Received: 6 February 2023 | Revised: 13 February 2023 | Accepted: 16 February 2023

DOI: 10.1111/iwj.14134

REVIEW ARTICLE

IWJ WILEY

Effects of non-pharmacological interventions on pain intensity of children with burns: A systematic review and meta-analysis

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Abstract

Pain is one of the complications associated with burns, which can lead to anxiety and sleeplessness in children. Various studies evaluated the effects of non-pharmacological interventions on burn wound care. The present study was conducted to determine the effects of non-pharmacological interventions on pain intensity of children with burns. A comprehensive systematic search was conducted in various international electronic databases, such as Scopus, PubMed, Web of Science, and Persian electronic databases such as Iranmedex, and Scientific Information Database using keywords extracted from Medical Subject Headings such as 'Non-pharmacological', 'Virtual reality', 'Pain', 'Burn', 'Wound' and 'Child' from the earliest to December 1, 2022. The risk of bias in the final articles was also assessed with the Version 2 of the Cochrane risk-of-bias tool for randomised trials (RoB 2). Finally, a total of 1005 burn patients were included in 19 studies. The age range of the patients was from 0.5 to 19 years. Of the participants, 50.05% were in the intervention group. All studies had a randomised clinical trial design. The results found that non-pharmacological

interventions significantly reduced pain intensity in children (ES: −0.73, 95% CI: −1.08 to −0.38, Z = 4.09, I^2:79.8, $P < .001$). Virtual reality (VR) (ES: −0.54, 95% CI: −1.19 to −0.18, Z = 2.90, I^2:72.9%, $P = .004$) and non-VR (ES: -0.86, 95% CI: −1.45 to −0.27, Z = 2.86, I^2:91.4%, $P = .04$) interventions decreased pain intensity significantly in children based sub-group analysis. Non-pharmacological interventions significantly reduced the pain intensity of dressing removal (ES: −0.77, 95% CI: −1.34 to −0.20, Z = 66.3, I^2:91.8%, $P = .008$), dressing application (ES: −0.53, 95% CI: −0.97 to −0.09, Z = 2.37, I^2:60.8%, $P = .02$), and physical therapy (ES: −1.18, 95% CI: −2.10 to −0.26, Z = 2.51, I^2:88.0%, $P = .01$). Also, interventions reduced the pain of burn wound care (ES: −0.29, 95% CI: −1.01 to 0.44, Z = 0.78, I^2:72.6%, $P = .43$), but it was statistically insignificant. In sum, the result of the present study indicated that using non-pharmacological interventions significantly reduced pain intensity in children. The reduction of pain intensity was greater in non-VR than in VR interventions. Future studies should focus on comparing VR interventions with non-VR and single versus multi-modal distraction to clarify the effectiveness of each.

KEYWORDS

alternative medicine, burns, meta-analysis, paediatrics, pain

Key Messages

- The results found that non-pharmacological interventions significantly reduced pain intensity in children (ES: −0.73, 95% CI: −1.08 to −0.38, Z = 4.09, I^2:79.8, $P < .001$)
- VR (ES: −0.54, 95% CI: −1.19 to −0.18, Z = 2.90, I^2:72.9%, $P = .004$) and non-VR (ES: −0.86, 95% CI: −1.45 to −0.27, Z = 2.86, I^2:91.4%, $P = .04$) interventions decreased pain intensity significantly in children based sub-group analysis
- Non-pharmacological interventions significantly reduced the pain intensity of dressing removal (ES: −0.77, 95% CI: −1.34 to −0.20, Z = 66.3, I^2:91.8%, $P = .008$), dressing application (ES: −0.53, 95% CI: −0.97 to −0.09, Z = 2.37, I^2:60.8%, $P = .02$), and physical therapy (ES: −1.18, 95% CI: −2.10 to −0.26, Z = 2.51, I^2:88.0%, $P = .01$). Also, interventions reduced the pain of burn wound care (ES: −0.29, 95% CI: −1.01 to 0.44, Z = 0.78, I^2:72.6%, $P = .43$), but it was statistically insignificant
- In sum, the result of the present study indicated that using non-pharmacological interventions significantly reduced pain intensity in children. The reduction of pain intensity was greater in non-VR than in VR interventions
- Future studies should focus on comparing VR interventions with non-VR and single versus multi-modal distraction to clarify the effectiveness of each

1 | INTRODUCTION

Burn injuries are one of the leading causes of disability and death in the world.[1-15] Burn injuries can be accompanied by physical and psychological changes such as post-traumatic stress symptoms, depression, insomnia, and pain.[16-24] Children's burns are traumatic physical and emotional experiences with long-term effects.[25-27] Pain is one of the disturbing factors in burn victims.[23,24,28-38] To prevent infection and heal the burn wound, frequently washed, debrided, and changed the dressing. Burns's wound care methods are often associated with severe pain and patients experienced more distress during wound care procedures.[39-53]

Although pharmacological treatment was considered before and during the dressing change, patients still

experienced severe pain and most of which scored 7 out of 10 based on the visual analog scale (VAS).[27] Pain management in children is one of the most complex and challenging medical issues.[26,54] Pain can induce adverse effects on mood, sleep, appetite, school performance, and reducing the pain threshold, social-anxiety disorders, anxiety, and fear of medical services.[39] Despite significant advances in pharmacological intervention for pain management of the burn wound, it had some adverse effects.[40] Opioid and non-opioid medications were used to relieve the pain of procedures related to burn wound care.[55] Although opioids were considered the main treatment intervention to manage burn pain, they cannot effectively cause analgesia.[40] Also, they can cause side effects such as nausea, constipation, drowsiness, and pharmacological tolerance and addiction in short and long-term usage.[39,56] In addition; opioids are not always available to the patients and medical staff, especially for outpatients.[55] Non-pharmacological interventions also can be a valuable approach to the management of burn pain.[57] In recent years, studies have recommended using pharmacological and non-pharmacological interventions simultaneously as combination approaches to improve the pain of burn wound care.[39] The non-pharmacological interventions such as hypnosis, relaxation techniques, and distraction can be helpful approaches to managing burn pain.[25,26,58] The studies considered distraction one of the most effective non-pharmacological methods of burn pain management in children.[59] This technique diverted the child's attention to another source during the painful procedure. As a result, it can reduce the pain signals reaching the brain to process the perception of pain.[39] Distraction techniques based on the sensory receptors included visuals such as watching television, video, and guided mental imagery. Also, auditory distraction included listening to music, stories, and funny jokes, and massage as tactile stimulation and other technique including the crossword puzzle, and the use of a bubble blower.[60] Engagement of different sensory receptors can improve pain.[39] Virtual reality (VR) can involve different sensory receptors, and it is one of the most effective techniques of distraction.[39,61] It is also can reduce the pain of burns in children and adults.[62] Hypnosis is another non-pharmacological intervention that has been investigated in various studies to identify the effects on pain among children. In Chester et al.'s study (2018), hypnosis effectively reduced children's anxiety and heart rate, but it did not significantly affect pain.

