristics of the included 14 studies is mentioned in Table 2 and Table 3. Studies published from 2005-2020 were included, we did not keep any publication restriction year. Majority of the studies were conducted in India[1-4,7,9-10,12,14,15] apart from this country, there were studies conducted in Chile[2], Mexico[5] and Syria[11]. The cumulative number of girls (285) were less as compared to the males (333) in the 09 studies. However, eight studies[4,5,7,9,11,14-16] did not mention the gender ratio.

The intervention group was divided as audio and audio visual distraction technique. The audio techniques were instrumental music[6,7,10], nursery rhymes[2,7,10], presentations[4,9,16], stories and folk tales[10], songs (English, Hindi, Punjabi)[10,12]. The audio-visual distraction aids were of a large variety like VR (Virtual reality) eye-glasses/VR box[1,5,11,14,15], cartoon, movies[2,3], video games[3], video songs[12], MP4 audio-visual files through ceiling mounted and chair audio-video device[16], television[4,15], mobile phones[1] and tablets[11].

The dental treatment which was conducted during the distraction techniques were LA during extraction[3,11], only local anaesthesia administration[1], multiple procedure (oral prophylaxis, restorations, invasive procedures) at multiple visits was most commonly followed in the selected studies[1,2,4,5,7,9,10,12,14-16].

The primary outcome was pain and anxiety, which was measure through various tools which we analysed in the quantitative analysis. Pulse rate[4,5,7,8,11-14,16], FLACC[5,11], Wong-Bakers FACES[1,11,14], VAS (Visual Analog scale)[1,2,14], FIS (Facial Image scale)[3,6], Behaviour scales[12], oxygen saturation levels[2,4,7,10,12,15,16], Venham's Picture test[4,7,10,15,16] and Venham's clinical anxiety test[1,] were the scales used in the studies. One of the study[6] also recorded OHI-S/deft.

Table 2: Characteristics of the included studies

Sr. No	Author	Study Id	Place Of The Study	Year Of Acceptance	Study Design	Sample Size At Baseline	Total Sample At Follow Up= N. (Drop Out %)	Age Group	Gender N(%)
1	M.Alhalabi et al [11]	Effectiveness Of Audio Visual Distraction Using Virtual Reality Eyeglasses Versus Tablet Device In Child Behavioral Management During Inferior Alveolar Nerve Block	Syria	2018	A Randomized Clinical Trial	102	101	6-10 (Mean Age Group 7.4)	42 Girls 60 Boys
2	G. A Rojasal-cayaga et al [6]	Music Distraction Effectiveness In Dental Anxiety And Treatment Adherence In 6-Year-Old Children	Chile.	2018	A Randomized Clinical Trial	176	84(47.7)	6	97 Girls 79 Boys
3	N. Agarwal et al [2]	Effectiveness Of Two Topical Anaesthetic Agents Used Along With Audio Visual Aids In Paediatric Dental Patients	Uttar Pradesh	2017	A Randomized Clinical Trial	120	120	3-14 Years	60 Girls 60 Boys
4	Prabhakr A. et al [4]	A Comparison Between Audio And Audiovisual Distraction Techniques In Managing Anxious Pediatric Dental Patients	Rohtak,	2007	A Randomized Clinical Trial	60	60	4-8 Years	-

Table 2: Characteristics of the included studies (continued)

Sr. No	Author	Study Id	Place Of The Study	Year Of Acceptance	Study Design	Sample Size At Baseline	Total Sample At Follow Up= N. (Drop Out %)	Age Group	Gender N(%)
5	Marwah N.A et al **[7]**	Music Distraction – Its Efficacy In Management Of Anxious Pediatric Dental Patients	Rohtak,	2005	A Randomized Clinical Trial	40	40	4-8 Years	-
6	M. Nunna et al **[1]**	Comparative Evaluation Of Virtual Reality Distraction And Counter-Stimulation On Dental Anxiety And Pain Perception In Children	India	2019	A Prospective Randomized single-Blinded (To The Subjects) Interventional Clinical Trial	70	70	7-11 Years	35 Females 35 Males
7	R. Kaur et al **[12]**	Comparative Evaluation Of The Effectiveness Of Audio And Audiovisual Distraction Aids In The Management Of Anxious Pediatric Dental Patients	Mumbai, India	2015	A Randomised Controlled Trial	60	60	4-6 Years 6-8 Years	-
8	Dr. B. Jethani et al [8]	Influence Of Music Therapy On Anxiety, Pain Perception, Heart Rate And Blood Pressure Of Patients Undergoing Endodontic Treatment	Bengaluru.	2019	A Randomized Control Trial	100	100	18 - 50 Years	51 Girls 49 Boys
9	H. N.Albagieh et al **[13]**	Effect Of Audiovisual Anxiety Control Methods With And Without Noise Cancelation For Adult Patients Undergoing Routine Dental Procedures	Saudi Arabia	2020	Randomized Controlled Clinical Trial	120	120	18-45 Years	-
10	S. Chaturvedi et al **[14]**	Comparative Evaluation Of Anxiety Level During The Conventional Dental Procedures With And Without Audiovisual Distraction Eyeglasses In Pediatric Dental Patients	Pimpri, Pune,	2016	Randomized Controlled Clinical Trial	40	40	6 And 10 Years	15 Girls 25 Boys

Table 2: Characteristics of the included studies (continued)

Sr. No	Author	Study Id	Place Of The Study	Year Of Acceptance	Study Design	Sample Size At Baseline	Total Sample At Follow Up= N. (Drop Out %)	Age Group	Gender N(%)
11	Dr. S. Allani et al **[3]**	Effectiveness Of Distraction Techniques In The Management Of Anxious Children In The Dental Operatory	Bangalore	2016	Interventional Study	60	60	4-8 Years	-
12	A. Garrocho Rangel et al **[5]**	A Video Eyeglasses/ Earphones System As Distracting Method During Dental Treatment In Children	Mexico	2018	A Crossover Randomised And Controlled Clinical Trial	80	72	5-8 Years	36girls 38 Boys
13	A. Sahu et al **[15]**	Managing Child's Dental Anxiety by Virtual Reality Distraction And 3d Audio-Visual Distraction Technique:	Jabalpur	2017	Comparative Study	60	60	4-12 Years	-
14	R. Jindal et al **[9]**	Can We Tune Our Pediatric Patients?	Punjab, India	2011	Randomized Controlled Clinical Trial	30	30	4-8 Years	-
15	M. Khandelwal et al **[16]**	Effectiveness Of Distraction Techniques In Managing Pediatric Dental Patients	India	2019	A Randomised Control Study	80	80	4-10 Years	-
16	S. Navit et al **[10]**	Effectiveness And Comparison Of Various Audio Distraction Aids In Management Of Anxious Dental Paediatric Patients	Lucknow.	2015	A Randomized Control Study	150	150	6-12 Years	-

