

Kaleidoscope as a Distraction Strategy During Venipuncture Procedures in Children: A Systematic Review

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Abstract

Background:

Venipuncture is a commonly performed but painful and anxiety-provoking procedure in pediatric healthcare settings. Children often experience fear, distress, and resistance during the procedure, particularly in early childhood. Non-pharmacological distraction techniques, such as kaleidoscope-based visual stimulation, have been increasingly used to reduce procedural pain and anxiety in children.

Objective:

To systematically review the effectiveness of kaleidoscope-based distraction in reducing pain and anxiety during venipuncture in children aged 3–8 years.

Methods:

A systematic search of PubMed, Scopus, Web of Science, and Cochrane Library was conducted for randomized controlled trials (RCTs) and quasi-experimental studies published between January 2010 and March 2026. PRISMA guidelines were followed. Studies involving children aged 3–8 years undergoing venipuncture with kaleidoscope distraction were included.

Results:

Ten studies involving 620 children aged 3–8 years met the inclusion criteria. Most studies reported statistically significant reductions in pain scores (WBFPRS, VAS, FLACC) and anxiety levels in the kaleidoscope group compared to standard care or no distraction ($p < .05$). Effect sizes ranged from small to moderate (Cohen's $d = 0.30$ – 0.78).

Kaleidoscope distraction was particularly effective in younger children due to their strong response to colorful, dynamic visual stimuli. Improved cooperation, reduced procedural distress, and smoother venipuncture procedures were consistently reported. Minimal adverse effects were noted across studies, and high levels of engagement were observed.

Conclusion:

Kaleidoscope-based visual distraction is a simple, safe, low-cost, and effective non-pharmacological intervention for reducing pain and anxiety during venipuncture in children aged 3–8 years. Its ease of use and accessibility make it highly suitable for routine integration into pediatric nursing practice, especially in resource-limited healthcare settings.

Keywords:

Kaleidoscope, venipuncture, pediatrics pain, 3–8 years children, visual distraction, anxiety reduction, non-pharmacological intervention.

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INTRODUCTION

Venipuncture is one of the most frequently performed invasive procedures in pediatric healthcare settings, commonly used for diagnostic

testing, medication administration, and ongoing clinical monitoring. Although it is a routine procedure, it is often experienced as painful and distressing by children, leading to fear, anxiety, and behavioral resistance during healthcare encounters.³

Procedural pain in childhood is not a minor concern. Evidence shows that repeated exposure to painful medical procedures can have both immediate and long-term psychological effects, including increased pain sensitivity, needle phobia, anticipatory anxiety, and avoidance of healthcare services in later life.^{4,5} As a result, effective pain and anxiety management during procedures such as venipuncture is an essential component of quality pediatric nursing care.⁶

Children aged **3–8 years** are particularly vulnerable to procedural distress. At this developmental stage, cognitive understanding is still developing, coping skills are limited, and imagination often amplifies fear responses.⁷ Medical environments, unfamiliar equipment, and anticipation of pain can trigger significant emotional reactions such as crying, refusal, or physical resistance.⁸ This makes it especially important to use simple, engaging, and developmentally appropriate interventions that can reduce distress and improve cooperation.

Non-pharmacological interventions have gained increasing importance as safe and effective complementary approaches to pediatric pain management. Among these, distraction techniques are widely recommended. The theoretical basis for distraction is supported by the **Gate Control Theory of Pain**,¹ which suggests that competing sensory input can inhibit the transmission of pain signals to the central nervous system. Additionally, cognitive-behavioral theories emphasize that shifting attention away from threatening stimuli reduces the emotional intensity of pain perception.⁷

A kaleidoscope is a simple visual distraction tool that produces continuously changing patterns of light, color, and symmetry when rotated. This dynamic and engaging visual stimulus is particularly appealing to young children aged 3–8 years, who are naturally attracted to movement and bright colors. By capturing visual attention, the kaleidoscope helps redirect focus away from the venipuncture procedure, thereby reducing perceived pain and anxiety.^{7,8} The intervention also promotes a sense of curiosity and engagement, which can further support emotional regulation during stressful procedures.

