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# The effect of virtual reality on patients' experiences of pain during painful wound care procedure: a systematic review and meta-analysis of randomized controlled trials

Serap Çetinkaya Özdemir[1*] and Minna Stolt[2,3]

## Abstract

**Background** Wound care procedures can often cause intense and intolerable pain for patients and negatively affect their quality of life.

**Objective** This study aimed to determine the impact of virtual reality applied in wound care procedures on pain management.

**Methods** A systematic review and meta-analysis. From online databases, including PubMed, ScienceDirect, Scopus, EBSCO (MEDLINE) and Web of Science. Two independent systematic searches of databases were conducted by two researchers. Two independent systematic searches of databases were conducted by two researchers in April 2025. The search strategy was adapted to bibliographic databases. All relevant studies published until the end of April 2025 were included, with no time restrictions applied to capture the earliest research on VR in wound care. Then, two reviewers independently screened literature, and extracted data. After conducting a quality assessment of the included literature, meta-analysis was performed. The degree of heterogeneity was also indicated by using $I^2$statistic.

**Results** This systematic review and meta-analysis included seven randomized controlled trials. The results of the studies included in the systematic review revealed that VR effectively reduced pain during dressing changes, as reported in most included studies. However, our meta-analysis for pain, based on three studies, revealed substantial heterogeneity ($I^2 = 86.19\%$) and did not show a statistically significant overall reduction in pain scores. Similarly, the meta-analysis for anxiety, derived from two studies, showed no heterogeneity ($I^2 = 0\%$) and did not yield a statistically significant pooled effect for anxiety reduction.

**Conclusion** Virtual reality shows promise in reducing pain during a wound care procedure. However, large-scale methodologically sound randomized controlled trials are recommended to determine its efficacy in reducing post-procedural pain and anxiety and its broader effect on vital signs.

**Clinical trial number** Not applicable.

**Registration** www.crd.york.ac.uk CRD420251021751, registered March 31, 2025.

*Correspondence:
Serap Çetinkaya Özdemir
serapc@sakarya.edu.tr

Full list of author information is available at the end of the article

**Keywords** Virtual reality, Wound, Pain, Anxiety, Experience, Systematic review, Meta-analysis

## Background

Wound care can cause intolerable pain that patients often experience. In particular, pain intensifies during wound care procedures such as wound washing, debridement and dressing changes [1, 2]. Pain during this process may negatively affect the quality of life of the patient [3].

Both pharmacologic and nonpharmacologic methods are available to manage pain during wound care. Non-opioid and opioids are among the pharmacological methods, while distraction (such as television, videos, music or other activities; chatting), relaxation breathing, spiritual care, reflexology, reiki and virtual reality constitute non-pharmacological methods [4, 5]. It is stated that both pharmacologic and nonpharmacologic techniques are effective in the control of wound-related procedural pain [6].

In recent years, it has been reported that virtual reality technology can be used as a complement to pharmacological methods in wound care [7, 8]. Virtual reality is a three-dimensional digital environment with multiple degrees of freedom that allows users to interact with their environment and have immersive experiences [9]. This technology stands out as a therapeutic method to reduce pain in wound care [7]. A systematic review and meta-analysis suggested that virtual reality application moderately reduces pain during wound dressing change and should be applied in conjunction with analgesic or anesthetic drugs included in the standard wound care procedure [8]. In a different study, it was determined that virtual reality effectively reduced the worst pain intensity during wound care and physical therapy of burn patients [10]. In a study, patients with burn wounds were divided into three groups: a virtual reality group, a music group, and a control group that received no intervention. After the intervention, a significant reduction in pain levels was observed in the virtual reality group [11].

These findings indicated that VR could be a complementary pain management intervention for burn patients [10, 11]. In addition to burn wounds, recent studies have demonstrated that virtual reality exerts analgesic effects on a variety of other wound types, including chronic wounds such as venous, arterial, pressure, neuropathic, and diabetic foot ulcers, as well as postoperative wounds, including those following haemorrhoidectomy and perianal abscess drainage [12–15].

When the available systematic reviews are examined, it is noteworthy that no study has addressed the effect of virtual reality on pain during the entire wound care process (dressing change / wound cleaning / debridement). Previous systematic reviews focused on specific areas; for example, one study evaluated VR therapy on pain and anxiety during wound care in hospitalized or outpatient adults [16], while another meta-analysis examined VR-based interventions for pain control in adult burn patients [2]. Previous studies and meta-analyses generally included both studies applying VR throughout the entire wound care process and studies using VR only during a single stage (most commonly dressing change), resulting in heterogeneous approaches. In contrast, the present study specifically focuses on VR application across the entire wound care process (dressing change, wound cleaning, and debridement), providing a more consistent and comprehensive understanding of its analgesic effects [2, 16].

## Methods

### Study design and protocol

We conducted this systematic review and meta-analysis using a prospectively registered protocol (CRD420251021751) and reported in accordance with Preferred Items for Systematic Reviews and Meta-Analysis (PRISMA) guidelines [17].

### Eligibility criteria

The PICOT (Population, intervention, comparison, outcome and study design) construct was used to inform the eligibility criteria.

### Population

Included: Adults (≥ 18 years) with acute or chronic wounds undergoing painful wound care procedures (e.g., dressing changes, wound cleansing, debridement), whether treated in outpatient or inpatient settings, and receiving virtual reality interventions.

Excluded: Children and adolescents (< 18 years).

(Participants under 18 years of age were excluded to ensure sample homogeneity. Pain perception and coping mechanisms differ substantially between pediatric and adult populations. In addition, the density of nociceptors per square meter of body surface is higher in children than in adults, which may contribute to differences in pain sensitivity and responses to wound care procedures) [18].