Table 3: Characteristics of the included studies

Sr. No	Author	Study Id	Type of Intervention group (N=)	Type of Distraction	Dental treatment	Type of outcome	Method of Outcome assessment	Authors Conclusions
1	M.Alhalabi et al [11]	Effectiveness Of Audio Visual Distraction Using Virtual Reality Eyeglasses Versus Tablet Device In Child Behavioral Management During Inferior Alveolar Nerve Block	Group A (Control Group) 34 Group B: 34 AV Eyeglasses (VR Box): The AV Eyeglasses Group C:34 Tablet	1 AV Eyeglasses (VR Box): The AV Eyeglasses 2 Tablet: The Tablet Capable Of Playing MP4 Audio-Visual Files,	Administration Of Local Anaesthesia Before Extraction	Anxiety	Behaviour Assessment Scale: (FLACC Scale) Pulse Rate Measures Pain Assessment Scale: The Wong-Baker FACES Pain Rating Scale	Videos shown on tablet gave the best result in relieving dental anxiety and pain during IAN block in children. Although the use of AV eyeglasses 'VR box' had no added advantage in a majority of children, but it was more acceptable in patients of 8-10 years
2	G. A Rojasal-cayaga et al [6]	Music Distraction Effectiveness In Dental Anxiety And Treatment Adherence In 6-Year-Old Children	Control :88 Experimental :88 Music Distraction By Earphones	Music Distraction By Earphones	Dental Treatment	Dental Anxiety	The Facial Image Scale (FIS) Frankl Behavioral Rate Scale (FBRS) The Def-T Index Simplified Oral Hygiene Index (OHI-S), Created By Green And Vermillion In 1960.	There was no impact of MD(Music Distraction) on adherence to treatment because there was no reduction in DA(Dental Anxiety)
3	N. Agarwal et al [2]	Effectiveness Of Two Topical Anaesthetic Agents Used Along With Audio Visual Aids In Paediatric Dental Patients	1)EMLA Cream Group Without AV Aids (N=30); 2) EMLA Cream Group with AV Aids (N=30); 2Sony Laptop with Earphones and DVD of Rhymes And Cartoon Movie 3) Benzocaine Gel Without AV Aids (N=30); 4) Benzocaine Gel with AV Aids (N=30). Sony V Laptop with Earphones and DVD of Rhymes and Cartoon Movie	Sony Vaio Laptop With Earphones And DVD Of Rhymes And Cartoon Movies.	Dental Treatment	Pain	VAS Pulse Oximeter (OMRON).	EMLA with AV Aids was better when compared with EMLA Without AV aids followed by benzocaine with AV Aids. Benzocaine topical anaesthetic agent without AV aids was least effective in reducing the pain scores and improving the oxygen saturation rate.

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Sr. No	Author	Study Id	Type of Intervention group (N=)	Type of Distraction	Dental treatment	Type of outcome	Method of Outcome assessment	Authors Conclusions
4	Prabhakr A. et al [4]	A Comparison Between Audio and Audio-visual Distraction Techniques In Managing Anxious Pediatric Dental Patients	Group A (Control) 30 Group B :30 Audio Presentation Through Headphone Group C:30 Audio Visual Presentation Through Television	Audio Presentation Through Headphones Visual Presentation Through Television	1 Screening 2 Oral Prophylaxis 3Cavity Preparation and Restoration 4 Extraction After The Administration Of Local Anaesthesia	Anxiety	Venhamís Picture Test, Venhamís Rating Of Clinical Anxiety, Pulse Rate And Oxygen Saturation,Which Were Measured Using Pulse Oximeter	Audio-visual distraction technique was more effective in managing anxious pediatric dental patient as compared to Audio distraction technique and normal dental setup.
5	Marwah N.A et al (7)	Music Distraction – Its Efficacy In Management Of Anxious Pediatric Dental Patients	Group A (Control Group):20 Music Group B:10 Instrumental Music Through Headphone Music Group C :10 Nursery Rhymes Music Through Headphone	Instrumental Music And Nursery Rhymes Music Through Headphones	1st Visit Screening 2nd Visit Oral Prophylaxis 3rd Visit Cavity Preparation and Restoration 4th Visit Extraction Of The Decayed Teeth.	The Anxiety	Venham's Picture Test, Venham's Anxiety Rating Scale Pulse Rate And Oxygen Saturation.	Audio distraction technique did decrease the anxiety level in the pediatric patients although not to a very significant level.
6	M. Nunna et al (1)	Comparative Evaluation Of Virtual Reality Distraction And Counter-Stimulation On Dental Anxiety And Pain Perception In Children	CS Group:35 Smartphone and Earphone VR Group:35 ANTVR Phone	1ANTVR Phone Glass T2 Designed for Lenovo (Model No: PA15LF53A, ANTVR Technology Co., LTD, 2smartphone (Lenovo Vibe K4 Note, Beijing, China) And Earphones (Sennheiser CX 180 Street II (Black), Sennheiser Electronic Gmbh & Co. KG. India)	LA Administration	Pain and Anxiety	1 A Pulse Oximeter 2 Wong-Baker Faces Pain Rating Scale (WBFPS) 3 Visual Analogue Scale (VAS). 4.The Objective Venham's Clinical Anxiety Rating Scale (VCARS)	VR distraction is a more useful behaviour guidance modality to decrease dental fear and anxiety in children during LA administration

Table 3: Characteristics of the included studies (continued)

Sr. No	Author	Study Id	Type of Intervention group (N=)	Type of Distraction	Dental treatment	Type of outcome	Method of Outcome assessment	Authors Conclusions
7	R. Kaur et al (12)	Comparative Evaluation Of The Effectiveness Of Audio And Audio-visual Distraction Aids In The Management Of Anxious Pediatric Dental Patients	Sub-Group 1: Control Group:20 • Sub-Group 2: Audio Distraction Group:20 Audio: Either English or Hindi Or Punjabi Songs Through Headphones • Sub-Group 3: Audio — Visual Distraction Group:20 Audio-visual: Either English Or Hindi Or Punjabi Short Dramatic Clips, Video Songs And Cartoons	Audio: Either English or Hindi or Punjabi Songs Through Headphones Audio-visual: Either English Or Hindi Or Punjabi Short Dramatic Clips, Video Songs And Cartoons Presentations Through Headphones	1. First Visit: Screening or Diagnosis. 2. Second Visit: Cavity Preparation Without the Need Of Administration of Local Anaesthesia. 3. Third Visit: Administration Of Local Anaesthesia For Invasive Procedures Like Extraction Or Endodontic Procedure.	Anxiety and Behaviour	1)Anxiety Level: Physiological Means Heart Rate Pulse Oximeter (Phoebus P121) Psychological Means Dental Subscale of Children's Fear Survey Schedule-Short Scale 2) Behavioural Means Comprised of: A. Clinical Anxiety Rating Scale B. Co-Operative Behavioural Rating Scale.	1. Audio and audiovisual distraction techniques provided effective distraction on both the age groups. Although when compared audiovisual distraction aids perform better than audio distraction aids. Audio and audio-visual distraction techniques reduced the fear and anxiety in both the age groups as depicted by heart rate and dfss-sf. However, maximum clinical anxiety/fear reduction was found in audio-visual group followed by audio group.
8	Dr. B. Jethani et al [8]	Influence Of Music Therapy On Anxiety, Pain Perception, Heart Rate And Blood Pressure Of Patients Undergoing Endodontic Treatment	Group A :50 Playlist of Their Choice Through Noise-Cancelling Headphones (Sony Headphones Mdrzx110nc, Sony, Japan Group B(Control):50	Playlist Of Their Choice Through Noise-Cancelling Headphones (Sony Headphones Mdrzx110nc, Sony, Japan)	Endodontic Treatment	Pain and Anxiety	1) Modified corah dental anxiety scale (MCDAS) to assess the baseline level of anxiety and Visual Analog Scale (VAS) 2) Systolic Blood Pressure (SBP), Diastolic blood pressure (DBP), and Heart rate (HR).	Music therapy administered to participants with different levels of anxiety during endodontic treatment significantly decreased level of pain, systolic blood pressure, diastolic blood pressure

