Non-Pharmacological Interventions For Mitigating Pediatric Pain During Injectable Vaccinations

Intervenções Não-Farmacológicas para a Mitigação da Experiência Álgica Pediátrica Durante a Aplicação de Imunizantes Injetáveis

Intervenciones No Farmacológicas para Mitigar la Experiencia del Dolor Pediátrico Durante la Administración de Vacunas Inyectables

RESUMO

Objetivo: identificar na literatura científica as evidências da adoção de diferentes estratégias não-farmacológicas cognitivas/comportamentais ou sensoriais/físicas para reduzir a dor durante a vacinação pediátrica. **Metodologia:** Scoping Review segundo as diretrizes do Joanna Briggs Institute. A busca, realizada entre julho e setembro de 2025 nas bases PubMed/MEDLINE, Cochrane CENTRAL e Google Scholar, incluiu ensaios clínicos de 2020 a 2025, em português e inglês, envolvendo crianças de 0 a 12 anos submetidas a imunizantes injetáveis. **Resultados:** Oito estudos com 772 crianças avaliaram intervenções como aleitamento materno, Buzzy, ShotBlocker, realidade virtual e brinquedos terapêuticos. Todas demonstraram redução significativa de dor e ansiedade em comparação à técnica convencional. **Considerações Finais:** Intervenções cognitivas/comportamentais e sensoriais/físicas mostraram-se eficazes na mitigação da dor, promovendo humanização e melhor qualidade na vacinação infantil.

DESCRITORES: Vacinação Infantil; Manejo da Dor; Ensaio Clínico; Prática Baseada em Evidências.

ABSTRACT

Objective: To ly identify evidence in the scientific literature on the adoption of different non-pharmacological cognitive/behavioral or sensory/physical strategies to reduce pain during pediatric vaccination. **Methodology:** Scoping Review according to the guidelines of the Joanna Briggs Institute. The search, conducted between July and September 2025 in the PubMed/MEDLINE, Cochrane CENTRAL, and Google Scholar databases, included clinical trials from 2020 to 2025, in Portuguese and English, involving children aged 0 to 12 years undergoing injectable immunizations. **Results:** Eight studies with 772 children evaluated interventions such as breastfeeding, Buzzy, ShotBlocker, virtual reality, and therapeutic toys. All demonstrated a significant reduction in pain and anxiety compared to the conventional technique. **Final Considerations:** Cognitive/behavioral and sensory/physical interventions proved effective in mitigating pain, promoting humanization and better quality in childhood vaccination.

DESCRIPTORS: Childhood Vaccination; Pain Management; Clinical Trial; Evidence-Based Practice.

RESUMEN

Objetivo: identificar en la literatura científica las evidencias de la adopción de diferentes estrategias no farmacológicas cognitivas/conductuales o sensoriales/físicas para reducir el dolor durante la vacunación pediátrica. **Metodología:** Revisión exploratoria según las directrices del Instituto Joanna Briggs. La búsqueda, realizada entre julio y septiembre de 2025 en las bases de datos PubMed/MEDLINE, Cochrane CENTRAL y Google Scholar, incluyó ensayos clínicos de 2020 a 2025, en portugués e inglés, con niños de 0 a 12 años sometidos a vacunas inyectables. **Resultados:** Ocho estudios con 772 niños evaluaron intervenciones como la lactancia materna, Buzzy, ShotBlocker, la realidad virtual y los juguetes terapéuticos. Todos ellos demostraron una reducción significativa del dolor y la ansiedad en comparación con la técnica convencional. **Consideraciones finales:** Las intervenciones cognitivas/conductuales y sensoriales/físicas se mostraron eficaces para mitigar el dolor, promoviendo la humanización y una mejor calidad en la vacunación infantil.