2 | RESEARCH QUESTIONS

This study was conducted to answer the following research questions:

- What is the effect of non-pharmacological interventions on pain intensity of children with burn?
- What are the effects of VR versus non-VR interventions on pain intensity of children with burn?

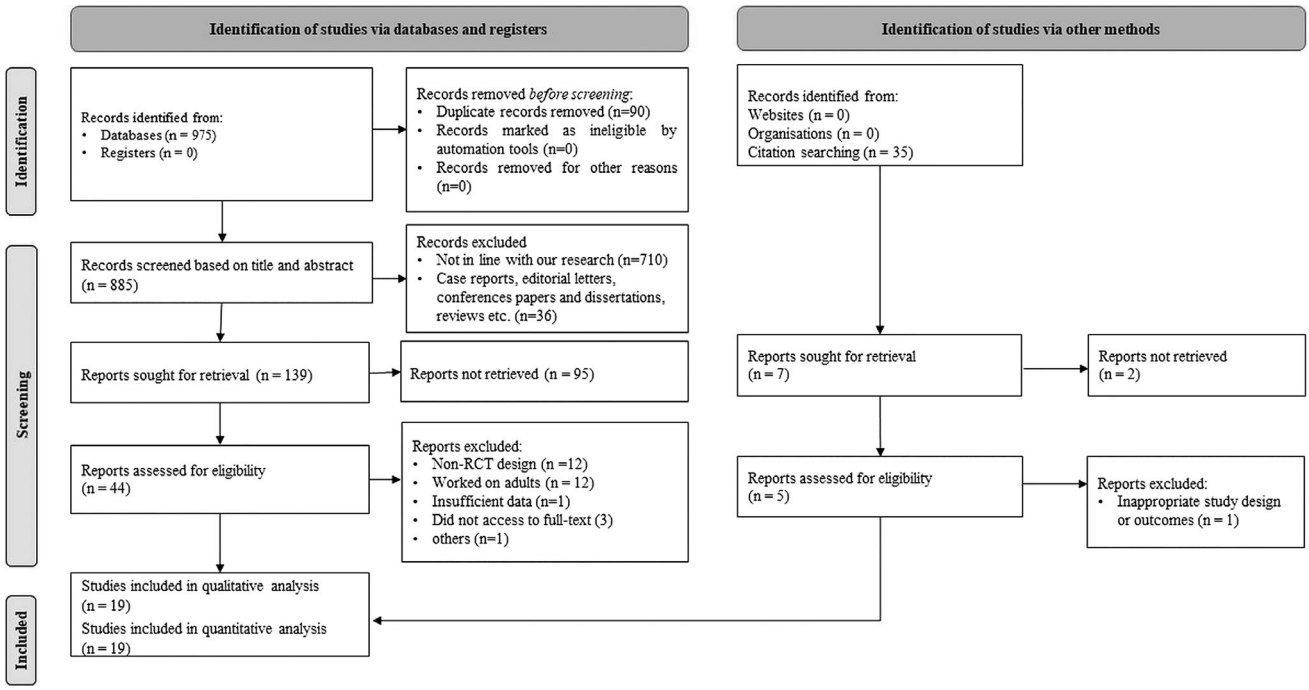

FIGURE 1 Flow diagram of the study selection process.

TABLE 1 Basic characteristics of the included studies in this systematic review and meta-analysis.

-Author -Year -Country	-Design -Sample size of I/C -Age range -M/F -Measurement scale -Procedure -TBSA (%) -Degree	Description of interventions in each group: -Standard care -Intervention -Results
- Kaya et al. - 2022 - Turkey	- RCT - 33/32 - 7 to 12 years - 15/18 - FACES pain rating - Dressing removal - <10 - 2°superficial and deep burn	- Children received standard care - Two Samsung Gear and Oculus Rift VR headsets were used for children during burn dressing. - VR showed an effective method of reducing pain.
- Armstrong - 2022 - USA	- RCT - 11/13 - 5 to 17 years - 19/16 - NRS - DR - 1 - 2,3	- Patients were able to use any distractions available in the home, including toys, mobile phones, and books. - VR-PAT consisted of a lightweight VR headset with a Virtual River Cruise game that is played on a smartphone. - VR-PAT be a useful distraction during home burn care and is reported to be easy to implement.
- Ali - 2021 - Egypt	- RCT - 11/11 - 9-16 years - 13/9 - VAS - PT - 21.185 - 2 deep partial thickness	- This group received a PT session that lasted for 20 min and the conventional pharmacologic protocol. - Subjects choose their favourite video based on VR Oculus. - VR showed a significant effect on the pain of burned patients.
-Cheraghi −2021 -Iran	- RCT - 40/40 - 6-12 years - 75/45 - Oucher - DR - 9-35 - 3	- The dressing was changed according to the usual routine of the ward. - In visual distraction, patients watched Tom & Jerry cartoons on the tablet from 2 min before the start of the dressing change until the end of the procedure. In addition, auditory distraction included 10 short songs that were selected and recorded on a tablet. - Visual and auditory distractions could reduce the pain intensity of burn dressing in paediatrics. The visual distraction method had a better effect on pain management.
-Xiang −2021 -USA	- RCT - 31/29 - 6-17 years - 45/45 - VAS - DR - 2.45 - 1 to 3	-Victims received routine distraction tools provided in the clinical setting including iPads, music, books, and/or talking. - Active VR participants played a VR game titled Virtual River Cruise. In this game, an otter floated a boat down a river, and players activated snow-blowing statues. The passive VR patients were immersed in the same VR environment as the active VR group. Although, they did not interact with the VR game. - Smartphone VR game was effective in reducing self-reported pain during dressing changes.
- Akgül −2021 -Turkey	- RCT - 36/36 - 2 months to 7 years - NR - FLACC - DR - <15 - Second-degree superficial	- Control group was treated with jojoba oil inhalation aromatherapy 15 min before dressing as a placebo. - Lavender-15 and 60 groups received lavender oil inhalation aromatherapy 15 and 60 min before dressing, respectively. - Inhalation aromatherapy before dressing in paediatrics with burns can reduce pain levels.

