Original Article

Effectiveness of Audiovisual Distraction in Reducing Children's Anxiety for Pain During Medical and Dental Treatments: A Systematic Review and Meta-analysis

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Abstract

Background: Audiovisual distraction is a potentially good technique to reduce medical treatment procedure-related fear and anxiety among children. However, few studies have assessed its effectiveness.

Objective: To conduct a systematic review and meta-analysis for evaluating the effectiveness of audiovisual distraction in reducing pain anxiety in pediatrics.

Methods: Randomized control trials and experimental studies that reported the use of audiovisual distraction during medical/dental treatments among children aged 3–8 years, used the Face, Legs, Activity, Cry, Consolability (FLACC) scale to assess pain, and were published between 2005–2021 and in English were retrieved from PubMed, Scopus, and Web of Science. A random-effects model was used for evidence analysis.

Results: A total of four studies were included in the systematic review and meta-analysis: two were from South Asia and one each were from Africa and North America. Three of these studies were randomized control trials. The variability among the studies was high. Three of the four studies found that AV techniques were significantly effective in reducing pain during procedures compared with the control group ($P < 0.00001$), while one study found no difference; the cumulative evidence in the forest plot was similar.

Conclusion: Cumulative evidence suggests that the use of audiovisual distraction is an effective strategy in reducing medical/dental procedures-related pain anxiety among children aged 3–8 years. However, evidence on this is currently limited, and thus further studies are required using various AD techniques and on different populations to substantiate these findings.

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Keywords: Audiovisual aids, anxiety, child, dental anxiety, distraction, pain

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INTRODUCTION

The prevalence of medical treatment procedure-related fear and anxiety is common among children, ranging from 6% to 20% in different populations.[1] Studies have shown that the development of such fear and anxiety is usually associated with past negative experiences resulting from painful procedures or techniques.[2] Children with anxiety have been found to have higher rates of dental caries and are more often have deferred or cancelled appointments.[2] Fear is a normal unpleasant emotional reaction to specific threatening stimuli, whereas anxiety is an excessive and unreasonable negative emotional reaction or disproportionate apprehension.[3] Given that anxiety among pediatric patients is common, behavioral management becomes necessary for successful completion of procedures. Some common such techniques are tell–show–do, positive reinforcement, nonverbal communication, distraction, and voice control.[4]

Pain is a multidimensional and complex construct that usually involves sensory, emotional, and cognitive elements,[5] which can modify pain experience.[4] Distraction is a state of mind that draws the attention of a person away from an unpleasant or painful stimuli.[5] There are two distraction methods that are widely used:

1. Active distraction, which involves activity of the child (e.g., moving legs and squeezing balls), and
2. Passive distraction, where the doctor actively distracts the child (e.g., telling a story or video streaming). Passive distraction can be either audio or audiovisual distraction (AD).

Audio distraction can be done via music, storytelling, or audio presentation through headphones, whereas AD can include story presentation on television, virtual reality, and even three-dimensional video glasses.[4]

Distraction techniques target the patient's limited attention ability, resulting in the withdrawal of attention from an unpleasant or noxious stimulus.[5] An ideal distractor will usually require an optimal amount of attention involving multiple sensory modalities (visual, auditory, and kinesthetic), active emotional involvement, and patient participation to compete with signals from noxious stimuli.[6] Recent distraction methods that use advanced audiovisual technology are more likely to meet these requirements. While some of them only use visual stimuli, the majority apply visual stimuli in combination with audio stimulation and expose the patient to two-dimensional (2-D) or three-dimensional (3-D) videos, which are referred to as virtual reality audiovisual systems or A/V eyeglass systems.[6] The amount of attention given to noxious stimuli modulates pain perception. Distraction can effectively be done by capturing child's various senses such as vision, hearing, and touch.[7]

It is hypothesized that active strategies are usually more effective than passive,[8] but some studies suggest that passive distractions are equally effective or sometimes even better, as active techniques are too demanding for children.[8] In medical settings and adult patients, the success of distraction techniques is well documented, but there are some gaps in knowledge as fewer studies done to evaluate the efficacy of distraction methods in pediatric patients.[9] There are many studies about the effect of AD techniques on anxiety during children's treatments, but they are controversial and there is no consensus.[7-10]

Worldwide, anxiety in children has long been a major concern for dentists, as it is very much prevalent and may have deleterious oral health-related effects such as high caries, social avoidance, and eating troubles. The American Academy of Pediatric Dentistry has specified several behavior management techniques, from "obtaining informed consent" to "conscious sedation," to address this problem. It is recommended that general anesthesia should be used as a last resort. In view of children's safety and satisfaction with health services, current trends suggest the use of non-aversive techniques such as AD, which are more acceptable to children, doctors, and parents.[11]

This systematic review was conducted with the objective of determining the effectiveness of AD in reducing anxiety for pain among children during medical and dental treatments.