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Sr. No	Author	Study Id	Type of Intervention group (N=)	Type of Distraction	Dental treatment	Type of outcome	Method of Outcome assessment	Authors Conclusions
9	H. N.Albagieh et al (13)	Effect Of Audiovisual Anxiety Control Methods With And Without Noise Cancelation For Adult Patients Undergoing Routine Dental Procedures	Group1 (N=12): Control, Group 2: (N=12) Audio Distraction + Noise And Visual Cancellation, Group 3: (N=12) Audio Distraction + Noise Cancellation, Group 4: (N=12) Audio Distraction + Visual Cancellation, Group 5: (N=12) Audio Distraction Only, Group 6: (N=12) Visual Distraction Only, Group 7: (N=12) Visual Distraction + Noise Cancellation, Group 8: (N=12) Visual Distraction + Noise Cancellation + Audio Distraction, Group 9: (N=12) Audio-visual Distraction, Group10: (N=12) Noise-Cancelling Headphones, Group11: (N=12) Regular Headphones	1) Noise Cancelling (Bose Quietcomfort 35II, Massachusetts) Or Sony Wireless Stereo Headset 2.0; Tokyo; Japan) Headphones Playing Weightless by Marconi Union. 2)For Additional Visual Cancellation Blindfold For Omission Of Surroundings 3)A Virtual Retinal Display (Homido V2, Lille, France) Playing Different Videos And Were Provided With Noise-Cancelling Or Regular Headphones 4)(For Additional Audio Distraction) Headphones	Basic Restorative Procedures For Class I, II, III, IV, And/Or V Lesions, Which Involved Injection Of Local Anes-thetic Solution	Anxiety	Anxiety Levels the Blood Pressure, Heart Rate, And Oxygen Saturation Levels The State-Trait Anxiety Inventory (STAI) Modified Dental Anxiety Scale (DAS)	Audio and audio-visual distraction methods are effective in reducing the anxiety levels of adult patients undergoing routine dental procedures, regardless of the use of noise cancellation.

Table 3: Characteristics of the included studies (continued)

Sr. No	Author	Study Id	Type of Intervention group (N=)	Type of Distraction	Dental treatment	Type of outcome	Method of Outcome assessment	Authors Conclusions
10	S. Chaturvedi et al [14]	Comparative Evaluation Of Anxiety Level During The Conventional Dental Procedures With And Without Audio-visual Distraction Eyeglasses In Pediatric Dental Patients	Group I : 20 Subjects (Wearing AVD Eyeglasses) Group II : 20 Subjects (Without Wearing AVD Eyeglasses.)	1)AV Wireless Eyeglasses with Earphones (Chinavasion Electronics. Eye Mobile Theatre Video Glasses, 52″ Virtual Screen) 2) Pulse Oximeter (Oxi-Stat 1010 Plus, Serial Number: 0103307)	Oral Prophylaxis, Restorative Treatment, And Pulpectomy Procedures	Pain and anxiety	Wong-Bakers Faces Pain Rating Scale Visual Analog Scale (VAS) Pulse Rate	The study supports the use of AVD video eyeglasses as a method of non-pharmacologic distraction aid leading to improved comfort and cooperation and reduced anxiety during pediatric conventional dental procedures.
11	Dr. S. Allani et al [3]	Effectiveness Of Distraction Techniques In The Management Of Anxious Children In The Dental Operatory	Group 1: 30 Video Games Group 2: 30 Favorite Cartoon Character	favourite Cartoon Character On Mobile Phone And. Ear Phones (Audio Distraction.) Video Games Of Their Interest	Dental Extraction Under Local Anaesthesia,	Anxiety	1) Facial Image Scale Through A Questionnaire 2) Ease Of Carrying Out The Procedure: Five Point Likert Scale	A cartoon video or video game on a mobile phone can be offered to most children as they are easy to implement, portable, and effective method to reduce anxiety in the preoperative area and during induction of local anaesthesia for dental extraction
12	A. Garrocho Rangel et al [5]	A Video Eyeglasses/ Earphones System As Distracting Method During Dental Treatment In Children	Control Group:40 Intervention Group:40 Video Glasses	The Virtual Private Theater Video Glasses (Chinavision®; Kowloon, Hong Kong, China), With Earphones,	Cavity Preparations, Pulpotomies/Metallic Preformed Crowns, Under Local Anaesthesia.	Pain and anxiety	Face, Legs, Activity, Cry, Consolability (FLACC) Scale. Pulse Rate, And Oxygen Saturation Measurements	. It could not demonstrate the superiority of the vees device, as an alternative distracting method of relaxation and pain reduction during dental treatment in pre-cooperative children.
13	A. Sahu et al [15]	Managing Child's Dental Anxiety by Virtual Reality Distraction And 3d Audio-Visual Distraction Technique:	Group A (Control Group) 30 Group B:30 Virtual Reality Box Group C:30 3D Audio-visual Presentation Through Television	1)Virtual Reality Box 2)3D Audio-visual Presentation Through Television	Cavity Preparation Restoration, Oral Prophylaxis Or Extraction Under Local Anaesthesia.	Anxiety	Venham's Picture Test	3D audio-visual distraction technique was more effective in managing anxious pediatric dental patient as compared to audio distraction technique and normal dental setup.

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Sr. No	Author	Study Id	Type of Intervention group (N=)	Type of Distraction	Dental treatment	Type of outcome	Method of Outcome assessment	Authors Conclusions
14	R. Jindal et al [9]	Can We Tune Our Pediatric Patients?	Control Group:15 Music Group :15 Audio Presentation Through Headphones	Audio Presentation Through Headphones	Four Visits: 1. Screening Visit 2. Oral Prophylaxis Visit 3. Restorative Procedures Without the Need of a Local Anesthetic Injection 4. Invasive Procedures Necessitating the Need of a Local Anesthetic Injection.	Pain and Anxiety	Venham's Picture Test Prior And Immediately After The Treatment	Audio distraction decreased the level of anxiety in anxious pediatric dental patients although to a significant level during the restorative procedure visit (3rd) and invasive procedure visit.
15	M. Khandelwal et al [16]	Effectiveness Of Distraction Techniques In Managing Pediatric Dental Patients	Group 1 (ControlGroup): 20 Group 2 (Audio Group): 20 Group 3 (Chair-Mounted Audio–Video Group): 20 Group 4 (Ceiling-Mounted Audio–Video).: 20	1) Audio Distraction Technique Through Headphones. 2) AVD Through A Chair-Mounted Audio–Video Device With Headphones. 3) AVD Through A Ceiling-Mounted Televisio	1)First Visit Screening and Intraoral Examination. 2)Second Visit Oral Prophylaxis. 3) Third Visit Cavity Preparation Followed by Restoration. 4)Fourth Visit Included Administration of LA Followed By Extraction Or Pulp Therapy.	Anxiety	RMS Pictorial Scale (RMS-PS) Venham Picture Test (VPT) Pulse Rate Oxygen Saturation	Ceiling-mounted and chair-mounted AVD techniques are a novel Distraction which can be an effective and alternative distraction technique for the behaviour management for anxious pediatric patients.