(Continues)

TABLE 1 (Continued)

-Author -Year -Country	-Design -Sample size of I/C -Age range -M/F -Measurement scale -Procedure -TBSA (%) -Degree	Description of interventions in each group: -Standard care -Intervention -Results
- Khadra - 2020 - Canada	-Cross-over RCT - 35/35 - 0.5-7 years - 27/11 - FLACC - Hydrotherapy - 6 - 1 to 3	- Pain medication was prescribed based on institution protocol. - Projector-based hybrid VR with Bubbles (an interactive pseudo-3D projector dome VR videogame). - Intervention reduced the pain related to hydrotherapy procedures.
- Hoffman - 2020 - USA	- RCT - 25/25 - 6-17 years - 42/8 - GRS - Burn wound debridement - 44 - Large severe burns	- Pain medication was prescribed as a routine treatment. - Patient watched the VR goggles without wearing a helmet - VR can significantly decrease procedural pain on the first day.
- Zhang - 2019 - China	- RCT −26/26 - 1– 3 years - 19/33 - MBPS - DR −13.32 - 2,3	- Patients were attended with the same parent to the dressing room. - The touch-screen computer was installed and powered on to play the content that was prepared for children in advance. - Medical screens can be used as a novel way to reduce the pain experience of burn patients.
- Chester - 2018 - Australia	- RCT −29/35 - 4-16 years - 38/26 - FPS-R - DR, DA - 1.12 - Any depth	- Routine care, including pharmacological and nonpharmacological interventions, was routinely performed. - Hypnotic induced using focused attention on their preferred place combined with deep breathing, muscle relaxation, and permissive, direct hypnotic suggestions. - Hypnosis did not decrease pain intensity.
- Burns-Nader - 2017 - USA	- RCT - 15/15 - 4-12 years - 19/11 - FACES - Hydrotherapy - 7.8 - 2,3	- Patients supported by a child life specialist with no added distraction tools. - Distraction performed using a computer tablet (iPad by Apple Inc.) - Tablet distraction provided by a child life specialist can be an appropriate method for improving pain management.
- Hyland - 2015 - Australia	- RCT - 50/50 - <16 years - 52/48 - CHEOPS - DR - 0.65 - Dermal to full thickness	- Standard care included minimal distraction provided by parents, music, a toy, or electronic device, and pharmacological interventions. - Child life therapy group received parental support, education, and distraction - The presence of a Child Life Therapist can significantly reduce the experience of pain.

TABLE 1 (Continued)

-Author -Year -Country	-Design -Sample size of I/C -Age range -M/F -Measurement scale -Procedure -TBSA (%) -Degree	Description of interventions in each group: -Standard care -Intervention -Results
- Jeffs - 2014 - USA	- RCT - 10/10 - 8-17 years - 19/9 - APPT-WGRS - Burn Wound Care - 4.05 - 1 to 3	- Staff were instructed to provide the usual care. - Patients in passive distraction watched a movie on movable television at the bedside and listened through headphones. Also, VR was delivered using SnowWorld, a three-dimensional, computer-generated, interactive VR software program. - This study supported VR, even without requiring the wearing of an immersive helmet, in decreasing pain in patients than a passive distraction.
- Brown - 2014 - Australia	- RCT - 40/35 - 4–12 years - 60/39 - FPS-R - DR - 1.88 - Any depth	- Standard distraction such as the use of television, videos, books, toys, and parental soothing was available - Ditto intervention group included the story of 'Bobby gets a burn' - The Ditto procedural preparation and distraction device were useful interventions to improve pain.
- Kipping - 2012 - Australia	- RCT - 20/21 - 11-17 years - 28/13 - VAS - DA - 4.9 - 1 to 3	- Patients had access to television, stories, music, and caregivers - The VR group received distraction via an off-the-shelf VR system, which included a head-mounted display - Nurses reported a statistically significant reduction in pain scores during dressing removal, although other pain outcomes were not statistically significant.
- Miller - 2011 - Australia	- RCT - 20/20 - 3-10 years - 21/19 - FACES - DA - 2.525 - 1 to 3	- Patients' access to television, video games, stories, toys, nursing staff soothing, and caregiver support - The MMD device was an adapted hand-held technology device that was interactive for the child through movement, touch screen, and multi-sensory reaction. - MMD protocol reduced the pain experiences during the burn care process.
- Schmitt - 2011 - USA	- cross-over RCT - 54/54 - 6-19 years - 44/10 - GRS - physical therapy - 1.5 to above 50 -NR	- Pharmacologic analgesia/sedation as routine care was used. - Snow World VR software was applied in the interventional group. - VR was an effective nonpharmacologic pain reduction technique in paediatrics.
- Whitehead-Pleaux - 2006 - USA	- RCT - 8/6 - 6-16 years - 5/9 - FACES - DR - 6.5 - Partial to full thickness	- The music therapist interacted verbally with the patient, offering support, and distracting the patient through conversation. - The music therapist played the guitar and sang the songs the subject had selected. - Results showed intervention did not decrease pain in subjects.

(Continues)

TABLE 1 (Continued)

-Author -Year -Country	-Design -Sample size of I/C -Age range -M/F -Measurement scale -Procedure -TBSA (%) -Degree	Description of interventions in each group: -Standard care -Intervention -Results
- Das - 2005 - Australia	- Cross-over RCT - 9/9 - 5-18 years - 6/3 - Faces scale - Dressing change - > 3 - NR	- Routine pharmacological analgesia was prescribed to subjects. - VR equipment constituted a laptop with the game software, and a head-mount display with a tracking system was considered for the intervention group. - The study supported that VR-based games can improve acute pain.