METHODS

This systematic review was registered in PROSPERO (Reg. no.: CRD42021245874) and performed in accordance with the Preferred Reporting Items for Systematic Review and Meta-Analyses Statement (PRISMA) guidelines.[12]

Information sources and search strategy

Searches were carried out in PubMed, Web of Science, and Scopus. Studies published between January 2005 and January 2021 were included. In PubMed, search was conducted using MeSH and other terms such as "Child" OR "Children" OR "Kid" AND "Distraction" OR "Audio-visual Distraction" AND "Dentistry" OR "Medicine". The searches were similarly carried out in the other two databases. Outcome was not used in the search strategy. The Population, Intervention, Comparison, and Outcome (PICO) and search strategy is presented in Table 1.

Eligibility criteria

Studies that met the following criteria were included: published in English; full-text availability; randomized control trials (RCTs) or experimental studies; included children aged 3–8 years; AD was used for medical and/or dental treatments; and Face, Legs, Activity, Cry, Consolability (FLACC) scale was used. The FLACC scale was chosen, as it is most widely used behavioral observation pain scale. Studies were excluded if they were unpublished manuscripts and thesis, book chapters, case studies; used other types of distraction techniques; or included children aged >8 years.

Study selection method

Two reviewers (the first and the second authors) independently carried out database search and read all the retrieved article titles and abstracts. The full text of articles were assessed if they met the initial inclusion criteria. If any differences arose regarding eligibility after the evaluation of full texts, it was resolved through mutual consensus, or through consultation with third reviewer.

Data extraction method

One reviewer independently conducted the data extraction. Information such as the name of the authors, publication year, and country was noted from the studies. The following characteristics were collected: details regarding the dental/medical setup, age group, treatment at each visit, sample size, interventions, distraction methods, distraction periods, and anxiety outcome measurement by questionnaires. The authors also performed a critical analysis of the included studies.

Assessing the risk of bias

To control the influence of bias, a quality assessment of the studies was done. The Cochrane Collaboration's Tool was used for the assessment of risk of bias. The following seven criteria were used for analyzing the included papers:

1. Random sequence generation (Selection bias)
2. Allocation concealment (Selection bias)
3. Blinding the participants and personnel (Performance bias)
4. Blinding of the outcome assessment (Detection bias)
5. Any incomplete outcome data (Attrition bias)
6. Selective reporting (Reporting bias)
7. Any other bias.

Data were entered in RevMan 5.3 (Cochrane Database of Systematic Reviews) for graphical representations.

Evidence synthesis

A random-effects model[13] was used for evidence analysis, because it considers the clinical heterogeneity of the included studies. Meta-analysis calculations and forest plot creation were done with RevMan 5.3 (Cochrane Database of Systematic Reviews).

RESULTS

A total of 4 studies were included with a total of 174 patients [Table 1 and Figure 1]. Table 2 provides a summary of the included studies. Very high variability was observed among the studies. The most common heterogeneity was with the AV equipment used during treatment. Of the four studies, three were RCTs, which used inferior alveolar nerve block injection for intervention, whereas one study was a quasi-experimental study that used venipuncture as an intervention.

Studies by El-Sharkawi *et al.*,[5] Mitrakul *et al.*,[2] and James *et al.*[1] found that AV techniques were significantly effective in reducing pain during procedures compared with the control group ($P < 0.00001$). While Garrocho-Rangel *et al.*[3] found no difference between the AV intervention and control group during all assessed dental treatment phases by various measures. Three different scales, heart rate, and oxygen saturation were used to evaluate dental anxiety and behavior in the included articles. The FLACC scale, FPS scale (Facial Pain Scale) and FPS-R (Facial Pain Scale Revised) were the scales used. For AD distraction, video eyeglasses were used in the studies by EL-Sharkawi *et al.*, Mitrakul *et al.*, and Gorrocho-Rangel *et al.* In the study by James *et al.*, animated cartoon was shown on a laptop

Table 1: Population, Intervention, Comparison, and Outcome, and Search strategy in databases

PICO	PICO's definition	Search terms used (MeSH and other terms with OR)	Number of papers in PubMed	Number of papers in Web of Science	Number of papers in Scopus
Population	Child aged 3–8 years	Child OR Children OR Kid	2,409,132	105,266	1,909,824
Intervention	Audio-visual distraction	Distraction OR audio-visual distraction	5688	429	946
Comparison	Treatments performed with and without AD	Dentistry AND Medicine	100,220	10,766	89,840
Outcome	Anxiety levels	Outcome not used in search strategy			
Terms - combined	"P," and "I," and "C"	(Child OR Children OR Kid) AND (Distraction OR Audio-visual Distraction) AND (Dentistry AND Medicine)	34	15	21