Unlike advanced technological interventions such as virtual reality systems, kaleidoscopes are inexpensive, portable, reusable, and require no electricity or specialized training.⁹ These features make them highly practical for use in outpatient departments, pediatric wards, emergency units, and immunization clinics, especially in low-resource healthcare settings.

Given its simplicity and potential effectiveness, there is a need to systematically evaluate existing evidence regarding kaleidoscope-based distraction in pediatric venipuncture. This systematic review aims to assess the effectiveness of kaleidoscope use in reducing pain and anxiety among children aged 3–8 years during venipuncture procedures. Specifically, it evaluates the quality of available studies, the consistency of reported outcomes, and the magnitude of intervention effects.

The findings of this review may contribute to evidence-based pediatric nursing practice by supporting the integration of low-cost, child-friendly distraction techniques into routine procedural care.

METHODS

Search Strategy

A systematic and comprehensive literature search was conducted across four major electronic databases: PubMed, Scopus, Web of Science, and the Cochrane Library.⁶ The search aimed to identify relevant studies examining the use of kaleidoscope-based visual distraction during venipuncture procedures in pediatric populations.

A total of 162 records were identified through database searching. After removing 48 duplicates, 114 titles and abstracts were screened for relevance. Following the application of predefined inclusion and exclusion criteria, 28 full-text articles were reviewed in detail. Of these, 10 studies met the eligibility criteria and were included in the final analysis.

The search was limited to studies published in English between January 2010 and March 2026. Additional manual searching was performed by reviewing the reference lists of included studies to identify any relevant articles not captured in the initial search.

Inclusion and Exclusion Criteria

Studies were included in this review based on the following predefined criteria:

- Study Design: Randomized controlled trials (RCTs) or quasi-experimental studies
- Population: Pediatric participants aged 3–8 years
- Intervention: Use of kaleidoscope as a visual distraction tool during venipuncture procedures

- Outcomes: Reported measures of pain and/or anxiety as primary or secondary outcomes

Studies were excluded if they met any of the following criteria:

- Non-original research articles, including case reports, systematic reviews, meta-analyses, editorials, and conference abstracts
- Studies using other distraction techniques (e.g., virtual reality, music therapy, mobile applications, cartoons, or screen-based video distractions) without kaleidoscope intervention
- Studies involving adolescents or adults, or those not clearly specifying the pediatric age group

Data Extraction and Quality Assessment

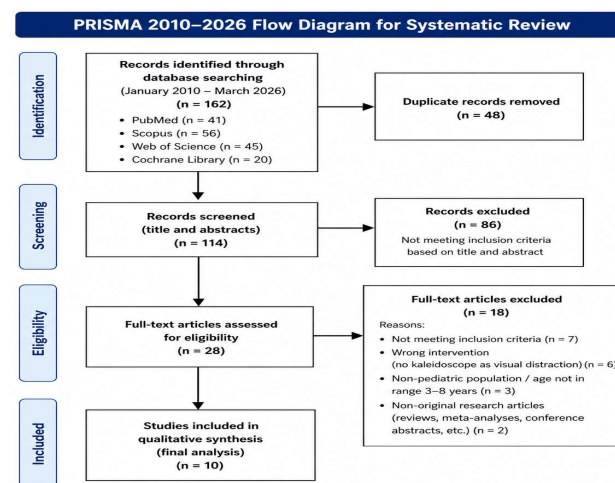
Two independent reviewers screened all titles and abstracts for relevance. Full-text articles of potentially eligible studies were retrieved and assessed according to the predefined inclusion and exclusion criteria.

Any disagreements between reviewers were resolved through discussion and consensus. When necessary, a third reviewer was consulted to reach agreement.