Abbreviations: CHEOPS, Children's Hospital of Eastern Ontario Pain Scale; DR, dressing removal; FACES, Wong baker faces scale; FPS-R, faces pain scale–revised; GRS, graphic rating scale; I/C, intervention/control; M/F, male/female; MBPS, modified behavioural pain scale; MMD, multi-modal distraction; NR, not reported; PT, physical therapy; RCT, randomised clinical trial; TBSA, total body surface area; VAS, visual analogue scale; VR-PAT, virtual reality pain alleviation tool.

- What are the effects of non-pharmacological interventions on pain intensity of different procedures in children with burn?

2.1 | Aim

According to nursing standards, burn pain relieving, especially in children, should be a priority in planning and nursing care.[60] However, different studies investigated the effects of non-pharmacological treatment on the pain management of burns patients, and fewer studies concentrated on the effect size of these interventions. Current systematic review and meta-analysis aimed to evaluate the effects of non-pharmacological interventions on pain management of children with burns.

3 | METHODS

3.1 | Study registration and reporting

This systematic review and meta-analysis were carried out using the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) checklist.[63] In addition, the current review was not registered in the database of the international prospective register of systematic reviews (PROSPERO) database.

3.2 | Search strategy

A comprehensive systematic search was conducted in various international electronic databases, such as Scopus, PubMed, Web of Science, and Persian electronic databases such as Iranmedex, and Scientific Information Database (SID) using keywords extracted from Medical Subject Headings such as 'Non-pharmacological', 'Virtual reality', 'Pain', 'Burn', 'Wound' and 'Child" from the earliest to December 1, 2022. For example, the search strategy was in PubMed/MEDLINE database including (('Non-pharmacological') OR ('Complementary')) AND (('Virtual reality') OR ('VR')) AND (('Pain') OR ('Acute pain') OR (Burning pain)) AND (('Burns') OR ('Burns patients')) AND (('Child') OR ('Children') OR ('Paediatric')). The boolean operators 'OR' and 'AND' were used to combine phrases. Iranian electronic databases' Persian keyword equivalents were also searched. Separately, two researchers conducted a thorough search. This systematic review and meta-analysis exclude grey literature, which includes expert comments, conference presentations, theses, research and committee reports, and current research. Grey literature refers to articles that have been electronically published but have not been reviewed by a for-profit publisher.[64]

3.3 | Inclusion and exclusion criteria

The inclusion criteria were the articles with randomised clinical trial (RCT) design, worked on children as a target

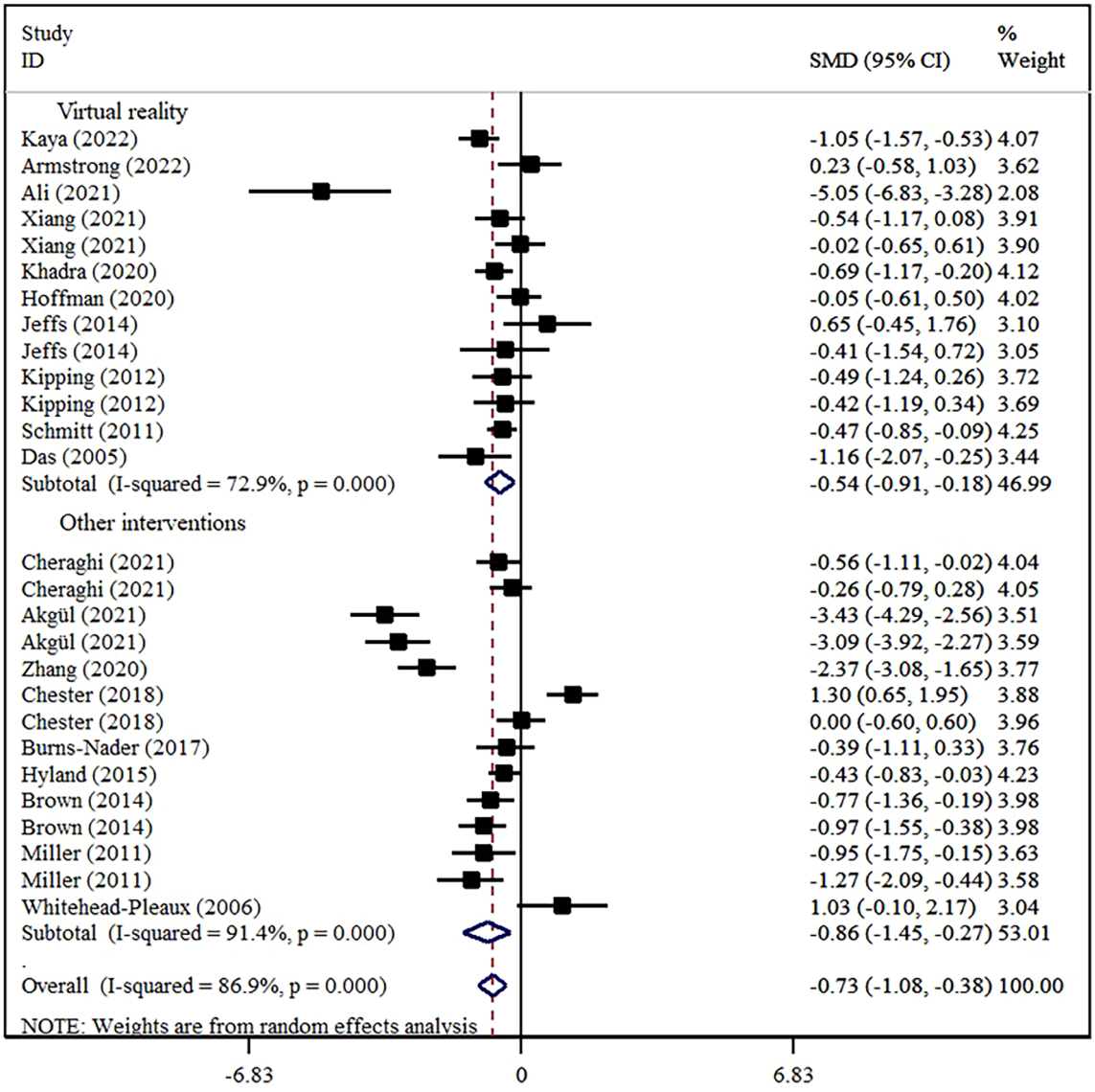

FIGURE 2 Forest plot effect of non-pharmacological (VR and non-VR) interventions on pain intensity.

group, comparison of non-pharmacological interventions with routine care, and assessment of pain intensity. Exclusion criteria were systematic reviews, letters to the editor, and not separating children from adults in the results section of articles.