DESCRIPTORES: Vacunación infantil; Manejo del dolor; Ensayo clínico; Práctica basada en la evidencia

Ana Carolina de Azevedo Pena
Bachelor's Degree in Nursing from the Santa Cruz University Center of Curitiba – UNISANTACRUZ
ORCID: https://orcid.org/0009-0001-0127-5757

Marielly Fernanda Oliveira
Bachelor's Degree in Nursing from the Santa Cruz University Center of Curitiba – UNISANTACRUZ
ORCID: https://orcid.org/0009-0004-0770-5051

Received: 12/06/2025
Approved: 12/22/2025

Michel Marcos Dalmedico
Doctorate in Health Technology from the Graduate Program in Health Technology at PUCPR
ORCID: https://orcid.org/0000-0002-8888-8360

Thais Pacheco
Master's Degree in Cell Biology from the Federal University of Paraná..
ORCID: https://orcid.org/0009-0006-7588-5044

INTRODUCTION

Live attenuated and inactivated vaccines use whole microorganisms that undergo processes to reduce or eliminate their virulence, i.e., their ability to cause disease, but preserve their immunogenic properties. Thus, they stimulate an immune response similar to natural infection, activating both innate and adaptive

DOI: https://doi.org/10.36489/nursing.2026v31i332p12516-12539

immunity, with the participation of cellular and humoral responses[1].

Vaccine development has always focused on diseases that are difficult to treat, for which prevention is the most effective strategy. Although many endemic infections fall into this category, epidemics are usually the main factor driving the creation of new vaccines[2].

Vaccination campaigns against smallpox and polio and efforts to eradicate measles represent important milestones in Brazilian public health. Between the 1970s and 1990s, the Ministry of Health consolidated immunization programs and epidemiological surveillance systems, ensuring broad vaccination coverage and demonstrating the effectiveness of the public system in preventing and controlling communicable diseases[3].

Immunization is a fundamental strategy in childhood, as it ensures collective protection against infectious diseases, offering high efficacy and low cost. Failure to adhere to the childhood vaccination schedule poses risks not only to the unimmunized individual, but also to the community at large, which becomes more vulnerable to the circulation of infectious agents and the spread of these diseases[4].

Childhood vaccination is a proven effective and safe intervention, responsible for preventing millions of deaths and complications from serious infections each year. However, since most vaccines are administered intramuscularly, this procedure is one of the main causes of pain and iatrogenic discomfort in childhood[5].

The lack of adequate pain management in newborns can cause physiological, hormonal, and behavioral changes, with potentially serious consequences in both the short and long term. These repercussions include apnea, cardiac arrhythmias, elevated intracranial and arterial pressure, tachypnea, immunosuppression, endocrine dysfunction, and impaired neurological development and healing[67]. In addition to pain, these procedures can trigger negative memories, such as fear, anxiety, and distress (*"needle* phobia"). Previous painful experiences also increase the child's sensitivity to pain[89].

Despite the wide availability of evidence-based interventions—safe and effective—to mitigate fear and pain during vaccination, their application in clinical practice remains limited[10]. One of the main factors contributing to this low adherence is the lack of knowledge among professionals about the different techniques for pain prevention and management[11]. The systematic inclusion of these strategies in vaccination routines has the potential to improve the child's experience, reduce the suffering associated with the procedure, and, consequently, promote vaccination adherence[12].

Considering the relevance of the topic, the objective of this study is to identify evidence in the scientific literature on the adoption of different non-pharmacological cognitive/behavioral or sensory/physical strategies to reduce pain during pediatric vaccination.

METHODOLOGY

This is *a Scoping Review* based on the guidelines of *the Joanna Briggs Institute - JBI Manual for Evidence Synthesis: Chapter 11: Scoping Reviews*[13]. According to JBI guidelines, a scoping review is appropriate for mapping key concepts, types of evidence, and knowledge gaps in a given field. This type of review allows for a systematic examination of the extent, variety, and nature of available evidence, including emerging research, and synthesizes relevant results without evaluating the effectiveness of interventions. In addition, it enables the rigorous organization of concepts and methodological characteristics, contributing to a comprehensive understanding of the topic under investigation. This scoping review was registered in the *Open Science Framework* (OSF) and is available at: https://doi.org/10.17605/OSF.IO/K4DPY

Conducting a scoping review involves five interrelated steps: 1) research question; 2) identification of relevant studies (search strategy); 3) screening and selection of studies; 4) data mapping; and 5) collection, summary, and reporting of results.

The research was guided by the following question: what is the current evidence on different non-pharmacological strategies for reducing pain during the administration of injectable immunizations in children?

A systematic search for relevant studies was conducted between July and September 2025 in the *PubMed/MEDLINE (National Library of Medicine, Bethesda, MD)* and Cochrane CENTRAL databases. Additionally, a complementary search for gray literature was conducted in Google Scholar.