### Intervention

Included: Studies in which virtual reality is applied throughout the entire wound care process (from initial assessment to dressing completion), either alone or as an adjunct to standard wound care.

Excluded: Studies applying virtual reality only during specific procedures (e.g., dressing changes, wound cleansing, debridement).

### Comparison

Included: Standard wound care (standard dressing change procedure/standard wound care) with or without other forms of distraction (TV, videos, books etc.)
Excluded: Studies not including a control group.

### Outcome

Included: Pain, anxiety, heart rate, blood pressure, body temperature, oxygen saturation, patients' experinces.

### Study design

Included: Randomised controlled trials (Parallel-group and crossover trials).
Excluded: Conference proceedings, dissertations, meta-analysis, reviews, qualitative studies, letters, abstracts, comments, editorials, case reports, case series.

Following the inclusion and exclusion criteria, a literature search was conducted.

### Literature search strategy

PubMed, ScienceDirect, Scopus, EBSCO (MEDLINE) and Web of Science databases were searched in April 2025 using appropriate keywords. A comprehensive search strategy was developed and applied to each database. To ensure both reproducibility and completeness, the search incorporated a combination of MeSH terms and Title/Abstract keywords. Search terms and strategies were made using keywords such as 'virtual reality', 'virtual realities', 'VR', 'virtual reality therapy', 'virtual reality exposure therapy', 'virtual reality immersion therapy', 'wound', 'injury', 'injury care', 'wound care', 'pain' and 'pain management'. The search strategy was adapted to bibliographic databases (Additional file 1). References of included studies were also manually screened. All relevant studies published until the end of April 2025 were included, with no time restrictions to capture the earliest research on VR in wound care.

### Study selection

Study selection was conducted using Rayyan software. After removing duplicate articles using Rayyan software, two researchers independently screened titles and abstracts according to the inclusion and exclusion criteria. No discrepancies were encountered during the screening process; therefore, consultation with a third reviewer was not required. The same two reviewers also independently assessed the full-text articles and jointly decided which studies to include. Since no disagreements occurred during this phase, consultation with a third reviewer was not necessary. After the study selection process, data extraction was conducted to systematically collect relevant information from the included studies.

### Data extraction

Descriptive data was extracted from each included article using a form developed by the research team. The data extracted included author(s), year of publication, study design, participants ((number, sex, inpatient, outpatient, mean age), wound type, wound site, wound size, pre-procedure medications, type of wound care procedure (dressing change / cleaning / debridement etc.), VR type (immersive/non-immersive), VR interactivity (active/passive). Immersive virtual reality fully immerses the user in a simulated environment, creating a sense of presence. Non-immersive virtual reality, on the other hand, provides the user with limited interaction through a screen and does not induce a sense of presence [19]. Active VR offers an interactive experience that allows the user to engage with objects in the virtual environment and control the experience [15, 20]. Passive VR involves the user taking on a purely observational role within the experience [13, 21, 22]. In addition, data extraction included VR content (game, environment, nature etc.), VR duration, frequency, control group, pain and anxiety scores, vital signs, patients' experience, key results, and quality scores. Two researchers first performed the data extraction independently. When there was missing data, one of the investigators (SÇÖ) contacted the study investigators. Another researcher from the research team checked the accuracy of the data (MS).

Following data extraction, the methodological quality of included studies was assessed to evaluate potential bias using the Joanna Briggs Institute (JBI) tool.

### Risk of bias

The methodological quality of the included studies was assessed using the 13-item Joanna Briggs Institute critical appraisal tool for the assessment of risk of bias in randomized controlled trials [23]. Two reviewers independently evaluated all 13 items of the checklist. Each item was assessed as "Yes," "No," "Unclear," or "Not applicable" based on the information provided in the study reports. Any discrepancies were resolved through discussion between the two reviewers; therefore, consultation with a third reviewer was not necessary. The aim of the appraisals was to assess the methodological quality of the studies, taking into account potential bias in study designs. The quality assessment was recorded for descriptive purposes and did not influence study inclusion criteria. The results of the risk of bias assessment are summarized in Table 1 to clearly illustrate the findings.

Following the assessment of methodological quality, data synthesis was performed to combine and analyze the extracted information.

**Table 1** Methodological quality assessment using the JBI checklist for randomized controlled trials

| Criteria Author (yr) | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | Quality score |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| McSherry et al., 2017 | ✓ | ? | ✓ | X | X | ✓ | ? | ✓ | ✓ | ? | ? | ✓ | ✓ | 7/13 |
| Ding et al., 2019 | ✓ | X | ✓ | X | X | ✓ | X | ✓ | ✓ | ? | ? | ✓ | ✓ | 7/13 |
| de Araújo et al., 2021 | ✓ | X | ✓ | X | X | ✓ | ? | ✓ | ? | ✓ | ✓ | ✓ | ✓ | 8/13 |
| Park et al., 2023 | ? | ? | ✓ | X | X | ✓ | ? | ✓ | ? | ✓ | ✓ | ? | ✓ | 6/13 |
| Zheng and Liu, 2023 | ✓ | ? | ✓ | X | X | ✓ | X | ✓ | ? | ✓ | ✓ | ✓ | ✓ | 8/13 |
| Spyrka et al., 2024 | ? | ? | ✓ | X | X | ✓ | ? | ✓ | ? | ? | ? | ? | ✓ | 4/13 |
| Belhan et al., 2025 | ? | ? | ✓ | X | X | ✓ | ? | ✓ | ? | ? | ✓ | ✓ | ✓ | 6/13 |