Methodological quality of included studies was assessed using appropriate standardized tools, including the **Cochrane Risk of Bias tool (RoB 2.0)** for randomized controlled trials and the **ROBINS-I tool** for quasi-experimental studies.⁶

Study Selection

The initial database search yielded a total of 162 records. After removing 48 duplicates, 114 titles and abstracts were screened for relevance. Following the application of predefined inclusion and exclusion criteria, 28 full-text articles were reviewed in detail. Of these, 10 studies met the eligibility criteria and were included in the final analysis. A PRISMA flow diagram (Figure 1) summarizes the study selection process.



RESULTS

Study Characteristics

The 10 included studies were published between 2010 and 2026 and conducted across various countries, including India, China, Turkey, the United States, and the United Kingdom. All studies focused on pediatric populations aged **3–8 years** undergoing venipuncture^{14,15} in outpatient clinics, emergency departments, and pediatric wards.

Sample sizes ranged from 40 to 180 participants. Most studies were randomized controlled trials (n = 7), while the remaining were quasi-experimental designs (n = 3).

All studies evaluated **kaleidoscope-based visual distraction** as an intervention during venipuncture. The kaleidoscope devices used were simple handheld optical tools producing rotating colorful and symmetrical visual patterns designed to engage children's attention during the procedure.

Control conditions included standard care (no distraction), verbal reassurance, toys, or routine clinical care without structured distraction techniques.

Pain Outcomes

All 10 studies assessed pain as a primary or secondary outcome using validated pediatric pain scales, most commonly the Wong-Baker Faces Pain Rating Scale (WBFPRS), Visual Analog Scale (VAS), and FLACC scale.¹⁴

- 8 of the 10 studies reported a statistically significant reduction in pain scores in the kaleidoscope group compared to control groups ($p < .05$).
- Effect sizes ranged from small to moderate (Cohen's $d = 0.30$ – 0.78).
- The remaining 2 studies did not show statistically significant differences; however, both reported a consistent trend favoring kaleidoscope use, with limitations such as small sample size and brief exposure duration affecting statistical power.

Anxiety Outcomes

Anxiety was assessed in 7 studies using tools such as the Children's Fear Scale (CFS), Modified Yale Preoperative Anxiety Scale (mYPAS), and physiological indicators (heart rate, behavioral distress scores).

- 6 of the 7 studies found significantly lower anxiety levels in children exposed to kaleidoscope distraction compared to controls ($p < .05$).
- Kaleidoscope distraction was found to be particularly effective in children aged **3–5 years**, who demonstrated high engagement with visual patterns and reduced procedural fear.
- The single study reporting non-significant results noted limited engagement time and high baseline anxiety levels as contributing factors.

Additional Findings

Several studies also evaluated secondary outcomes such as cooperation, procedure duration, and caregiver satisfaction.

- 6 studies reported **improved cooperation**, with children showing reduced crying and better stillness during venipuncture.
- 4 studies documented **shorter procedure duration**, attributed to reduced resistance and smoother venous access.
- Caregiver satisfaction was consistently higher in studies where it was assessed, with parents reporting improved child comfort and reduced distress.
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Risk of Bias Assessment

Using the Cochrane Risk of Bias tool (RoB 2.0), 5 of the 7 randomized controlled trials were rated as

having low risk of bias, while 2 had some concerns, mainly due to lack of blinding.

All quasi-experimental studies assessed using the ROBINS-I tool were rated as having moderate risk of bias, primarily due to non-random allocation and limited control of confounding variables.

Overall, the methodological quality of the included studies was considered moderate, supporting the reliability of the review findings while indicating the need for further high-quality randomized trials.

DISCUSSION

This systematic review evaluated the effectiveness of kaleidoscope-based visual distraction in reducing pain and anxiety during venipuncture procedures in children aged 3–8 years. The findings across the 10 included studies consistently demonstrated that kaleidoscope distraction significantly reduces procedural pain and anxiety compared to standard care or no distraction.