The theoretical framework was based on the integration of the following terms*:* Immunization OR Childhood Vaccination; Acute Pain; Pain Management; Non-Pharmacological Interventions.

The inclusion criteria were: i) articles published in full; ii) in Portuguese or English; iii) published between 2020 and 2025 (until September); iv) reporting different non-pharmacological interventions for the relief or prevention of pain in children during the administration of injectable immunizations; v) clinical trials as the methodological design; vi) patients between 0 and 12 years of age.

The following were excluded: i) unavailable articles; ii) other age groups; iii) other methodological de-

DOI: https://doi.org/10.36489/nursing.2026v31i332p12516-12539

signs; iv) pharmacological interventions in both groups studied.

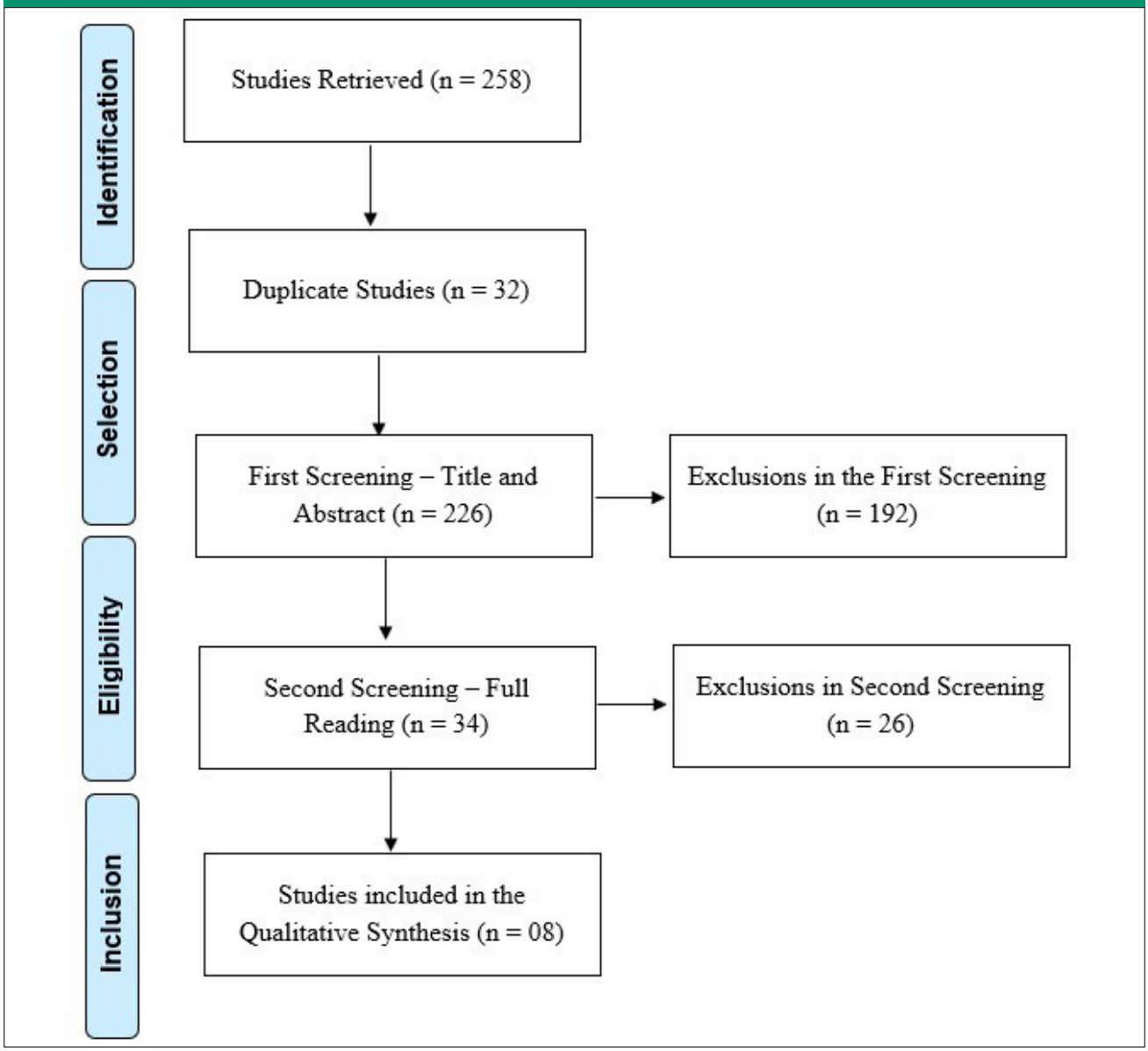
All retrieved studies were screened and evaluated for eligibility according to the inclusion criteria by two independent reviewers. The screening and selection process consisted of two phases: (i) evaluation of titles and abstracts; (ii) full reading of the selected studies and justification of exclusions.