3.4 | Study selection

EndNote 8X was used to manage the data for this systematic review. Based on the inclusion and exclusion criteria, two researchers independently assessed the study titles, abstracts, and the full texts of the publications, and the removal of duplicate studies both manually and electronically. While choosing the studies, the third researcher settled any differences between the first two researchers. To avoid data loss, references were lastly thoroughly reviewed.

3.5 | Data extraction and quality assessment

Information including the name of the first author, year of publication, location, design, sample size, age range, male/female ratio, measurement scale, procedure, total body surface area (TBSA), degree of burn, standard care, intervention, and result was extracted from the articles which included in this systematic review and meta-analysis. The risk of bias in the final articles was also assessed with the Version 2 of the Cochrane risk-of-bias tool for randomised trials (RoB 2).

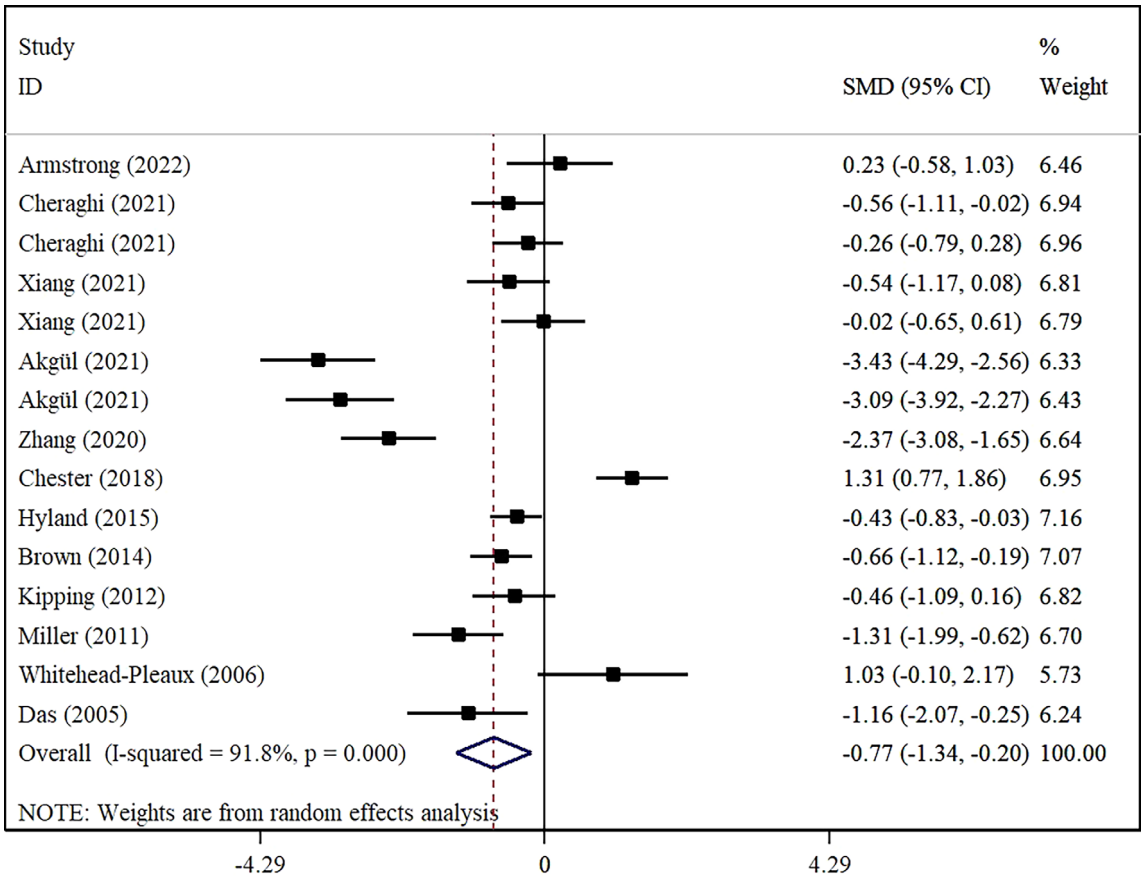

FIGURE 3 Forest plot effect of non-pharmacological on pain of dressing removal.

3.6 | Statistical analysis

Quantitative analysis was performed in STATA version 14 software. To obtain the standard mean difference (SMD), the sample size, mean change, and standard deviation change were extracted from the articles. Heterogeneity was also checked using the I^2 statistic. A value above 50% was considered as high heterogeneity, and a random effect model was used.

3.7 | Sensitivity analysis

Sensitivity analysis was also performed to evaluate the effect of each article on pooled effect size.

3.8 | Publication of bias

The publication bias was analysed qualitatively and quantitatively with Funnel Plot and Egger's test, respectively.

4 | RESULTS

4.1 | Study Selection

As shown in Figure 1, a thorough search of electronic resources yielded 975 studies. Because 90 of the studies were duplicates, they were excluded from the study. Out of the remaining 885 papers, 36 studies were determined to be inappropriate for inclusion in this systematic review and meta-analysis because they were not interventional studies, and 710 papers were eliminated because they failed to meet the objectives of the study. After a thorough analysis of the complete texts of the publications, 24 research were ignored for having insufficient methodology or findings, and five studies were disregarded for having insufficient data. Finally, 19 studies[26,27,39,40,54-61,65-71] remained in this systematic review and meta-analysis.