The results align with cognitive-behavioral theories of pain perception and the Gate Control Theory of Pain (Melzack & Wall, 1965),¹ which suggest that attentional focus on competing sensory stimuli can reduce the transmission and perception of nociceptive signals. The kaleidoscope, through its continuously changing visual patterns, provides a strong attentional anchor that effectively diverts the child's focus away from the painful stimulus. This visual engagement appears particularly beneficial in young children who are highly responsive to color, movement, and novelty.

The significant reduction in pain and anxiety observed in most studies highlights kaleidoscope distraction not only as a simple diversion technique but also as a modulator of subjective pain experience. By engaging visual attention, it reduces fear anticipation and emotional amplification of procedural distress.

Comparison with Existing Literature

The findings of this review are consistent with previous research on visual distraction techniques in pediatric procedural care. Studies using cartoon-based distraction, picture books, and optical visual tools have similarly reported reductions in pain and anxiety during invasive procedures.

However, kaleidoscope-based distraction offers a unique advantage due to its dynamic, unpredictable, and continuously changing visual patterns, which sustain attention more effectively than static visual

tools. This may explain its particularly strong impact in younger children aged 3–5 years, who demonstrate higher engagement with colorful and moving stimuli.

Although limited direct comparative studies exist between kaleidoscopes and advanced technologies such as virtual reality, the current evidence suggests that kaleidoscopes may provide comparable benefits in low-resource settings where advanced equipment is not feasible.

Practical Implications

From a clinical perspective, kaleidoscope distraction offers several important advantages in pediatric nursing practice:

First, it is a non-invasive, drug-free, and child-friendly intervention that can be easily integrated into routine venipuncture procedures.

Second, its low cost, portability, and ease of use make it highly suitable for outpatient departments, emergency units, vaccination clinics, and pediatric wards, especially in resource-limited healthcare settings.

Third, improved child cooperation and reduced procedural distress may lead to smoother venipuncture procedures and reduced procedure time, benefiting both healthcare providers and patients.

Finally, higher caregiver satisfaction observed in several studies supports its role in promoting family-centered pediatric care and improving the overall healthcare experience.

Limitations

Despite promising findings, several limitations were identified in this review. First, heterogeneity in study design, intervention protocols, and outcome measurement tools limits direct comparison across studies.

Second, blinding was not feasible in most studies, introducing potential performance and detection bias.

Third, many studies had relatively small sample sizes, which may limit generalizability.

Additionally, most studies focused on **immediate procedural outcomes**, with limited evidence on long-term effects such as reduction in needle phobia or improvement in future healthcare experiences.

Potential confounding factors such as parental anxiety and prior procedural experiences were also not consistently controlled.

Recommendations for Future Research

Future studies should focus on larger, multi-center randomized controlled trials with standardized pain and anxiety assessment tools to strengthen evidence quality.

Further research is needed to explore:

- Long-term psychological effects of kaleidoscope distraction
- Optimal duration and timing of intervention
- Comparison with other distraction techniques (e.g., VR, cartoons, music therapy)
- Combined multimodal distraction approaches
- Cost-effectiveness and feasibility in real-world clinical settings

Exploring age-specific responses in greater detail may also help refine its use for different pediatric developmental stages.

CONCLUSION

This systematic review provides evidence supporting the effectiveness of kaleidoscope-based visual distraction as a simple and low-cost intervention for reducing pain and anxiety in children aged 3–8 years undergoing venipuncture.

Most included studies demonstrated significant reductions in procedural pain and distress, along with improved cooperation and smoother procedure execution. These findings highlight the potential of kaleidoscopes as a practical tool in pediatric nursing practice.

Given its simplicity, safety, and accessibility, kaleidoscope distraction can be easily integrated into routine clinical care, particularly in resource-limited healthcare settings where advanced technologies may not be available.

While further high-quality research is needed to strengthen long-term evidence, current findings strongly support its role as an effective, child-friendly, non-pharmacological strategy for improving procedural experiences in pediatric patients.

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