From the list of selected studies, each manuscript was screened by the two reviewers, who extracted administrative data (authors, year of publication, country of origin, journal) and clinical data (study characteristics, main results, characteristics of the intervention and control groups). The data obtained were organized for presentation in a narrative synthesis.

RESULTS

Based on the search strategy, 258 potentially eligible studies were identified and analyzed by the authors. Through a classification process guided by the aforementioned inclusion and exclusion criteria, eight relevant studies comprised the final sample of this study. This process is illustrated in Figure 1.

Figure 1 – Flowchart of identification, selection, and inclusion/exclusion of studies.



DOI: https://doi.org/10.36489/nursing.2026v31i332p12516-12539

Table 1 – Narrative synthesis summarizing the general characteristics of the studies

Author/Year	Country	Title	Base journal
Unesi et al, 2024[14]	Iran	The Effect of a Combination of Vibration and External Cold on Pain Caused during Vaccine Injection in Infants: A RandomizedClinical Trial	Int J Clin Pract/ Pubmed
de la Cruz Herrera et al, 2025[15]	Spain	Use of virtual reality in the reduction of pain after the administration of vaccines among children in primary care centers in Central Catalonia: Randomized clinical trial	Plos One / Pubmed
Queiroz et al, 2024[16]	Spain	The effect of breastfeeding on reducing pain induced by pentavalent vaccine in infants: a randomized clinical trial	Rev Esc Enferm USP/ Pubmed
Viggiano et al. 2020[17]	Italy	Analgesic effects of breast- and formula feeding during routine childhood immunizations up to 1 year of age	Pediatr Res/ Pubmed
Vitor et al, 2025[18]	Brazil	Virtual Reality for Pain Relief in Children During Vaccination: Randomized Pilot Study	Pain Manag Nurs/ Pubmed
Şıktaş, Uysal, 2023[19]	Turkey	The Effect of Buzzy Application on Pain Level During Vaccine Injection in Infants	J NUrs Care Qual/ Pubmed
Can et al, 2025[20]	Turkey	The effect of ShotBlocker® on pain and satisfaction during measles-rubella-mumps vaccination: A randomized controlled trial	J Pediatr Nurs/ Pubmed
Dilek et al, 2024[21]	Turkey	Technology versus nostalgia; A randomized controlled trial of the effect of virtual reality and kaleidescop on pediatric pain, fear and anxiety management during immunization	J Pediatr Nurs/ Pubmed

Source: the authors, 2025.