Table 3: Characteristics of the included studies (continued)

Sr. No	Author	Study Id	Type of Intervention group (N=)	Type of Distraction	Dental treatment	Type of outcome	Method of Outcome assessment	Authors Conclusions
16	S. Navit et al [10]	Effectiveness And Comparison Of Various Audio Distraction Aids In Management Of Anxious Dental Paediatric Patients	1.) Control Group –30 2.) Experimental /Audio Group – 1. Group I –30 Instrumental Music Group. 2. Group II –30 Musical Nursery Rhymes Group. 3. Group III – 30 Latest Hindi Movie Songs Group. 4. Group IV –30 Audio Stories Group Consisting of Popular Children Stories and Folk Tales.	MP3 Player Headphones Audio MP3 Files Of Popular Movie Songs, Instrumental Music, Nursery Rhymes And Children Stories.	Four Dental Visits – 1) Screening, 2) Oral Prophylaxis, 3) Cavity Preparation and Restoration 4) Procedures Performed Under Local Anaesthesia, Like Extractions, Pulpotomies And Pulpectomies.	Anxiety	1. Venham's Picture Test 2. Venham's Anxiety Rating Scale 3. Fingertip Pulse Oximeter	Stories, songs and nursery rhymes were significantly more effective in managing anxiety as compared to the children treated in normal setup.

doi 10.17796/1053-4625-46.2.2

Risk of bias

Risk of bias was assessed by the two independent reviews for RCTs included in the review and discrepancies were resolved by discussion and appropriate consultation with a third reviewer. The domains for risk assessment were arranged as high, uncertain or low risk, based on selection bias (random sequence generation and allocation concealment), performance bias (blinding), detection bias (assessor blinding), attrition bias (incomplete outcome data), and reporting bias (selective reporting). Thus, the overall risk for individual studies were assessed as low, moderate or high risk based on the domains and criteria. Most of the studies showed detection and performance bias. Studies conducted by Al Habib *et al* and Nunna *et al* could be considered with acceptable methodology for future studies reference (Figure 2 and Figure 3).

The studies were then selected for quantitative synthesis based on the outcome measures of the parameters. The outcome measures were extracted as post intervention scores/values in mean and standard deviation format. A total 05 studies were eligible for meta-analysis. The analysis was performed with RevMan software version 5.3 and appropriate effect size and effect model after the assessment of heterogeneity.

Quatitative Analysis

Audio distraction techniques vs Control

The meta-analysis was done for the studies which assess pulse rate as primary outcome, in reducing anxiety and pain, which included 4 studies. The fixed effect model was applied as heterogeneity was I^2=0%, the cumulative mean difference was -2.42(CI: -3.56, -1.29) this indicating that pulse rate was higher in control group than the intervention group (audio distraction) (Figure 4)

The meta-analysis done for analysing the oxygen saturation level, in 3 studies showed that the cumulative mean difference was 0.02(CI: -0.22,0.26) with I^2=0%, on application of fixed effect model. This showed that intervention and control did not show any difference in oxygen levels after the treatment. (Figure 5)

The Venham's Picture test was analysed on quantitative basis, with fixed effect model (I^2=0%) showed that cumulative mean difference was -0.03(CI: -0.21,0.14). The mean value indicated that there was not much difference in the anxiety levels between the control and audio distraction group when measured through Venham's picture test. (Figure 6)

The meta-analysis was conducted for anxiety when measured through Venham's clinical test with fixed effect model showed that cumulative mean difference was 0.04(CI: -0.09,0.18). This was interpreted that there was not much difference in Venham's clinical test scores between the two groups. (Figure 7)

Audio-visual distraction techniques vs Control

The meta-analysis conducted for audio-visual distraction aids for pulse rate change, on application of fixed effect model, showed that the cumulative mean difference was -6.01(CI: -8.50, -3.52) thus indicating that the pulse rate was higher in control group than the intervention group (AV distraction techniques) (Figure 8)

The oxygen saturation level was assessed for audio-visual distraction aids, with fixed effect model, the cumulative mean difference was 0.08(CI: -0.10,0.26). ($p \leq 0.05$) Thus it indicated that there was no difference in oxygen saturation levels in both the group as similar to audio distraction findings. (Figure 9)

The quantitative analysis done for Venham's picture test gave a cumulative mean difference as -1.37(CI: -2.57, -0.18) with random effect due the significant heterogeneity I^2=93%. This indicated that audio-visual distraction group had less score for Venham's Picture test as compared to the control group. (Figure 10)

Audio vs Audio-visual distraction techniques

The meta-analysis was conducted to compare between the two main intervention in reducing anxiety with pulse rate as the outcome. With I^2=0%, heterogeneity, we applied fixed effect model and found that cumulative mean difference was 3.70(CI: 1.87,5.53) thus conclusively suggesting that post intervention audio-visual aids the pulse rate is still lower than audio group patients. (Figure 11)

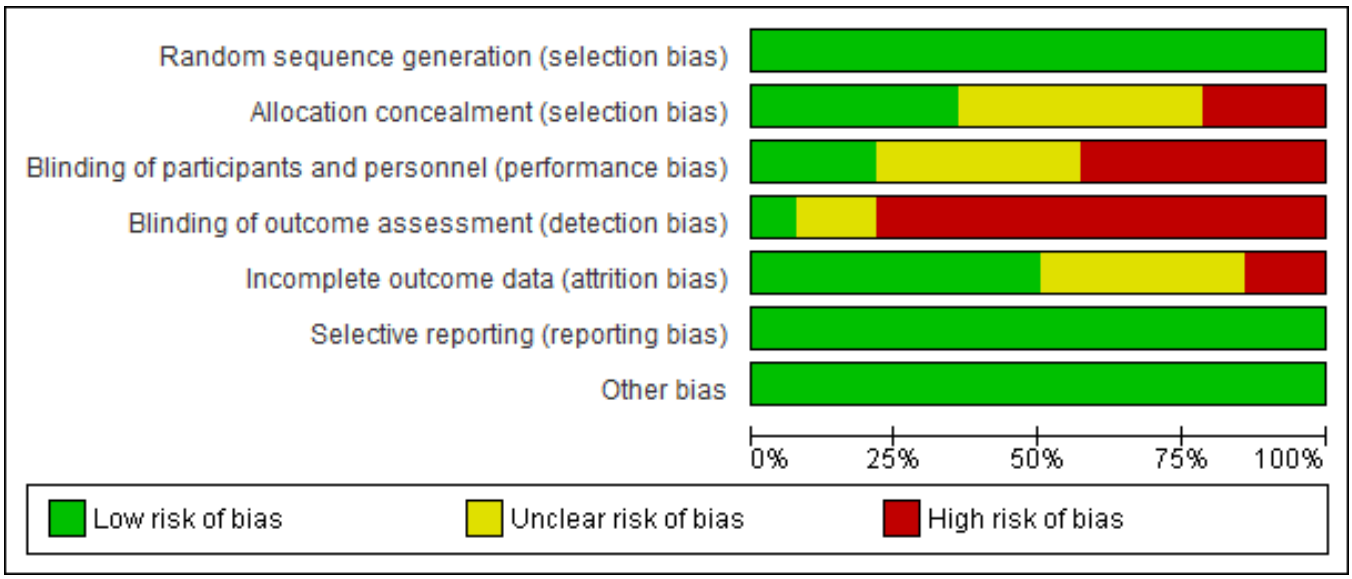

Figure 2- Risk of bias graph: review authors' judgements about each risk of bias item presented as percentages across all included studies.