Symbols: ✓: Yes; X: No; ?: Unclear; 0: not applicable

JBI = Joanna Briggs Institute

This table presents the methodological quality assessment of included studies using the JBI Critical Appraisal Checklist for Randomized Controlled Trials, which includes the following criteria:

1. Was true randomization used for assignment of participants to treatment groups?
2. Was allocation to treatment groups concealed?
3. Were treatment groups similar at the baseline?
4. Were participants blind to treatment assignment?
5. Were those delivering the treatment blind to treatment assignment?
6. Were treatment groups treated identically other than the intervention of interest?
7. Were outcome assessors blind to treatment assignment?
8. Were outcomes measured in the same way for treatment groups?
9. Were outcomes measured in a reliable way?
10. Was follow up complete and if not, were differences between groups in terms of their follow up adequately described and analysed?
11. Were participants analysed in the groups to which they were randomized?
12. Was appropriate statistical analysis used?
13. Was the trial design appropriate and any deviations from the standard RCT design (individual randomization, parallel groups) accounted for in the conduct and analysis of the trial?

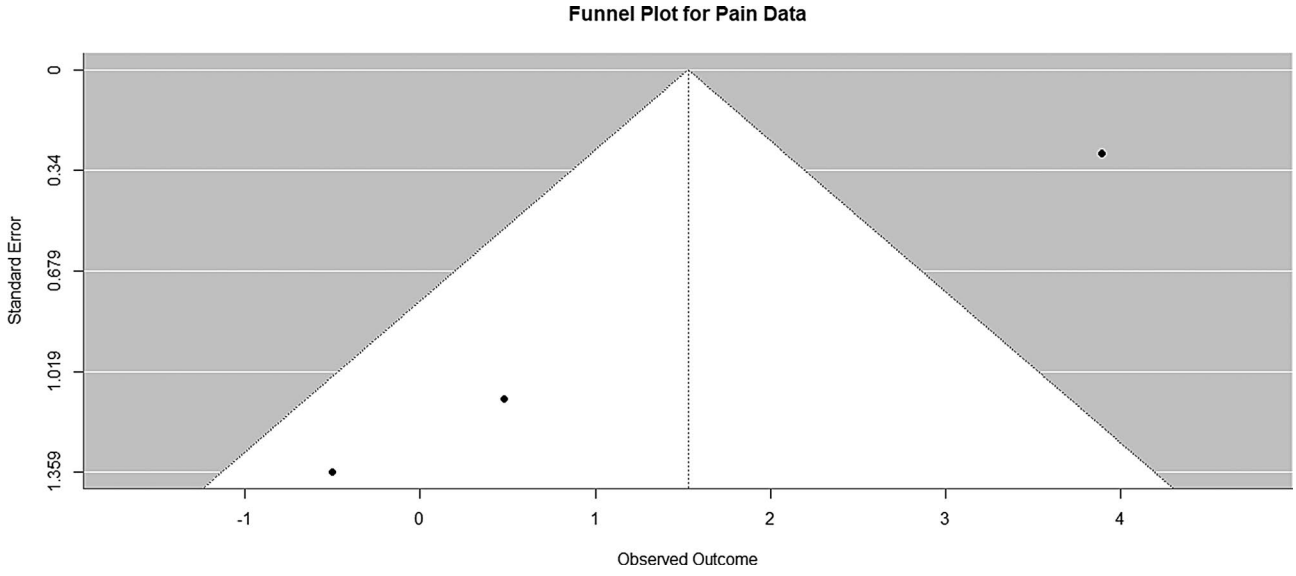



**Fig. 1** Funnel plot showing the effect of virtual reality on pain

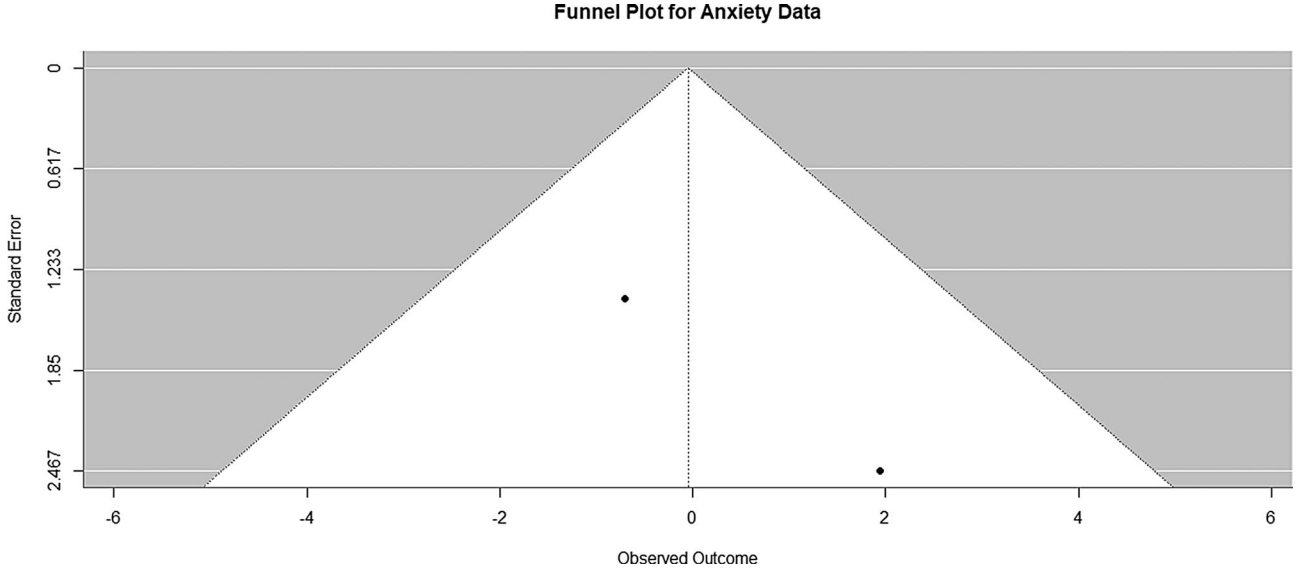



**Fig. 2** Funnel plot showing the effect of virtual reality on anxiety

### Data synthesis

In our systematic review, we grouped participant data using means, numbers and percentages. We assessed the statistical significance of findings regarding clinical practice based on a p-value of $< 0.05$. All analyses for pain and anxiety from extracted data, including graphical assessments and heterogeneity tests were performed using R software version 4.4.2 with help of 'metaphor' package.