Table 2: – Narrative summary of the main clinical outcomes

Author/ Year	Study groups	Results
Unesi et al, 2024[14]	Intervention: Vaccine administration with vibrating device + cold applied near the injection site (1 minute before to 15 seconds after). (n = 40) Control: Conventional vaccine administration (n = 40)	Less pain and crying in the intervention group: pain (MBPS 6.1 ± 1.8 vs. 7.2 ± 0.1; p = 0.032) and duration of crying (32.47 ± 16.78 vs. 51.02 ± 25.9 s; p < 0.001). (MBPS)
de la Cruz Herrera et al, 2025[15]	Intervention: Use of virtual reality (VR) glasses showing age-appropriate videos (n= 74) Control: Conventional vaccine administration (n= 72)	The median pain score for the first vaccine fell to 0 (no pain) in the VR group, compared to 2 in the control group. More than 53% of children with VR felt no pain. VR group vs. Control group p< 0.001 VR maintained a lower and more stable HR (median 104 vs. 121 bpm; p < 0.001). (WBFPS, Heart Rate Recording)
Queiroz et al, 2024[16]	Group 1: Breastfeeding before vaccination (n= 30) Group 2: Breastfeeding before and during vaccination (n= 30) Control: Conventional vaccine administration (n = 30)	Control group: 7.43 (Severe pain) Intervention Group 1 (Breastfed only 5 minutes before vaccination): 6.06 – Not significant. Intervention Group 2 (Breastfed before and during vaccination): 3.83 (moderate pain) - Highly significant (p < 0.001).(FLACC)
Viggiano et al. 2020[17]	Group 1: Breastfeeding during vaccination (n= 54) Group 2: Milk formula intake during vaccination (n= 35) Control: Children were only held by their mothers (n= 73)	Both breastfeeding and formula feeding may have an intrinsic effect against painful stimuli during vaccination. Comparison between groups (Breastfeeding, Formula, and Control) p<0.001 (NIPS, FLACC)
Vitor et al, 2025[18]	Intervention: Instructional Therapeutic Play Session, followed by use of Virtual Reality (VR) glasses (during application (n = 25) Control: Therapeutic Toy, without IVR (n= 23)	Children in the intervention group reported no pain in 17 (74%) vaccine applications, while those in the control group reported no pain in 6 (24%) applications, demonstrating statistical significance (p < 0.001; RR 0.34; 95% CI 0.17-0.71) (FPS-R)
Şıktaş, Uysal, 2023[19]	Intervention: Use of the Buzzy device (n= 30) Control: Conventional vaccine application (n= 30)	The mean heart rate in the Buzzy group was significantly lower than in the control group. Between the group that used the Buzzy device and the control group: p= 0.001(FLACC)
Can et al, 2025[20]	Intervention: Infants who received the vaccine using ShotBlocker (n = 30) Control: Conventional vaccine administration (n= 30)	Significant reduction in pain with ShotBlocker (p < 0.001); lower post-vaccination HR (117.7 ± 3.27 vs. 123.7 ± 3.41 bpm; p < 0.001); greater maternal satisfaction (NEW-SNCS; p < 0.05). (FLACC, Newcastle Satisfaction with Nursing Care Scale)
Dilek et al, 2024[21]	Group 1: Use of Quest 2 glasses with roller coaster videos (n=42); Group 2: Children receive kaleidoscope, visual toy as distraction technique (n= 42) Control: Conventional vaccine administration (n=42)	Virtual reality and kaleidoscope > control for pain, fear, and anxiety reduction; kaleidoscope > VR (p < 0.006), with lower mean scores for pain (0.83 ± 1.06), fear (0.60 ± 0.84), and anxiety (0.85 ± 1.07). (WBFPS CFS, CAM-S)
List of Acronyms: P: level of statistical significance; N: number of participants; IG: intervention group; CG: control group; VR: virtual reality; MBPS: Modified Behavioral Pain Scale; FLACC: Face, Legs, Activity, Cry, Consolability; NIPS: Neonatal Infant Pain Scale; FPS-R: Faces Pain Scale - Revised; CFS: Child Fear Scale; CAM-S: Children's Anxiety Meter-State; WBFPS: Wong-Baker Faces Pain Scale; BTI: Instructional Therapeutic Toy; HR: heart rate.		

Source: the authors, 2025.

DOI: https://doi.org/10.36489/nursing.2026v31i332p12516-12539

DISCUSSION

Based on a comprehensive search strategy, eight relevant studies were included, evaluating a total of 772 children for the outcome "reduction/mitigation of pain experience during the administration of injectable immunizations." Compared to the conventional technique of administering injectable immunizations, a reduction in pain and anxiety related to the procedure was observed.

The narrative synthesis of the results highlights the use of the following resources available to manage pain during the administration of injections: a) Sensory/physical: Breastfeeding; *Buzzy; ShotBlocker* b) Cognitive/behavioral: Virtual reality; therapeutic toy.

The analysis of the studies suggests that: breastfeeding and milk formula are highly effective interventions, especially when applied during the procedure; virtual reality is a powerful distraction technique, significantly reducing pain and physiological stress; Cold/Vibration devices are also effective in reducing pain and stabilizing physiological parameters, in addition to increasing the satisfaction of parents/caregivers. These elements constitute the thematic axes of the discussion in this review.

4.1 Sensory/physical

4.1.1 Breastfeeding:

From a physiological point of view, breastfeeding promotes the release of oxytocin and beta-endorphin, hormones responsible for promoting well-being and reducing pain perception. In addition, this practice stimulates the serotonergic system, which aids in the emotional regulation of the infant. The sucking motion also acts as a distraction, helping to mitigate painful responses during procedures such as vaccination[(22)] .