PICO's – Population, Intervention, Comparison, and Outcomes

for AD distraction. Studies by Mitrakul *et al.* and Gorrocho-Rangel *et al.* used AD distraction for patients during dental treatment. El-Sharkawi *et al.* used AD distraction during administration of local anesthesia for dental procedures, while the study done by James *et al.* used AD distraction during venipuncture.

Two studies were performed in South Asia (India and Thailand), while one each was in Africa (Egypt) and North America (Mexico). All studies compared the findings between the group undergoing treatment along with an AD distraction and the control group (i.e. undergoing treatment without AD distraction).

Figures 2 and 3 show that blinding of participants was done in only one study.[2] In the study of Goroccho-Rangel *et al.*,[3] the outcome data were incomplete. There was a low risk of bias for random sequence generation and selective reporting. There was a high risk of bias for blinding of the outcome assessment that is detection bias. There was an unclear risk of bias for allocation concealment and other bias.

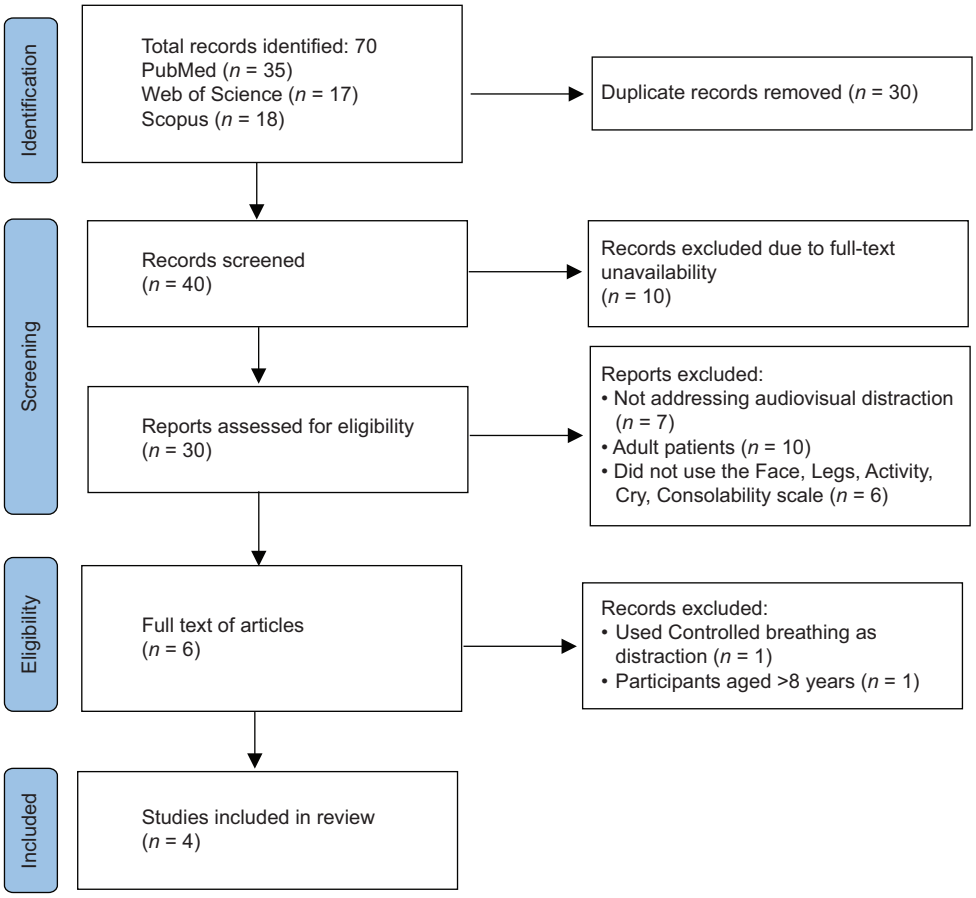

Figure 1: PRISMA flow diagram of the search

Table 2: Reviewed treatment outcome of included studies

Authors	Year	Country	Study design	Sample size	Age (years)	Study groups	AV equipment	Outcome measures
El-Sharkawi *et al.*[5]	2012	Egypt	RCT	42	5–7	Control group AV distraction group	Personal eye wear cinema IMV260	FPS scale FLACC scale
Garrocho-Rangel *et al.*[3]	2018	Mexico	RCT	40	5–8	Control group AV distraction group	Video eye glasses, ear phones system (VESS)	FLACC scale Heart rate O_2 saturation
Mitrakul *et al.*[2]	2015	Thailand	RCT (cross over trail)	42	5-8	Control group AV distraction group	Video glasses cool vision 3	FPS-R Heart rate FLACC
James *et al.*[1]	2012	India	Quasi experimental design	50	3-6	Control group AV distraction group	Animated cartoon on laptop	FLACC