A random-effects meta-analysis model was applied to account for potential heterogeneity between the studies. Effect sizes were computed as mean differences and standard deviations between pre-test and post-test scores within the VR and control groups. The between-study variance (tau-squared, $\tau^2$) was estimated using the Restricted Maximum Likelihood (REML) method. Between-study heterogeneity was assessed using Cochran's Q statistic and quantified by the $I^2$ statistic to estimate the proportion of variability due to heterogeneity rather than chance. Forest plots were also constructed to visually summarize individual study effect sizes and their confidence intervals alongside the pooled estimate. To evaluate potential publication bias, funnel plots were generated and visually inspected for asymmetry (Figs. 1 and 2) [24]. Statistical significance was assessed at the 0.05 level ($p \leq 0.05$).

## Results

### Literature search

A total of 1597 studies were identified by analyzing the identified databases. After removing duplicates and reviewing the title and abstract, 21 articles were eligible for full text review. During the full-text review phase, 14 studies were excluded because they did not meet the inclusion criteria. After screening, 7 randomized controlled trials [12, 13, 15, 20–22, 25] were included. The PRISMA 2020 flowchart provided detailed screening results (Fig. 3).

### Description of study design and participants

Table 2 provides a summary of seven randomized controlled trials published between 2017 and 2025. The included studies were conducted in Türkiye [25], China and Canada [15], the United States [20, 21], Poland [22], China [12], and Brazil [13]. 3 studies were conducted with inpatients [12, 15, 20] and 4 studies with outpatients [13, 21, 22, 25]. The number of participants varied between 17 and 182. A total of 545 subjects were included; 510 subjects were analyzed in parallel group trials [12, 15, 21, 22, 25], 35 subjects were analyzed in crossover studies [13, 20].