4.2 | Study Characteristics

As shown in Table 1, a total of 1005 burn patients were included in 19 studies.[26,27,39,40,54-61,65-71] The age range of

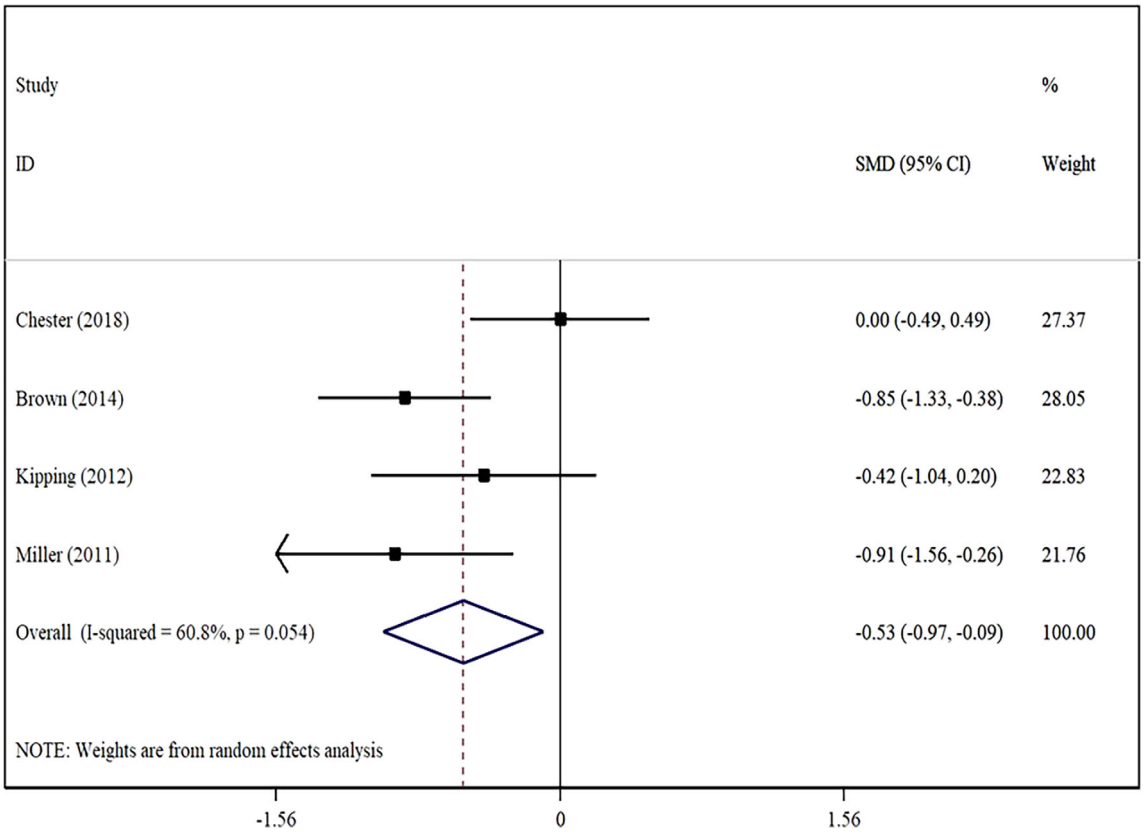

FIGURE 4 Forest plot effect of non-pharmacological on pain of dressing application.

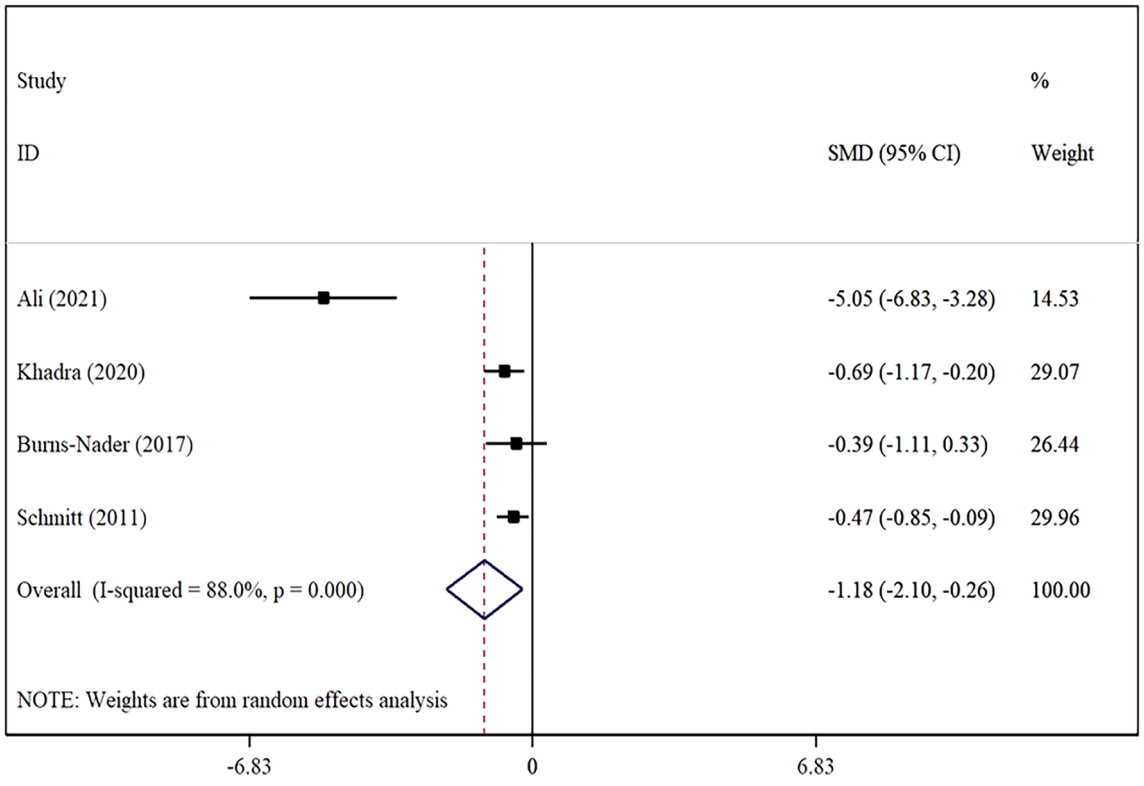

FIGURE 5 Forest plot effect of non-pharmacological on pain of physical therapy.