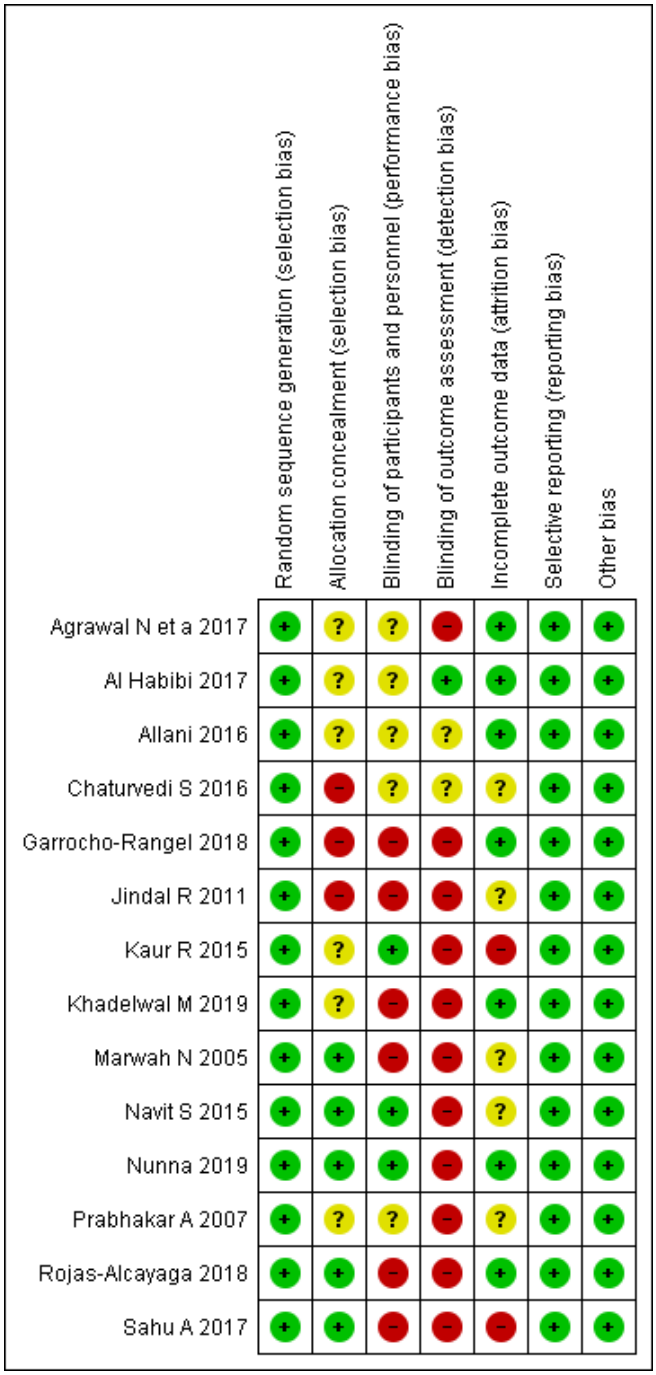

Figure 3- Risk of bias summary: review authors' judgements about each risk of bias item for each included study.

The quantitative synthesis was done for comparing the oxygen saturation levels between the two interventions. The fixed effect model was applied due to less heterogeneity on 0%. The cumulative mean difference was -0.04(CI: -0.21, 0.12) ($p \leq 0.05$) thus indicating that oxygen saturation levels were almost equal in both audio-visual distraction and audio group patients. (Figure 12)

The meta-analysis was conducted for both the groups as Venham's picture test measurement tool. Fixed effect model application gave a cumulative mean difference as 0.38 (CI: 0.08,0.68) thus indicating audio visual group had lower picture test scores as compared to audio group. (Figure 13)

Publication bias

Funnel plots were derived for audio distraction aids outcome with Venham's Picture Test and Venham's Clinical anxiety and also for audio-visual distraction aids outcome with Venham's Picture Test. The studies showed moderate bias with asymmetry of the plot along with small beneficial effect based on the levels of the studies.

DISCUSSION

Dental anxiety and pain are psychological state considered non-specific lack of ease, apprehension, or negative thoughts regarding what may occur during a dental treatment, frequently related with past traumatic experiences in the dental setting[5]. Audio-visual aids can alleviate dental anxiety and pain by distracting two types of sensations; hearing and seeing[11].

The superior results with the audiovisual aids can be explained on the fact that while listening to stories, songs, watching cartoons, children become more engrossed and concentrate deflecting their attention from the anxiety causing dental stimulus. Since they often close their eyes to concentrate, the sights and sounds of the dental treatment are screened out, leading to further reduction of anxiety[10].

Till our knowledge there is scarcity of literature in reviews based on our topic of interest. We aimed to conduct this systematic review and meta-analysis to consolidate and summarize the findings for comparisons between the audio and audio-visual distraction aids, as to which is a concretely better choice for managing pediatric patients. We performed exclusive search on the electronic database with stringent inclusion and exclusion criteria to reduce overall variation in the studies. Fourteen studies were included in this review. We found that majority of the studies had used audio distraction aids as compared to audio-visual distraction techniques in children. Most of the studies included in this review were carried out in India and with almost a balanced gender distribution. The types of distraction aids were of a variety including newer technology like VR box or eyeglasses and traditional ones like songs, cartoons or rhymes. Risk of bias was moderate for all the studies. The studies were further screened and selected for meta-analysis. The heterogeneity was least in almost all the comparisons. Wherever the heterogeneity was high we applied the random effect model and interpreted the cumulative mean difference for a conclusion.[22,23] The quantitative analysis concluded that both interventions (audio and audio-visual) are better than control (no distraction) in reducing pain/anxiety. But still when both interventions were compared against one another, audio-visual were dramatically better than just audio aids as distraction technique.

This finding was supported by, studies done by Agrawal N *et al* [2] and Kaur[12] indicated a definite positive effectiveness of AV distraction technique in managing dental anxiety in children. The better results acquired with the Audiovisual aids can be due to the fact that Audio-visual distraction allowed the children to use two of their senses, becoming more engrossed and thereby distracting their attention from the anxiety resulting from the local anesthesia administration[2]. Kaur R *et al* [12] in his study, observed that children were most relaxed in audiovisual followed by audio group and were least relaxed in control group during three dental visits. Similar results were found in the study by Prabhakar *et al* 2007 [4]. Owing to the reason that the child while watching the cartoon movie or other audiovisual distraction aids, there is multi-sensory engagement and concentration on the screen, thereby screening out the sight of dental treatment.