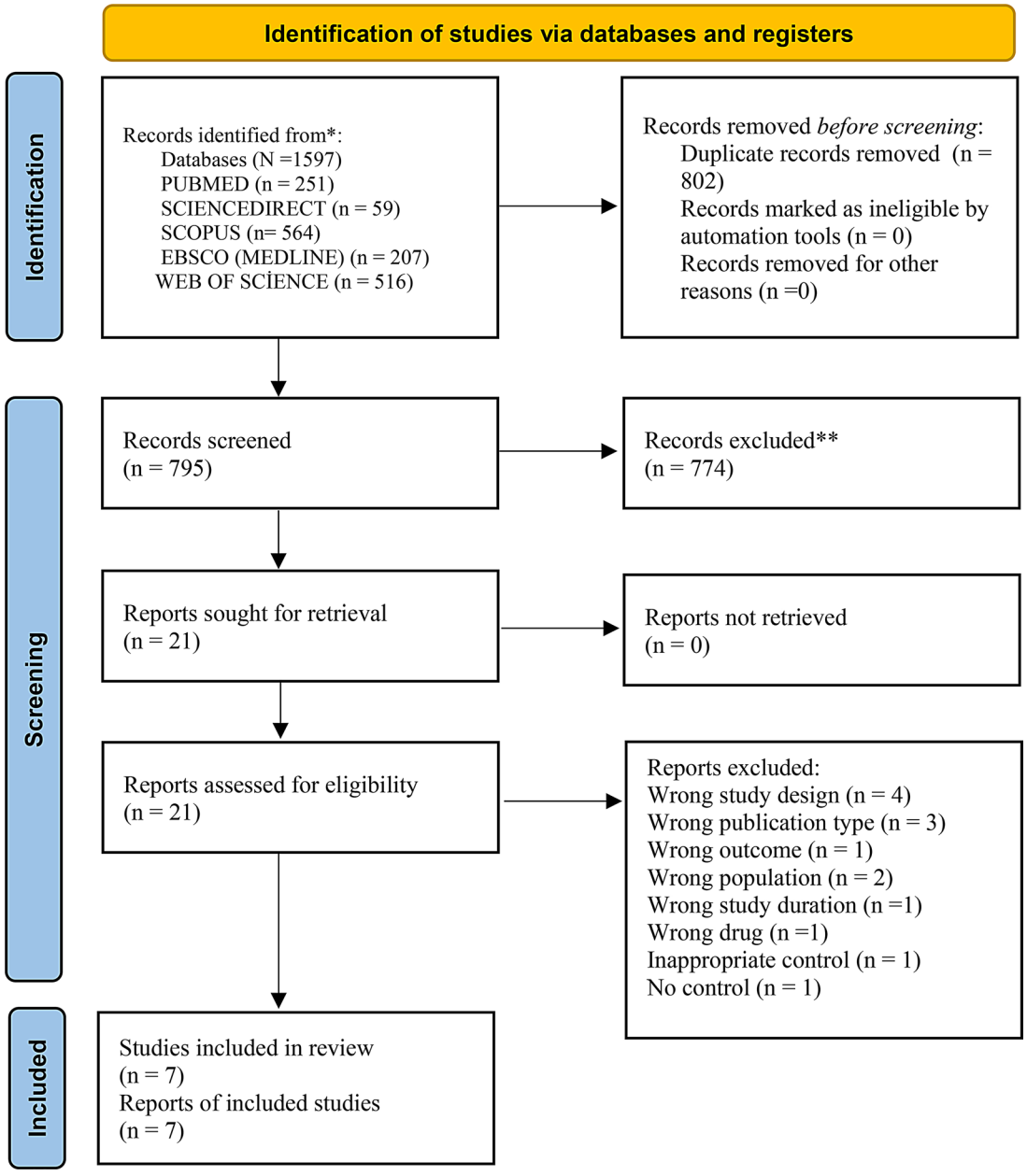



**Fig. 3** PRISMA 2020 flow diagram

**Table 2** Characteristics of included reviews ($n=7$)

| Author(s), year | Study design | Participants | | | | Wound type | Wound site | Wound size | Pre-procedure medications | Type of wound care procedure (dressing change / cleaning / debridement etc.) |
|---|---|---|---|---|---|---|---|---|---|---|
| | | *N* | G (M/F) | S-(İnpatient/outpatient) | MA (age range) | | | | | |
| McSherry et al., 2017 | Crossover randomized controlled study | 18<br>C:15<br>E:15 | M:13(72%)<br>F:5(28%) | A community-based hospital with 427 beds in the Pacific Northwest region of the United States, home to a 16-bed regional burn center verified by the American Burn Association-inpatient | 38.4 ± 15.5(20–73) | Partial or full thickness burn wound:15 (83%)<br>Nonburn wound (necrotizing fasciitis or decubitus ulcers):<br>3(17%) | Not available | Deep or partial thickness burn wounds (at least 5% of the body surface area) or complex non-burn wounds such as necrotising fasciitis or large decubitus ulcers | 1.0 mcg/kg IV fentanyl 20 min before wound procedure; additional 0.25 mcg/kg IV fentanyl given upon patient request during dressing change<br>Total fentanyl administration before dressing procedures (mcg/kg)<br>Control group:<br>72.2 ± 7.9<br>VR group:<br>71.5 ± 8.2<br>($p > 0.05$)<br>Total fentanyl administration during dressing procedures (mcg/kg)<br>Control group:<br>29.2 ± 4.5<br>VR group:<br>17.9 ± 6.0<br>($p = 0.02$) | Dressing change: removal of old dressing, wound hygiene, and redressing per departmental standards for wound type<br>The mean time of the dressing change:<br>Control group:<br>30.7 ± 15.1(10–68)<br>VR group:<br>29.9 ± 12.9 (10–55) |

**Table 2** (continued)

| Author(s), year | Study design | Participants | | | | Wound type | Wound site | Wound size | Pre-procedure medications | Type of wound care procedure (dressing change / cleaning / debridement etc.) |
|---|---|---|---|---|---|---|---|---|---|---|
| | | *N* | G (M/F) | S-(İnpatient/outpatient) | MA (age range) | | | | | |
| Ding et al., 2019 | Prospective, open-label randomized controlled study | 182<br>C:91<br>E:91 | M(VR group): 34(37.4%)<br>M(Control group): 38 (41.8%)<br>F(VR group): 57 (62.6%)<br>F(Control group): 53 (58.2%) | Huiqiao Medical Centre at Southern Hospital of Southern Medical University, Guangzhou, Guangdong Province, China; Department of Health Care, Chinese PLA Southern Theatre Command General Hospital, Guangzhou, Guangdong Province, China; and Dialysis Centre, York Central Hospital, Richmond Hill, Ontario, Canada-inpatient | 45.8 ± 12.6(18–65)<br>VR group: 46.3 ± 11.8<br>Control group: 45.2 ± 12.6 | Postoperative wounds after haemorrhoidectomy | Anus and rectum | Not available | Not available | Dressing change: removing the dressings, cleaning and sterilizing the wound, wound assessment and covering the wound with a new dressing<br>The mean time of the dressing change: 22.3 ± 1.2 min<br>The mean time of the dressing change:<br>Control group: 20.4 ± 4.1<br>VR group: 21.2 ± 3.8 |
| de Araújo et al., 2021 | Crossover randomized controlled study | 17 | M:15(88.2%)<br>F:2(11.8%) | a stomatherapy clinic in Ceará, Brazil-outpatient | Not Available | Chronic wounds (venous ulcer, arterial ulcer, pressure ulcer, neurotrophic ulcer, diabetic foot, or other) | Not Available | Not Available | Analgesics are not given. | Dressing change: removal of the dressings for replacement wound bed cleaning with liquid solutions (0.9% saline solution and polyhexanide at room temperature), conservative instrumental debridement with a carbon scalpel blade no. 15, insertion of primary coverage and secondary occlusion of the lesion |