Breastfeeding is an effective strategy for reducing pain in newborns and infants. This analgesic effect is associated with the presence of bioactive substances in breast milk, such as the amino acid tryptophan, a precursor of melatonin, a hormone involved in the regulation of the circadian cycle, sleep, and immune responses. In addition, sensory stimuli from skin-to-skin contact, smell, touch, and sounds during breastfeeding contribute to pain modulation, promoting a decrease in heart rate and attenuating signs of discomfort, such as crying, anxiety, and stress[(9)] . To maximize the analgesic effect, it is ideal to breastfeed before, during, and after immunization[(23)].

It can be said that during the breastfeeding process, a complex network of multifactorial components integrates to enhance the analgesic capacity of this practice. It has been observed that, from the moment the mother positions the infant on her lap to initiate non-nutritive sucking, which stimulates the milk ejection reflex, until nutritive sucking is established, various chemical and behavioral phenomena interact in a coordinated manner, promoting relaxation and pain relief in the infant[(16)] .

Breastfeeding during vaccination is a simple, safe, and effective intervention to reduce infant distress, which can and should be recommended by healthcare professionals. Therefore, breastfeeding during immunization is recommended as an intervention to reduce pain in infants. This procedure requires less time, minimal effort, and is economically feasible, with no side effects, [and]can be easily implemented, even in low-resource settings.

4.1.2 *Buzzy*

The *Buzzy* device is shaped like a bee and has removable pads that can be cooled before use. It combines vibratory stimulation with superficial cooling of the skin, which helps to reduce pain[(24)]. The analgesic action of this device is based on the theory of gate control[(((25))] , according to which cold and vibration stimuli, conducted by slow-transmitting unmyelinated C nerve fibers, can inhibit the passage of acute pain caused by the needle, mediated by A fibers[(((26))] .

Data from a systematic review showed that the device promotes a significant reduction in pain and anxiety levels related to procedures involving needles, when compared to the group that did not receive the intervention. This decrease was observed in children under 12 years of age and confirmed by different evaluation perspectives — including reports from the children themselves, their guardians, and observers[(27)]. Another similar study highlights that the use of cold vibration through the device can have beneficial effects in reducing anxiety and pain levels in children and adolescents undergoing needle procedures[(28)].

There is still debate about which factor is primarily responsible for the effectiveness of the *Buzzy* device: vibration, skin cooling, or a combination of both, since the evidence points to favorable results for each of these mechanisms. In addition, it is believed that part of its analgesic effect is related to the distracting nature of the device, which is especially relevant in younger children[((29))] .

4.1.2 *ShotBlocker*

ShotBlocker is an alternative non-pharmacological method for reducing pain during needle procedures. It is a flexible, drug-free, U-shaped plastic device with small blunt protrusions on its sides, which is applied directly to the skin. In the center, there is an opening for inserting the needle. When the device is pressed firmly against the skin, these bumps provide painless tactile stimu-

DOI: https://doi.org/10.36489/nursing.2026v31i332p12516-12539

lation, which reduces the perception of pain caused by the needle[(30,31)].

The use of *ShotBlocker* had a positive impact during the administration of vaccines to infants, resulting in lower pain perception, reduced heart rate increase, and greater maternal satisfaction. These results reinforce the relevance of the use of non-pharmacological methods by nursing professionals in the management of pain associated with invasive procedures. Furthermore, the dissemination and incorporation of these strategies among nurses and parents, associated with the active participation of both during the procedure, can contribute to minimizing infant discomfort and increasing family satisfaction[(20)].

It is therefore evident that *ShotBlocker* is a low-cost and easy-to-use resource with the potential to help control pain, anxiety, and fear in both pediatric and adult patients. Several studies point to its use as a local pressure device in pain management during the administration of injections, as highlighted in scope reviews and clinical practices[(32)].