FLACC – Face, Legs, Activity, Cry, Consolability; AV – Audiovisual; FPS – Facial Pain Scale; FPS-R – FPS revised; VESS – Video eye glasses, ear phones system

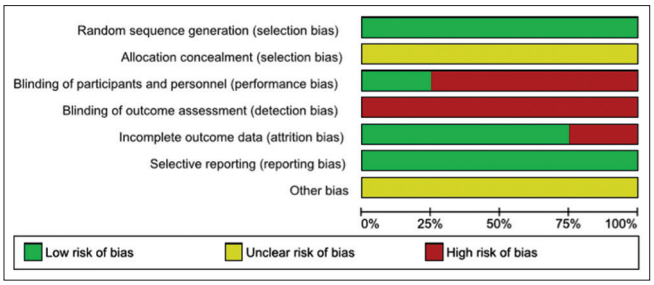

Figure 2: Risk of bias assessment

Meta-analysis

According to the forest plot in Figure 4, the cumulative effect of three of the four studies demonstrated that AD distraction was effective in reducing pain compared with controls, while only one study favored the control group [Figure 4]. The Funnel plot showed heterogeneity, where studies by James *et al*.[1] and Gorrocho-Rangel *et al*.[3] showed variation [Figure 5].

DISCUSSION

In the management of children during medical and dental procedures, health professionals should aim to reduce fear and anxiety by various behavior management methods. To achieve this without pharmacological methods can be challenging; nonetheless, non-pharmacological, psychological techniques have been shown to be useful in managing pain conditions in the pediatric population.[14] AD is a popular non-pharmacological behavior management technique used for children,[15] but its effectiveness has been poor in the medical and dental domains. Advance audiovisual eyeglass systems use multiple sensory stimulus and claim effective distraction from hospital environment.[16,17] Accordingly, this systematic review was conducted to provide cumulative evidence on the effectiveness of AD in reducing pain anxiety among children during medical or dental procedures.

While the current literature is limited, this review found that three of the four studies found that AD significantly reduced anxiety and enhanced positive attitudes in pediatric patients during medical/dental treatment procedures. The study by Gorrocho-Rangel *et al*.,[3] found no difference between the AD and control groups. The contrast in the findings of this study with the others may be because of the difference in methodology, as this study used oxygen saturation to determine anxiety and the washout period between the appointments was <1 week.

The review included studies that evaluated children aged 3–8 years, as patients of this age group have anxious behavior during dental/medical treatment, which is difficult

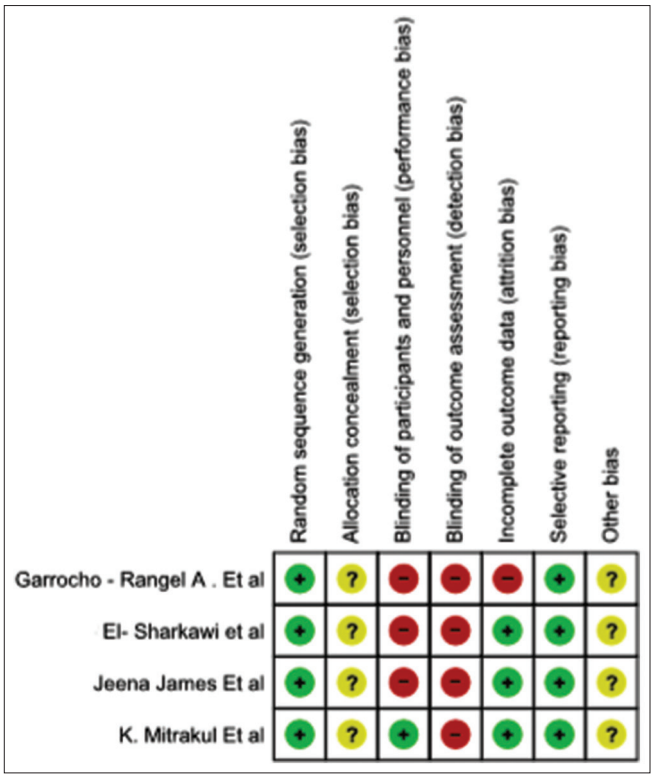

Figure 3: Quality assessment of included studies

to control as they are yet incapable of thinking rationally.[9] In addition, patients in this age group are mature enough to accept and interact with the AD technique, whereas those aged <3 years might not have the attention required for AD. Children aged >8 years have cognitive development for which AD may not be sufficiently immersive.