**Table 2** (continued)

| Author(s), year | Study design | Participants | | | | Wound type | Wound site | Wound size | Pre-procedure medications | Type of wound care procedure (dressing change / cleaning / debridement etc.) |
|---|---|---|---|---|---|---|---|---|---|---|
| | | *N* | G (M/F) | S-(İnpatient/outpatient) | MA (age range) | | | | | |
| Park et al., 2023 | Prospective randomized controlled study | 25<br>C:10<br>E:15 | M(VR group): 53%<br>M(Control group):60%<br>F(VR group):47%<br>F(Control group):40% | Sparrow Hospital's wound clinic-outpatient | Not available | Venous stasis diabetic ulcer<br>breast from surgical complication | Control group:<br>Leg from venous stasis ($n=6$)<br>Foot from diabetic ulcer ($n=4$)<br>Breast from surgical complication ($n=1$)<br>VR group:<br>Leg from venous stasis ($n=10$)<br>Foot from diabetic ulcer ($n=6$)<br>Breast from surgical complication ($n=2$) | Not available | Topical lidocaine | Wound debridement: wound cleansing, topical lidocaine<br>The mean time of wound debridement<br>Control group: 5.1 min (2–12 min)<br>VR group:7.4 (3–16 min) |
| Zheng and Liu, 2023 | Prospective randomized controlled study | 172<br>C:86<br>E: 86 | M(VR group):56(65.1%)<br>M(Control group): 54(62.8%)<br>F(VR group): 30(34.9%)<br>F(Control group):32(37.2%) | Day Treatment Centre-inpatient | 45.6 ± 8.6 | Postoperative wounds perianal abscess | anus | Not Available | analgesic | Dressing change: removing the dressings and evaluating wound, cleaning and sterilizing to achieve full drainage, and finally sterilized dressing covering<br>The mean time of the first dressing change:22.5 ± 4.3 min |

**Table 2** (continued)

| Author(s), year | Study design | Participants | | | | Wound type | Wound site | Wound size | Pre-procedure medications | Type of wound care procedure (dressing change / cleaning / debridement etc.) |
|---|---|---|---|---|---|---|---|---|---|---|
| | | *N* | G (M/F) | S-(İnpatient/outpatient) | MA (age range) | | | | | |
| Spyrka et al., 2024 | Randomized controlled study | 60<br>C:30<br>E:30 | M:31 (51.7%)<br>F:29 (48.3%) | Surgical Outpatient Clinic at Krapkowice Health Centre (LLC), the Surgical Outpatient Clinic and Healthcare Centre at Jan Paweł II District Hospital in Włoszczowaand the Wound Treatment Clinic at the Specialist Hospital of Priest B. Markiewicz Subcarpathian Oncology Centre in Brzozowo-outpatient | 62.28 ± 6.2 | Venous leg ulcers | Left shin: 28 (46.7%) right shin: 32 (53.3%) | Control group: The mean size of ulcer: 13.94 ± 2.28 Ulceration surface ($cm^2$): 10.2–18.7 (13.94) VR group: The mean size of ulcer: 14.59 ± 2.33 Ulceration surface ($cm^2$): 10.6–19.1 (14.59) | Analgesics are not given. | Dressing replacement and wound debridement: firstly, the wound was washed with an antiseptic containing 0.1% polyhexanide and poloxamer 188, and then, necrosis and fibrin were mechanically removed using a sterile Volkman bone curette |
| Belhan et al., 2025 | Randomized controlled study | 71<br>C:35<br>E:36 | M (VR group): 28(77.8%)<br>M (Control group): 26(25.7%)<br>F(VR group): 8(22.2%)<br>F(Control group): 9(25.7%) | A wound care clinic located in Istanbul, Turkey-outpatient | (18–65)<br>VR group: 62,39 ± 13,41<br>Control group: 64,29 ± 11,31 | Control group: diabetic foot: 20(57.1%) venous ulcer: 8(22.9%) Other:7(20%)<br>VR group: diabetic foot: 26 (72.2%) venous ulcer: 4 (11.1%) other:6(16.7%) | Chronic wounds on their legs The wound type was mostly diabetic foot | Not available | Analgesics Control group: 4(11.4%) VR group:9(25%) | Dressing change |

**Table 2** (continued)

| Author(s), year | Intervention description | | | | Control group |
|---|---|---|---|---|---|
| | VR type (immersive/nonimmersive) | VR Interactivity (active / passive) | VR content (game, environment, nature etc.) | VR duration, frequency | |
| McSherry et al., 2017 | Immersive | Active | SnowWorld | Mean VR session duration: 23.2 ± 5.9<br>There were two sequential wound care procedures compared:<br>1.Wound procedure with IVR distraction therapy<br>2.Wound procedure without the use of IVR.<br>12 patients (67%) completed both treatments (with and without IVR); 6 patients (33%) completed only one treatment. | Wound care procedure |
| Ding et al., 2019 | Immersive | Active | Snow World | Mean VR session duration: 21.2 ± 3.8<br>First dressing change<br>VR group that received VR distraction during dressing change plus standard pharmacological analgesic intervention. | Standard pharmacological analgesic intervention: a standard postoperative treatment regimen including wound care, dressing changes, sitz baths and pharmacological medications including analgesics (flurbiprofen axetil) |

**Table 2** (continued)

| Author(s), year | Intervention description | | | | Control group |
|---|---|---|---|---|---|
| | VR type (immersive/nonimmersive) | VR Interactivity (active / passive) | VR content (game, environment, nature etc.) | VR duration, frequency | |
| de Araújo et al., 2021 | Immersive | Passive | Beaches (Wineglass Bay and 12 Apostles, both in Australia; Tropical Beach Escape, Philippines; Fern Bern and Fantail Falls, New Zealand)<br>Rural areas (Northern Lights, United States; Forest Creek, Germany; Rice Terraces, Philippines) and National Park (Glenn Canyon, United States), with 360° video images and location-specific spatial sounds | Mean VR session duration:22<br>One group used VR in the first session, while the other group did not. Seven days later, the groups were switched so that each participant could experience wound dressing change both with and without VR. | Standard dressing change procedure: removal of existing dressings. Cleaning of the wound bed with liquid solutions (0.9% saline solution and polyhexanide at room temperature). Conservative instrumental debridement (with carbon scalpel blade no. 15). Placement of a primary dressing and secondary closure of the lesion as directed by a stomatherapy and dermatology specialist nurse |
| Park et al., 2023 | Immersive | Passive | The VR content consisted of a playlist of freely available 360-degree field of view videos sourced from YouTube | Mean VR session duration: 7.4 (3–16)<br>Patient's VR experience during a single wound debridement procedure | Debridement procedure |
| Zheng and Liu, 2023 | Immersive | Passive | Immersive 360° Cine-VR film scene | Mean VR session duration: 23.2 ± 5.9<br>VR group: VR distraction + analgesics first dressing change at postoperative second day during hospital stay. | Conventional dressing changes: only analgesics |