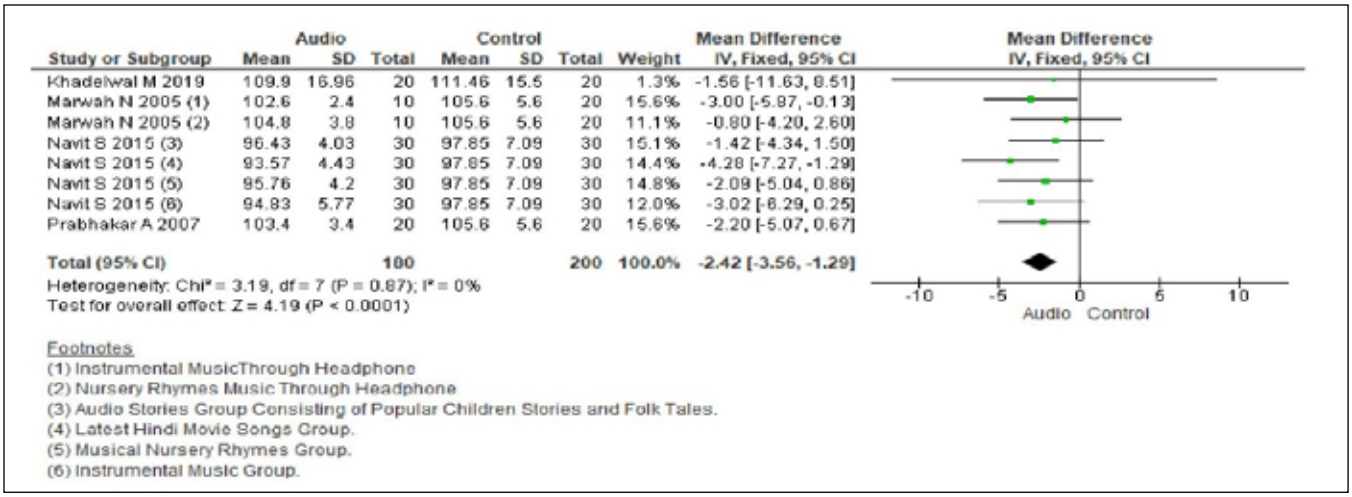

Figure 4. Forest plot for Pulse rate in children

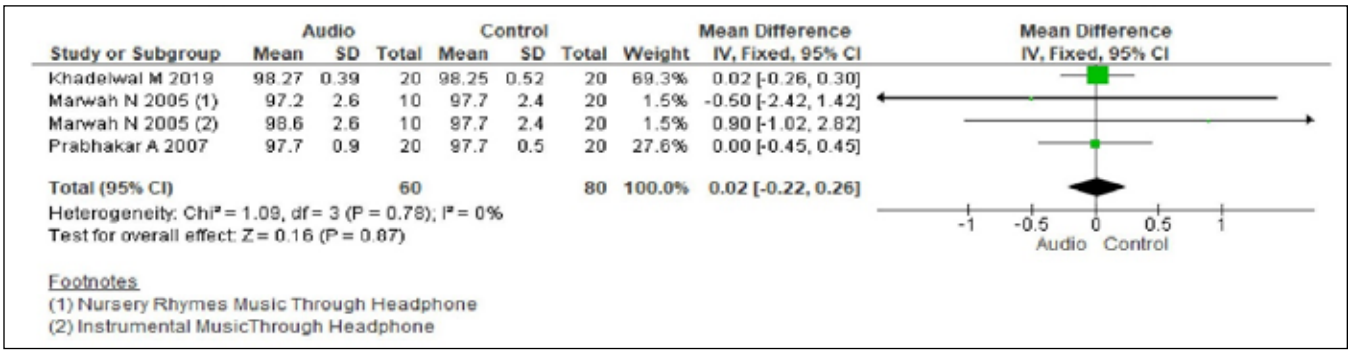

Figure 5. Forest plot for O_2 saturation levels in children

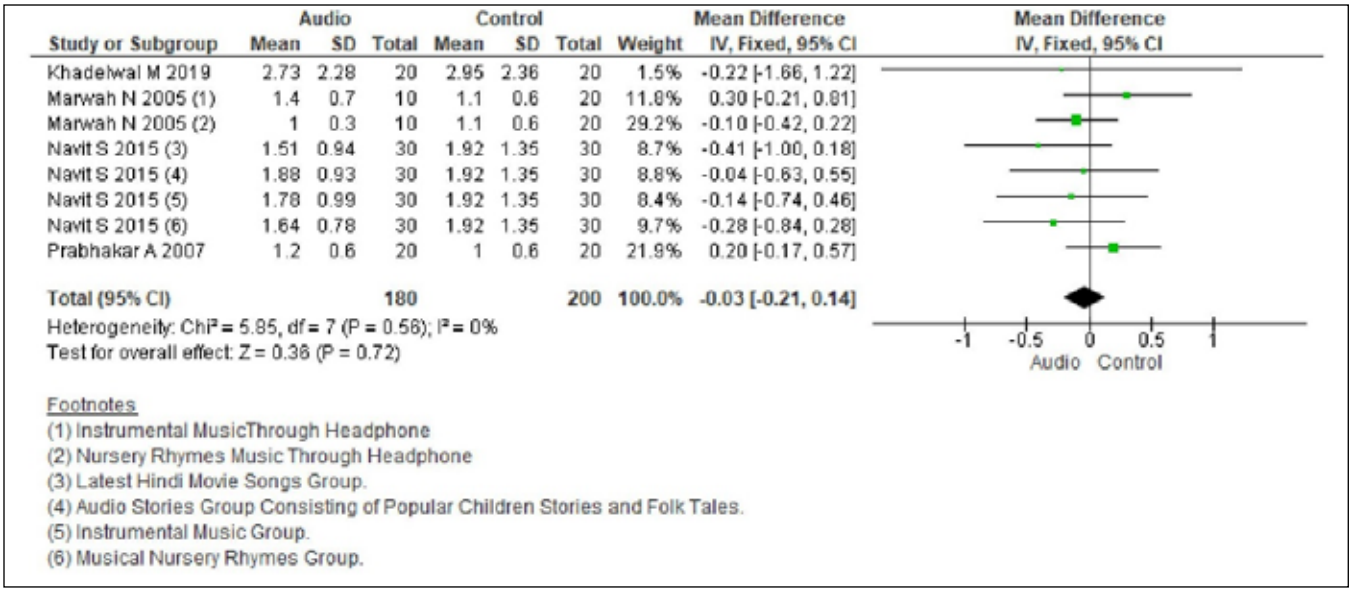

Figure 6. Forest plot for Venham's Picture Test in children

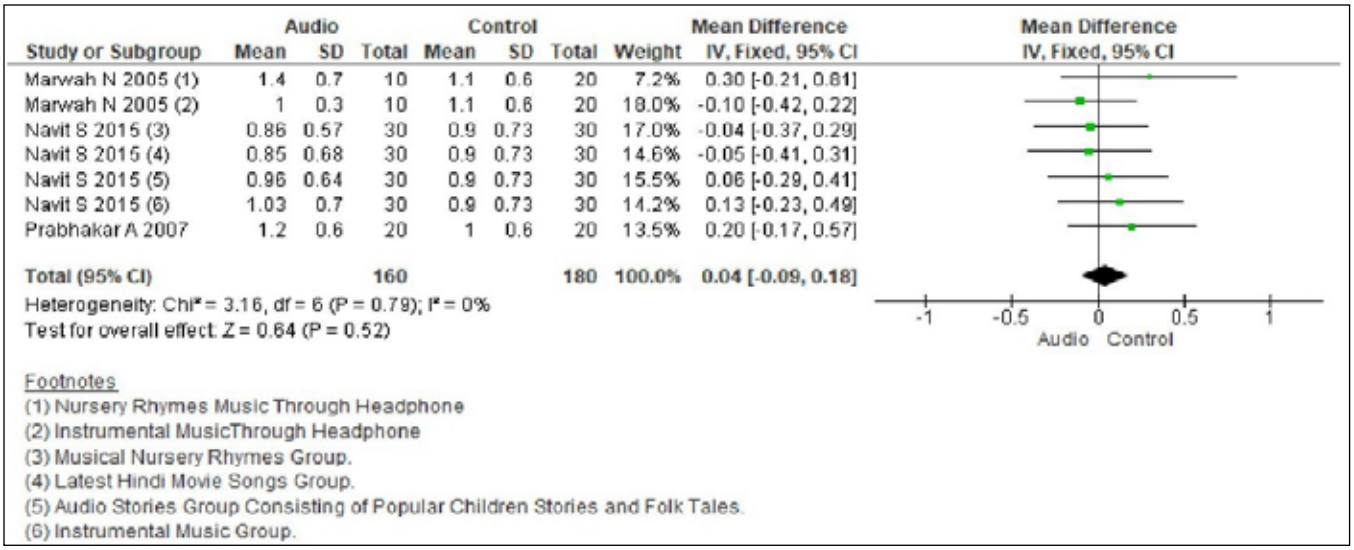

Figure 7. Forest plot for Venham's Picture Test in children

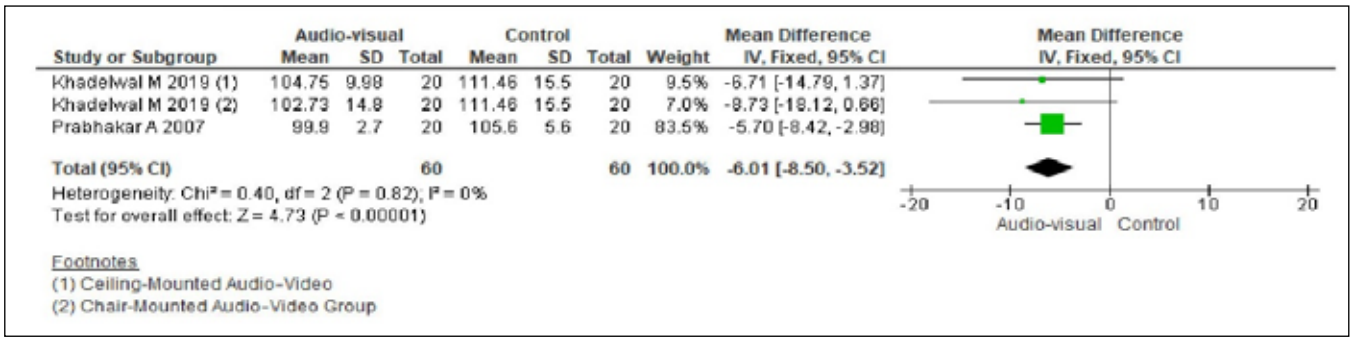

Figure 8. Forest plot for pulse rate in children

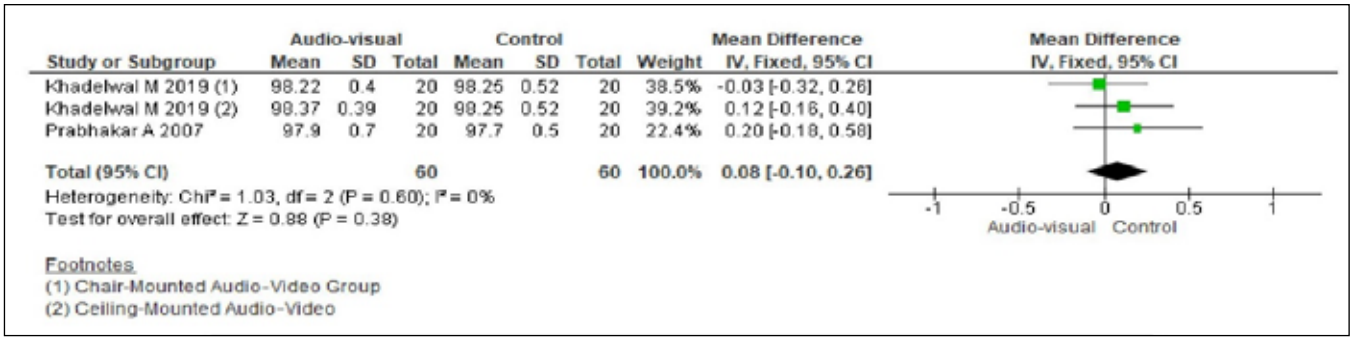

Figure 9. Forest plot for O_2 saturation levels in children

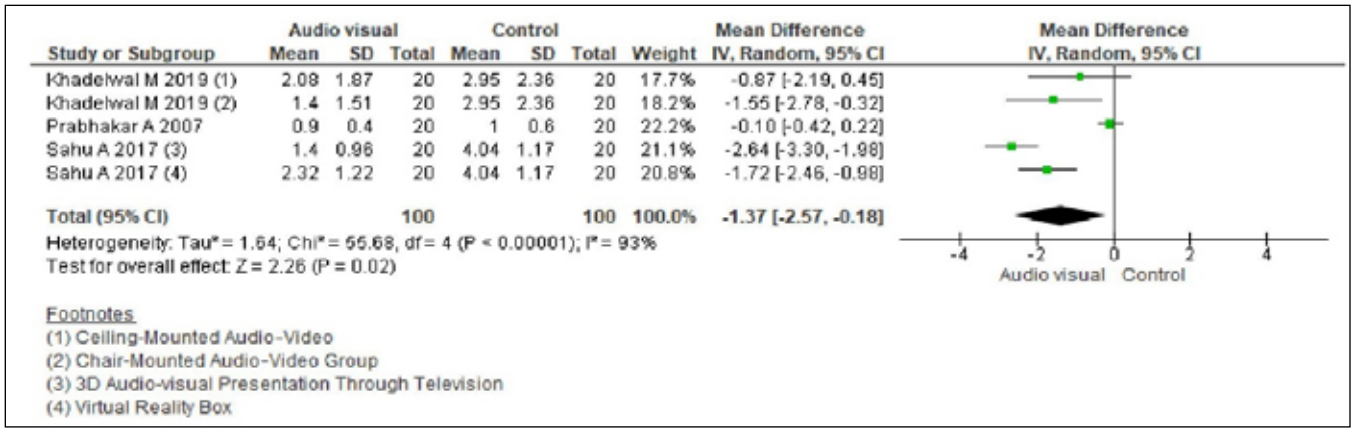

Figure 10. Forest plot for Venham's Picture Test in children

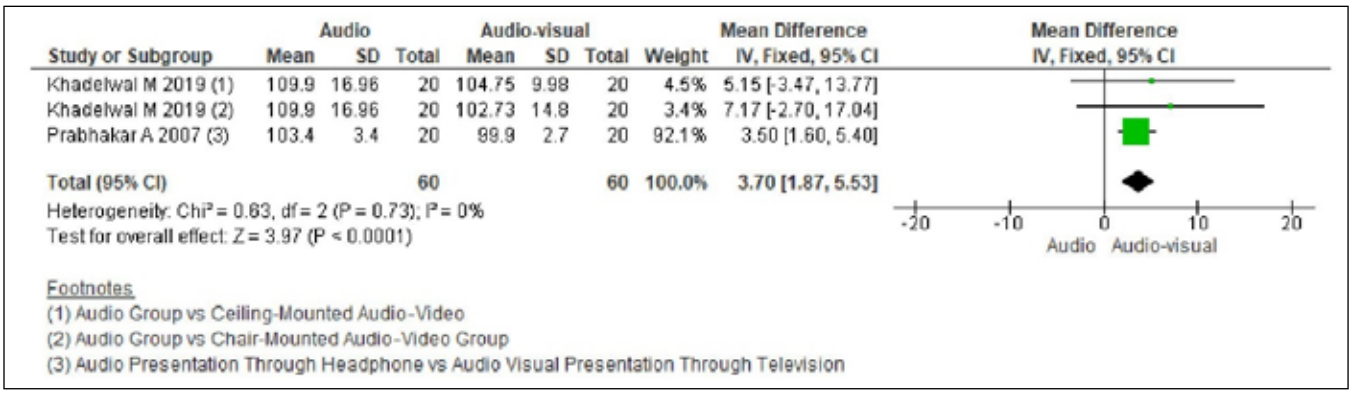

Figure 11. Forest plot for pulse rate in children

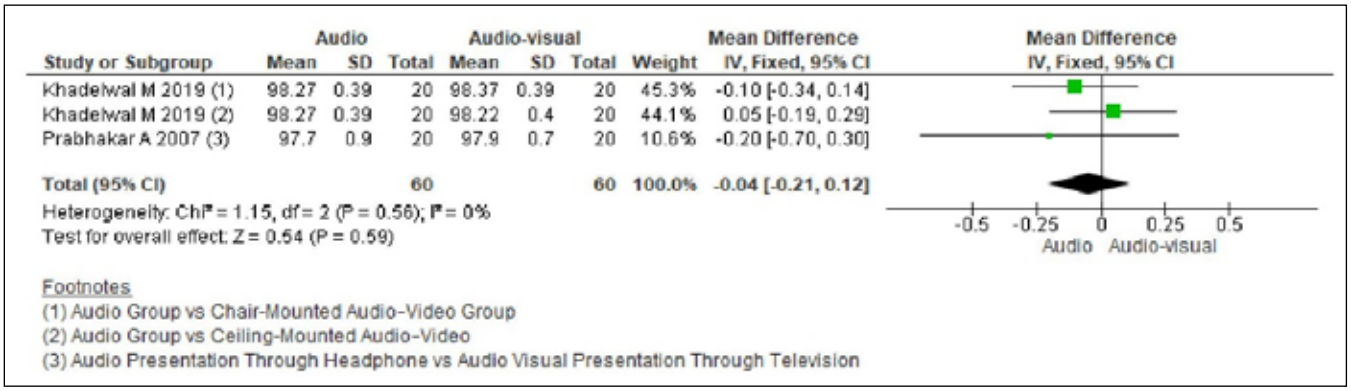

Figure 12. Forest plot for O_2 saturation levels in children

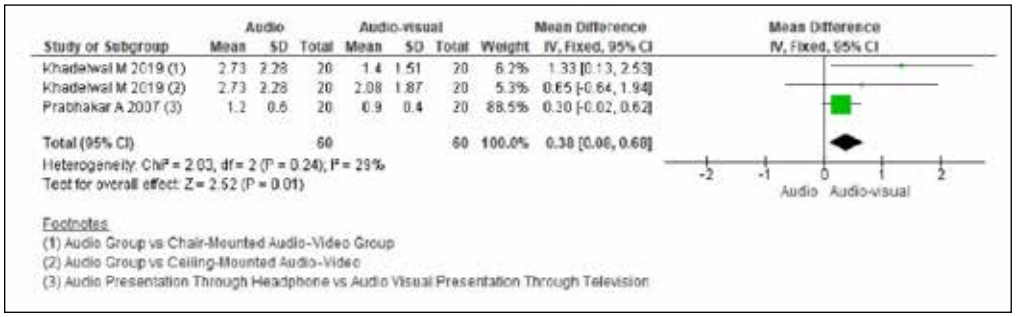

Figure 13. Forest plot for Venham's Picture Test in children

In contrast, Saumya Navit *et al*[10] concluded that audio stories distraction was most effective in reducing anxiety for children undergoing dental treatment. The superior results can be explained on the fact that while listening to stories, children becomes more engrossed and concentrate on the audio story presentations, thus diverting their attention from the anxiety causing dental stimuli. This was in consensus with Prabhakar *et al* , 2007[4] study. This might be because of the fact that the child listening to music tends to close his or her eyes thereby removing the sight. Moreover, music helped to cut down the discomforting noise of hand pieces or other anxiety inducing stimuli and these two advantages combined with the effect of choice based music provided relaxation might be due to playing familiar songs helped child gain control over the discomforting stimulus and gave them a feeling of being in the familiar environment. This was also in accordance with the study conducted by Marwah *et al*, 2005[7] in which the choice of music was left to the child dental patient[12].

However, in the study performed by Rojas-Alcayaga1 *et al* [6], the results showed that musical distraction had no effect on the experience of dental anxiety among children who entered the oral health program.

Audio visual distraction using tablet device, which was fixed to the dental chair, was superior in child behavioral management and pain control during IAN block compared to using AV eyeglasses "VR Box" and control group[11].

But Albagieh *et al* concluded that audio and/or visual distraction using VRD effectively lowered the anxiety levels of adult patients, particularly when noise cancellation was additionally used, this combination was the most effective in reducing anxiety levels[13]. These results were similar to the study by Allani S *et al* [3].

Virtual reality is the Gen Z invention and innovation. This technology has now seeped into dentistry providing professionals with better techniques to manage anxious children for dental treatment.[11,13]