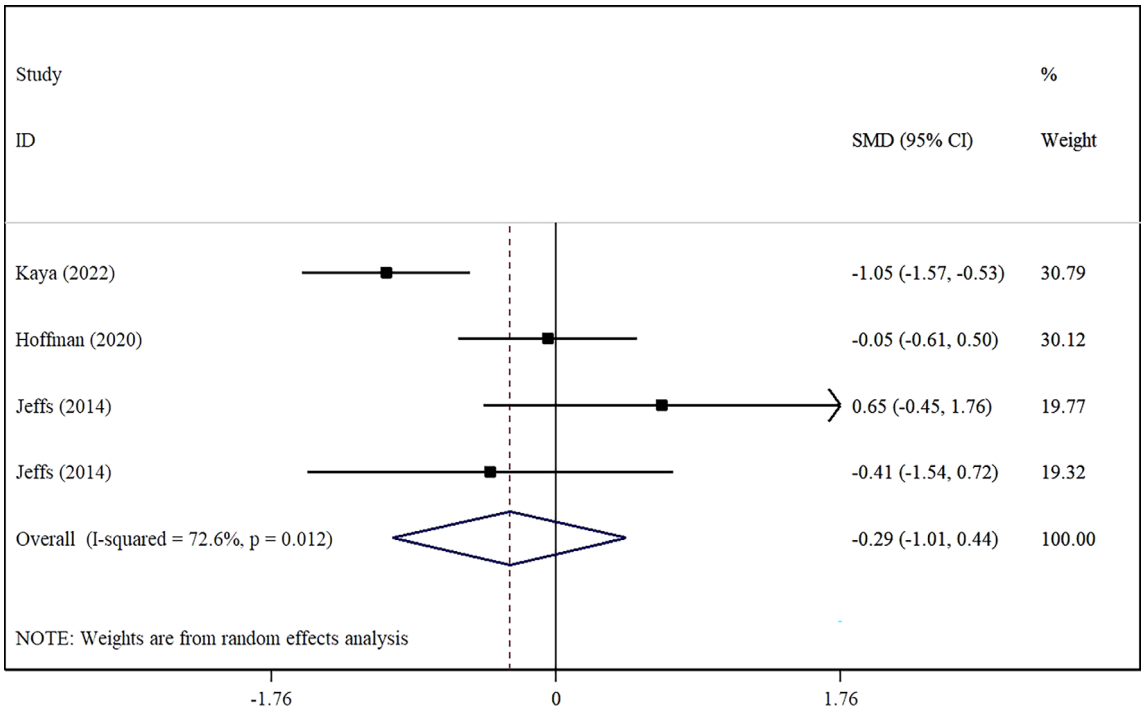

FIGURE 6 Forest plot effect of non-pharmacological on pain of burn wound care.

the patients was from 0.5 to 19 years. Of the participants, 50.05% were in the intervention group. All studies had an RCT design. Interventions were conducted to manage the pain intensity during procedures such as dressing removal, dressing application, physical therapy, and wound care. The number of 10 articles were related to VR intervention, and others were non-VR. Three[27,39,68] and 16 articles had cross-over RCT designs, respectively. The geographical distribution of study locations included America ($n = 7$), Australia ($n = 6$), Turkey ($n = 2$), China ($n = 1$), Egypt ($n = 1$), Iran ($n = 1$), and Canada ($n = 1$).

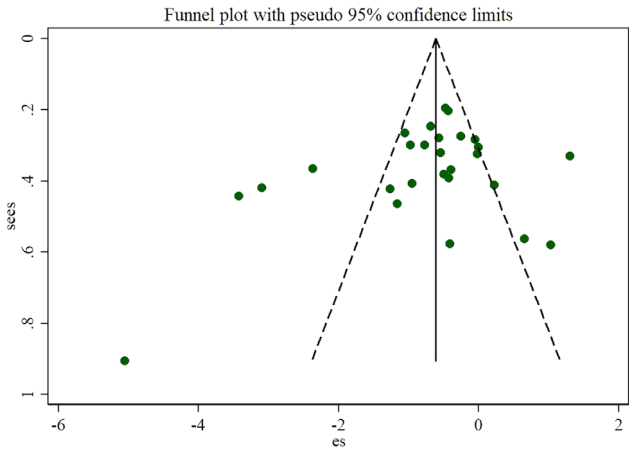

FIGURE 7 Funnel plot effect of non-pharmacological interventions on pain intensity.

4.3 | Pain intensity

The results found that non-pharmacological interventions significantly reduced pain intensity in children (ES: −0.73, 95% CI: −1.08 to −0.38, Z = 4.09, I^2:79.8, $P < .001$) (Figure 2).

4.4 | Effect of VR versus non-VR interventions

VR (ES: −0.54, 95% CI: −1.19 to −0.18, Z = 2.90, I^2:72.9%, $P = .004$) and non-VR (ES: −0.86, 95% CI: −1.45 to −0.27, Z = 2.86, I^2:91.4%, $P = .04$) interventions decreased pain intensity significantly in children based sub-group analysis (Figure 2).

4.5 | Effect of non-pharmacological interventions on different procedures

Non-pharmacological interventions significantly reduced the pain intensity of dressing removal (ES: −0.77, 95% CI: −1.34 to −0.20, Z = 66.3, I^2:91.8%, $P = .008$)

Tools name	Rob II						
Items / Author name	Random sequence generation	Allocation concealment	Blinding of participation and personal	Blinding of outcome assessment	Incomplete outcome data	Selective reporting	Other biases
Kaya *et al.*, 2022	-	?	?	?	+	+	+
Armstrong *et al.*, 2022	+	?	?	?	-	+	-
Ali *et al.*, 2021	+	+	?	?	+	+	-
Cheraghi *et al.*, 2021	+	?	+	-	+	+	+
Xiang *et al.*, 2021	?	?	-	+	+	+	+
Akgül *et al.*, 2021	+	?	+	+	+	+	+
Hoffman *et al.*, 2020	+	?	-	?	?	+	?
Zhang *et al.*, 2020	+	?	?	?	+	+	+
Khadra *et al.*, 2018	+	+	-	-	+	+	+
Chester *et al.*, 2018	+	+	?	+	+	+	-
Burns-Nader *et al.*, 2017	+	?	-	-	+	+	-
Hyland *et al.*, 2015	+	?	-	-	+	+	+
Jeffs *et al.*, 2014	+	?	-	+	?	+	-
Brown *et al.*, 2014	+	?	?	?	+	+	+
Kipping *et al.*, 2012	+	+	-	?	+	+	-
Miller *et al.*, 2011	+	+	-	-	-	+	-
Schmitt *et al.*, 2011	+	?	-	-	+	+	+
Whitehead-Pleaux *et al.*, 2006	?	?	?	?	+	+	-
Das *et al.*, 2005	?	?	?	?	+	+	-
?: Unclear/ +: Low risk/ -: High risk/ 0							

FIGURE 8 Risk of bias final studies.