**Table 2** (continued)

| Author(s), year | Intervention description | | | | Control group |
|---|---|---|---|---|---|
| | VR type (immersive/nonimmersive) | VR Interactivity (active / passive) | VR content (game, environment, nature etc.) | VR duration, frequency | |
| Spyrka et al., 2024 | Immersive | Passive | The VR application connected to goggles enables users to select preferred sceneries (beach, forest, mountains, desert island, canyon) and listen to nature sounds (sea, wind, leaves, waves, birds) via headphones. | Mean VR session duration: not reported<br>VR group: VR during the wound cleaning procedure | Only mechanical cleaning |
| Belhan et al., 2025 | Less immersive | Passive | Patients were shown nature-themed videos via virtual reality glasses. The videos featured calming natural scenes accompanied by relaxing background sounds, including waterfalls and birdsong. | Mean VR session duration: not reported<br>Patient's VR experience during a single wound care | Standard care (routine care) |

| Author(s), year | Pain scores (before/ after) | Anxiety scores (before/ after) | Vital signs (Heart rate, blood pressure, body temperature, oxygen saturation, and respiration rate) | Patients' experience with VR | Key results | Quality scores |
|---|---|---|---|---|---|---|
| McSherry et al., 2017 | Visual Numeric Scale (VNS): pain intensity is measured with a patient verbal report of pain on a 0 to 10 verbal numeric scale.<br>Post dressing change pain:<br>Control group:5.7 ± 2.6<br>VR group:5.8 ± 2.9<br>($p > 0.05$) | VNS: anxiety severity is measured with a patient report of anxiety on a 0 to 10 VNS<br>Post dressing change anxiety:<br>Control group: 3.5 ± 2.6<br>VR group:3.5 ± 3.0<br>($p > 0.05$) | Not available | Majority ($n = 8$) reported that VR ↓ pain during dressing procedure.<br>Majority reported ($n = 7$) that VR ↓ anxiety during dressing procedure.<br>Over 75% found VR helpful and stated it improved the dressing procedure experience.<br>3 of 12 participants (25%) did not want to use VR for future dressing changes. | Immersive-VR significantly reduced the amount of opioid medication administered during painful wound care procedures when IVR was used compared with no IVR. | **7/13** |

**Table 2** (continued)

| Author(s), year | Pain scores (before/ after) | Anxiety scores (before/ after) | Vital signs (Heart rate, blood pressure, body temperature, oxygen saturation, and respiration rate) | Patients' experience with VR | Key results | Quality scores |
|---|---|---|---|---|---|---|
| Ding et al., 2019 | Visual Analogue Scale (VAS): The VAS referred to a 10-cm visual scale representing a continuum with the ends marked 0 (no pain) and 10 (unbearable pain) During dressing change pain (5, 10, 15, 20 min): ↓ in VR group compared to control group (all $p < 0.05$). Pain over time: ↓ in VR group compared to control ($p < 0.01$) Post-dressing change pain: Control group:4.28 ± 1.33 VR group:4.26 ± 1.31 ($p > 0.05$) | Not available | Heart rate: ↑ in both groups during dressing vs. baseline Heart rate over time: ↑ in total sample ($p < 0.03$) During dressing change heart rate (5, 10, 15, 20 min): Control group VR group ($p > 0.05$) During dressing change SaO2 (between groups): Control group VR group ($p > 0.05$) | Not available | Immersive VR combined with standard analgesics significantly improved pain relief during dressing changes after haemorrhoidectomy compared to analgesics alone, suggesting VR is a valuable pain management adjunct | **7/13** |

**Table 2** (continued)

| Author(s), year | Pain scores (before/ after) | Anxiety scores (before/ after) | Vital signs (Heart rate, blood pressure, body temperature, oxygen saturation, and respiration rate) | Patients' experience with VR | Key results | Quality scores |
|---|---|---|---|---|---|---|
| de Araújo et al., 2021 | The Faces Pain Scale VAS<br>During dressing change pain intensity:<br>Control group:8(6–9.5)<br>VR group (↓):1(0–2.5)<br>($p < 0.001$)<br>Post-dressing change pain intensity:<br>Control group:<br>05(5–8)<br>VR group (↓):01(0–2)<br>($p < 0.00$) | Not available | Post dressing change heart rate:<br>Control group:89(85–92)<br>VR group:80(76–82)<br>($p = 0.001$)<br>Post dressing change systolic blood pressure:<br>Control group:<br>136 (128–148)<br>VR group:<br>130 (124–140)<br>($p = 0.012$)<br>Post dressing change diastolic blood pressure:<br>Control group:<br>90(88–92)<br>VR group:<br>88 (80–90)<br>($p = 0.004$)<br>Post dressing change temperature:<br>Control group:<br>37(36–37)<br>VR group:<br>36(36–37)<br>($p = 0.083$)<br>Post dressing change oximetry:<br>Control group:<br>98 (97–99)<br>VR group:<br>98 (97–99)<br>($p = 0.317$) | During dressing change typical facial expression of pain:<br>Control group:9(52.9%)<br>VR group:2(11.8%)<br>($p = 0.016$)<br>During dressing change altered body movement:<br>Control group:10(58.8%)<br>VR group:3(17.6%)<br>($p = 0.065$)<br>During dressing change protective posture:<br>Control group:7(41.2%)<br>VR group:1(5.9%)<br>($p = 0.031$)<br>During dressing change sweating:<br>Control group: 3(17.6%)<br>VR group:2(11.8%)<br>($p = 1.000$)<br>During dressing change pallor:<br>Control group:1(5.9%)<br>VR group:0(0)<br>p=----<br>Satisfaction<br>Extremely satisfied:11(64.7%)<br>Very satisfied:6(35.3%)<br>Discomfort<br>Absent:16(94.1%)<br>A little bit:1(5.8%) | Virtual reality showed positive effects in pain relief during chronic wound dressing change. | **8/13** |