In a study by Mohammed *et al* [11], a total of 101 children (60 boys and 41 girls) in all groups, pain and behavioral scales scores (Heart pulse rate, W-B faces, FLACC) were recorded. However, it was found that AV eyeglasses "VR Box" had no added advantage in child behavioral management which was similar to the findings in the control group. This could be due to the use of AV eyeglasses "VR Box" can remove the real world's vision, thus increasing the child anxiety from the new and more threatening surrounding environment. This result was close to the child anxiety which was faced by the children in the control group from the vision of the dental instruments. The outcomes obtained from the study Garrocho-Rangel *et al* [5] also did not show that Video Eyeglasses/ Earphones System (VEES), employed as distracting devices, exerted any effect on the reduction of children's anxiety or pain perception during the dental treatment, compared with traditional non-aversive behavioral management[5].

Virtual reality immersion has been shown to be somewhat more effective than audio visual distraction because it augments detachment from viewing and hearing what is happening in the environment. A systematic review conducted by Eijlers *et al* concluded through their findings that though VR is an effective intervention but still paucity is present in the research to comment firmly[24].

Liu Y *et al* [20] conducted a systematic review and evaluated audio-visual distraction techniques on the management of dental anxiety of children. The study findings showed that distraction techniques were effective in relieving dental anxiety. But they had low-quality evidence hence our study could contribute a higher evidence with concrete conclusions intended by the meta-analysis. Prado *et al* [21] also conducted systematic review of randomized controlled trials with the similar aim of ours. The conclusions showed that various distraction techniques ranging from audio to camouflage were effective in reducing fear and anxiety. These findings were in consensus with our study, going further we, inclusively undertook the quantitative analysis and found the results through sub-group analysis with various outcomes. Zhang *et al* [25] in their meta-analysis, concluded that oxygen saturation levels during the dental treatment in audiovisual distraction group was higher than control. This is in consensus with our findings, and we also assessed many other parameters to confirm the same with Venham's picture test or pulse rate.

Those patients with dental problems not only doubt about visiting a dentist but also their fear and anxiety in the office makes any action impossible for the dentist[26] .Those patients with dental problems not only doubt about visiting a dentist but also their fear and anxiety in the office makes any action impossible for the dentist. Thus the traditional or conventional distraction aids instead of virtual reality eye wear are more effective as they are easily available, cost effective, portable, popular and well known among kids of all age ranges.[26]