4.2 Cognitive/behavioral

4.2.1 Virtual reality (VR)

VR is an interactive computer system that places the user in a simulated and immersive three-dimensional environment. In the context of health, it has stood out as a promising non-pharmacological strategy for reducing fear, suffering, and pain in children during immunization. Immersion, provided by head-mounted devices, stimulates multiple senses and diverts the child's attention from the procedure, promoting cognitive-emotional modulation of pain through attention, sensory perception, and intercortical processing[(33,34)]. The analgesic effect of VR stems from the intercortical modulation of pain signaling pathways, mediated by cognitive and emotional processes such as attention, memory, and sensory perception (visual, auditory, and tactile)[(35)] .

Immersive Virtual Reality is a highly effective and well-accepted intervention that makes vaccination a significantly less painful and less anxiety-provoking experience for children in primary care. It has been observed that age plays a decisive role, with younger children reporting greater pain intensity. In addition, the use of immersive VR was associated with greater parental satisfaction with the procedure. These positive effects may promote adherence to the vaccination schedule and minimize suffering for both children and their caregivers[(36)].

Despite the potential of virtual reality (VR) as a non-pharmacological intervention for pain relief through distraction, uncertainties remain regarding its effectiveness in clinical practice. Its implementation is limited by factors such as high cost, equipment size, the need for specific technical training, and the risk of cybersickness—a discomfort resulting from the conflict between sensory stimuli processed by the central nervous system. The most frequently associated symptoms include dizziness, nausea, headache, sweating, and eye fatigue, especially after prolonged periods of use[(37)].

A systematic review with meta-analysis demonstrated that VR is an effective non-pharmacological intervention for reducing pain, fear, and anxiety in children undergoing medical procedures, especially those involving needles. The effects were more consistent when used immersively and in older children, who are capable of greater cognitive engagement. Despite the favorable results, the authors highlight methodological heterogeneity, small sample sizes, and a lack of standardization among studies, which limits the strength of the evidence. VR is a promising strategy, but its routine incorporation into clinical practice requires further randomized, standardized studies with safety and clinical feasibility assessments. [(38)]

A notable finding from one of the included studies is the comparison between Virtual Reality technology and the Kaleidoscope. The Kaleidoscope proved to be consistently and significantly superior, with the lowest means on the three outcome scales evaluated (pain, fear, and anxiety)[(21)] . This result highlights the relevance of low-cost interventions that are easily integrated into clinical practice, challenging the premise that advanced technological solutions are always the most effective.

4.2.2 Therapeutic Toy

Therapeutic play is a structured technique that comes in three distinct forms: dramatic play, focused on the child's emotional expression and catharsis; instructional play, which prepares the child for medical procedures; and physiological function training, designed to enhance the use of bodily functions according to the child's clinical condition[(39)] .

Therapeutic play is a fundamental non-pharmacological strategy in child care during immunization, as it encourages the expression of feelings, reduces fear, anxiety, and pain, and promotes greater cooperation during the procedure. Through structured play, children can symbolically understand the stages of vaccination, which helps reduce stress and cope with the invasive procedure. The use of therapeutic toys during immunization is associated with reduced pain behaviors, less agitation, and greater satisfaction among parents and professionals, reinforcing its relevance as a practice of humanization and child-centered care[(40-42)].

Engaging the child through therapeutic toys, allowing them to handle

DOI: https://doi.org/10.36489/nursing.2026v31i332p12516-12539

and focus their attention on the object, contributes to reducing tension and promoting relaxation. It is recommended that the toy be used from the child's arrival at the vaccination room until the end of the procedure, allowing the nurse to explain the stages of vaccination in a clear and age-appropriate manner. This strategy promotes understanding of the procedure, reducing the fear and suffering associated with immunization[(((43)))] .

FINAL CONSIDERATIONS

Based on a rigorous search strategy, different non-pharmacological strategies were identified that reduced the painful experience in children of different age groups during the administration of injectable immunizations. It should be noted that all cognitive/behavioral or sensory interventions reported in clinical trials showed better results than the conventional technique.

Despite the potential benefits observed, the heterogeneity of protocols and studies with small samples are insufficient to extrapolate individual results, which indicates the need for more robust studies that allow for the generalization of results and the routine incorporation of these interventions into clinical practice.

It should be noted that the incorporation of these practices in the context of childhood vaccination represents an advance in the humanization of care and the quality of health care, and therefore represents an important subject for future studies.

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DOI: https://doi.org/10.36489/nursing.2026v31i332p12516-12539

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DOI: https://doi.org/10.36489/nursing.2026v31i332p12516-12539