(Figure 3), dressing application (ES: −0.53, 95% CI: −0.97 to −0.09, Z = 2.37, I^2:60.8%, $P = .02$) (Figure 4), and physical therapy (ES: −1.18, 95% CI: −2.10 to −0.26, Z = 2.51, I^2:88.0%, $P = .01$) (Figure 5). In addition, interventions reduced the pain of burn wound care (ES: −0.29, 95% CI: −1.01 to 0.44, Z = 0.78, I^2:72.6%, $P = .43$) (Figure 6), but it was statistically insignificant.

4.6 | Sensitivity analysis

Results found removing each study did not change the pooled effect size of non-pharmacological interventions on pain intensity of burns in children (95% CI: −1.14 to −0.30).

4.7 | Publication bias

Although visual inspection of the funnel plot indicated the probability of publication bias (Figure 7), the result of Begg's statistical test was insignificant ($P = .2$).

4.8 | Risk of bias

Each final study was evaluated in terms of risk of bias according to Rob 2 tool and was determined in Figure 8.

5 | DISCUSSION

The present study was conducted to determine the effect of non-pharmacological interventions on various painful procedures related to burn wound care in children. The results showed that the use of non-pharmacological interventions compared with routine care significantly reduced the intensity of pain in children.

The present study comprehensively investigated the effect of non-pharmacological RCT interventions compared with routine care. A meta-analysis study in 2021 also investigated the effect of non-pharmacological interventions on pain and distress related to burns in children.[72] In this study, 15 studies were included in the final meta-analysis and reported the effect of two types of VR and non-VR interventions on pain intensity in three dimensions self-reported, observer view, and behavioural changes during painful procedures of burns. Meanwhile, in the current study, we examined the effect of each of the VR and non-VR interventions based on children's self-reported reports. In addition, the present study separated the effect of non-pharmacological interventions on various procedures, such as dressing removal, dressing application, hydrotherapy, and burn wound care, and reported 27 effect sizes from 19 articles. We used sensitivity analysis and publication bias in the current research.

Based on the current study findings, non-VR interventions led to a greater reduction in pain intensity compared with VR. Among the included studies, no study

compared VR intervention with non-VR, and future studies can compare them together. It has been found that the age group can affect the pain relief of using VR intervention so adults benefit more compared with children.[73] VR intervention can be used in form of immersive and non-immersive methods.[74] Previous studies have shown that immersive VR can be more effective than non-immersive to reduce the intensity of burns pain, which is related to more distraction in patients.[75]

Based on the studies included in the present meta-analysis, most of the studies focused on determining the effect of non-pharmacological interventions on the intensity of dressing removal pain in children. Non-pharmacological interventions significantly reduced the pain intensity of dressing removal, dressing application, and physical therapy procedures. Although interventions also decreased pain during wound care procedures, it was not significant statistically. The priority of pain management during each procedure has not been determined in previous studies. it seems necessary for future studies to compare the effect of non-pharmacological interventions on each procedure.

Among the interventions used in included studies, VR was more used than other interventions such as aromatherapy, music therapy, and hypnosis. Compared with other interventions, music therapy had fewer challenges in terms of cost and accessibility, and therefore it can be applied in future studies.[76]

Aromatherapy essential oil such as lavender has also been used in form of topical and inhalation to improve pain. A few studies have examined aromatherapy in the management of burns pain in children.[77] Another intervention, hypnosis, created its effect with relaxation, separation, and suggestibility of patients. This procedure required an expert and its effectiveness is also different in subjects.[78] In the present research, one study investigated the effect of hypnosis and the result showed an insignificant reduction of pain in children.[67]

In one study, the individual effects of auditory and visual stimulation were examined with the control group, and in another research, a multidimensional distraction technique was used for pain management, and their effects were also positive on the pain reduction of wound burns care.[60] Although there is a need to evaluate individual and combined effects in future studies to determine their effectiveness.[69]

6 | LIMITATIONS

Lack of access to the full text of some articles however, we send an email to the authors. In addition, we detect a high heterogeneity between the studies and performed a sub-group analysis based on the interventions and procedures to decrease it, which can be another limitation of the present study. Although this systematic review and meta-analysis was conducted based on the PRISMA checklist, however, it was not registered in the international prospective register of systematic reviews (PROSPERO) database, and a public protocol does not exist. Limiting the search to Persian and English electronic databases has caused articles in other languages not to be included in this systematic review and meta-analysis. In the present systematic review and meta-analysis, the grey literature was not seriously searched because they did not fully depict the results, and the results may change completely when they are not published. Lack of serious evaluation of grey literature in this systematic review and meta-analysis can be as a limitation.

6.1 | Implications for health managers and policymakers

According to the results of the present study, health managers and policymakers can reduce the pain of burn procedures in children by creating a platform for the use of non-pharmacological treatments in medical centres, along with routine treatment. In addition, subsequently, with the reduction of pain during the procedure, it becomes easier for health care workers to perform them on children.

6.2 | Implications for future research

The result of this systematic review and meta-analysis showed that the importance of pain control during each procedure had not been established in earlier research. Future research should assess the impact of non-pharmacological therapies on each procedure, it seems.

7 | CONCLUSION

Overall, the result of the present study showed that the use of non-pharmacological interventions significantly reduced the intensity of pain in children during burns wound care. In addition, the reduction in pain intensity was greater in non-VR than in VR interventions. It seems that these simple, low-cost, and practical interventions, can be used for reducing the intensity of pain associated with various procedures, including removal and application of dressing, and physical therapy in children with burn. However, future well-designed studies are recommended to confirm the efficacy of these and other

potentially effective interventions for the reduction of pain in children with burn.

AUTHOR CONTRIBUTIONS

All authors: idea for the review, study selection, data extraction, interpretation of results, writing of the manuscript. All authors read and approved the final manuscript.

FUNDING INFORMATION

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

CONFLICT OF INTEREST STATEMENT

We do not have potential conflicts of interest with respect to the research, authorship, and publication of this article.

DATA AVAILABILITY STATEMENT

The data sets used during the current study are available from the corresponding author upon request.

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How to cite this article: Farzan R, Parvizi A, Haddadi S, et al. Effects of non-pharmacological interventions on pain intensity of children with burns: A systematic review and meta-analysis. *Int Wound J*. 2023;20(7):2898-2913. doi:10.1111/iwj.14134