It was observed that the review was in consensus with the study conducted by Asl Aminabadi *et al*.[7] and Bagattoni *et al*.,[18] which were in favor with AD and stated that AD was an effective method for behavior management in children during treatments. Our forest plot demonstrated that the cumulative result favored AD.

A random-effects model was used for the meta/evidence-analysis of the overall data because it considers the clinical heterogeneity of the included studies. In three of the four included studies, the AD intervention was during the administration of local anesthesia by "inferior alveolar block" for dental procedures. In the other study,[1] AD intervention was during prick for venipuncture for medical treatment.

Limitations and recommendations

AD can be considered as a useful intervention in day-to-day practice and this systematic review can provide insights into clinical applications. A certain degree of heterogeneity was noted among the studies. The heterogeneity was mainly due

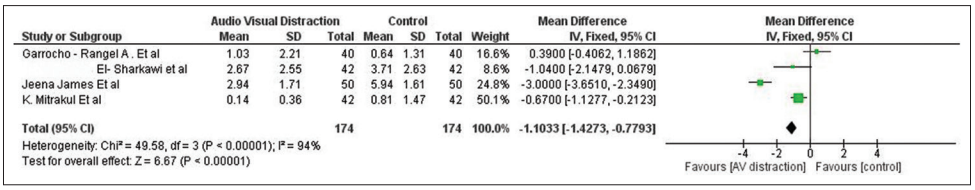

Figure 4: Forest plot. SD: Standard deviation, CI: Confidence interval, IV: Intravenous

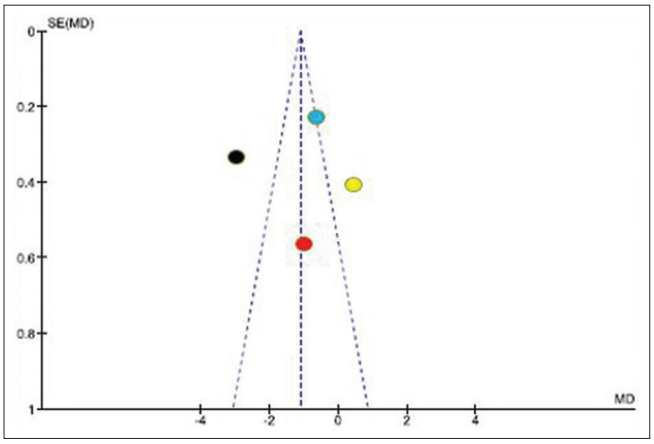

Figure 5: Funnel plot - Black dot – James *et al*.[1], yellow dot – Gorrocho-Rangel *et al*.[3], red dot – El-Sharkawi *et al*.[5], Blue dot – Mitrakul *et al*.[2]

to the difference in the types of treatments and in methods used to evaluate anxiety in children. Different types of devices like video eyewear's, eyeglasses and laptops were used in the studies for distraction; the effectiveness can differ across devices and these differences can be taken into consideration in future studies. Although findings from this systematic review indicate that AD can help in reducing the anxiety in pediatric patients, the number of studies is low not only overall but also for a specific population. In addition, most of the studies were of moderate to high risk of bias.

The findings of the current meta-analysis indicate the need for further randomized controlled trials to further substantiate the findings of the studies in the literature. Such studies should also consider the baseline anxiety levels in the included children to avoid its confounding effect. In addition, studies are required across different populations to provide local data for clinicians, as the effectiveness of AD may vary based on populations/social constructs. Future studies can also use different types of distraction techniques, such as active/passive distraction, virtual reality distraction, and immersive virtual reality with active participation of patients, to determine which technique is most effective.

CONCLUSION

This meta-analysis found that AD is an effective technique in reducing medical/dental treatment-related anxiety for pain among children aged 3–8 years. However, the evidence on this is currently limited, and thus further studies are required using various AD techniques and across different populations to substantiate these findings.

Peer review

This article was peer-reviewed by two independent and anonymous reviewers.

Data availability statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

Author contributions

Conceptualization: R.U.P.; Methodology and Data analysis: P.S.O.; Writing–original draft preparation: P.S.O.; Writing – review and editing: R.U.P.; Supervision: D.G.

All authors have read and agreed to the published version of the manuscript.

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Conflicts of interest

There are no conflicts of interest.

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