We also recommend that future studies may compare the specific audio and AV aids to point out to the exclusive one which can be used pediatric dentist in managing patients. Also we assessed a variety of tools for assessing the outcome. This might have created a bit of heterogeneity and variation in our findings. Hence, we implore future researchers to conduct individual trials with stringent protocol or methodology to contribute for homogenous literature that could build a still stronger meta-analysis evidence. The studies were limited when assessing for pain outcome according to our search. Limited studies were acquired in adult population which may be accounted to less studies conducted using AV aids in the same. There is also a need to conduct studies which compare the traditional audio-visual aids with VR, the technology of current era.

Although it has been hypothesized that active strategies are more effective than the passive ones, all these studies (all articles with positive response) suggested that passive distraction may be as effective or even better, since, the active forms are too demanding for children[3].

We hope that these findings suggest that alteration of the patient's environment in order to create a more pleasant treatment experience is largely beneficial for both the patient and dentist[13].

Since anxiety should be assessed as a critical step not only in anxiety management for high-DA patients, but also in pain control for all dental patients[27]. When compared to both the types of distraction aids, AV aids were better in reducing anxiety/pain but all the same audio distraction was most commonly used. We assume that it's because audio aids are more accessible, affordable and comfortable to the child, where he/she is aware of surroundings and less anxious about not able to comprehend the settings in which the child is treated. This creates a bond of trust and faith on the operator eventually for a positive reinforcement now and in the future.

CONCLUSION

This systematic review and meta-analysis indicate that audio-visual distraction aids are always a better tool but when considering the availability and accessibility and comfort, audio distraction aids are still a choice of intervention to reduce pain and anxiety in children. Due to a variety of distraction aids used we could not zero down on a particular one. But using audio distraction aids when audio-visual aids are not available could be acceptable way for distracting and treating children. Newer AV aids are now available which give better results, which should be used in clinics for claiming its effectiveness.

The authors report no conflicts of interest and are alone responsible for the content and writing of the paper

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