**Table 2** (continued)

| Author(s), year | Pain scores (before/ after) | Anxiety scores (before/ after) | Vital signs (Heart rate, blood pressure, body temperature, oxygen saturation, and respiration rate) | Patients' experience with VR | Key results | Quality scores |
|---|---|---|---|---|---|---|
| Park et al., 2023 | Pain scores are collected using a likert scale (0 = least pain, 10 = most pain)<br>During the debridement and post-debridement pain (between groups):<br>Control group<br>VR group<br>($p > 0.05$) | Anxiety scores were collected using a likert scale (0 = least anxiety, 10 = most anxiety)<br>During the debridement and post-debridement anxiety (between groups):<br>Control group<br>VR group<br>($p > 0.05$) | Not available | VR patients reported significantly ↑ enjoyment scores than no VR patients during peri-debridement (6.0 vs. 0.6, $p < 0.01$) and post-debridement (7.0 vs. 1.1, $p < 0.01$) stages. All patients in the VR group reported having a positive experience, noting that VR helped them relax and that they would recommend its use to others. Minor side effects were observed, with one patient reporting dizziness and two reporting nausea. | Pain and anxiety levels did not differ significantly between the VR and No VR groups during the debridement and post-debridement periods. | **6/13** |
| Zheng and Liu, 2023 | VAS<br>During<br>dressing change pain (5, 10, 15, 20 min): ↓ in VR group compared to control group (all $p < 0.05$).<br>Pain (VR group): ↓ over time ($p < 0.01$, repeated measures)<br>Pain (Between Groups):<br>Post-dressing change: ($p > 0.05$) | Not available | During<br>dressing change pulse rate (5, 10, 15, 20 min): between groups (all $p > 0.05$)<br>Pulse rate over time: ↑ in both VR and control groups ($p < 0.05$)<br>During<br>dressing change $SaO_2$: Stable & normal throughout procedure. | Not available | VR can be used as an effective adjuvant pain distraction approach for postoperative dressing change. | **8/13** |

**Table 2** (continued)

| Author(s), year | Pain scores (before/ after) | Anxiety scores (before/ after) | Vital signs (Heart rate, blood pressure, body temperature, oxygen saturation, and respiration rate) | Patients' experience with VR | Key results | Quality scores |
|---|---|---|---|---|---|---|
| Spyrka et al., 2024 | Numerical Rating Scale (NRS): It contains 11 pain intensity levels—from 0 to 10, where 0 means no pain at all and 10 means the worst imaginable pain.<br>During wound debridement pain:<br>Control group: 4.73 ± 1.20<br>VR group:1.13 ± 0.68 ($p < 0.001$)<br>Men: 1.38 ± 0.62<br>Women: 0.86 ± 0.66 ($p = 0.041$) | Not available | Not available | Not available | The use of VR in patients with venous leg ulcers was associated with reduced pain during wound cleansing. | **4/13** |

**Table 2** (continued)

| Author(s), year | Pain scores (before/ after) | Anxiety scores (before/ after) | Vital signs (Heart rate, blood pressure, body temperature, oxygen saturation, and respiration rate) | Patients' experience with VR | Key results | Quality scores |
|---|---|---|---|---|---|---|
| Belhan et al., 2025 | Numeric Pain Intensity Scale: The Pain Intensity Scale consists of a horizontal line with a "0" at the starting point, meaning "no pain," and a "10" at the end point, meaning "worst possible pain".<br>Pain (VR group):<br>Pre: 1.91 → Post: 2.35 ($p=0.357$)<br>Pain (Control Group):<br>Pre: 2.62 → Post: 2.58 ($p>0.05$)<br>Pain (Between Groups):<br>Pre-procedure: ($p=0.742$)<br>Post-procedure: ($p=0.391$) | Spielberger State Trait Anxiety Inventory: This scale is a 4 point Likert scale which has 20 items. Each item is scored from 1 (never) to 4 (almost always)<br>Anxiety (VR Group)<br>Pre: 35.31 → Post: 36.11 ($p>0.05$)<br>Anxiety (Control Group)<br>Pre: 40.91 → Post: 39.77 ($p>0.05$)<br>Anxiety (Between Groups)<br>Pre-procedure: Intervention group had ↓ anxiety ($p=0.001$)<br>Post-procedure: ($p=0.057$) | Not available | Virtual Reality Symptom Questionnaire (created by the researchers according to the literature):<br>Only four of the patients (11.1%) using virtual reality glasses experienced low-level symptoms.<br>General discomfort:1(2.8%)<br>Headache:1(2.8%)<br>Tired eyes:1(2.8%)<br>Blurred vision:1(2.8%) | Virtual reality application during dressing of patients with chronic wounds on their legs did not have a significant effect on pain and anxiety | **6/13** |

N: number; G: gender; F: female; M: male; S: setting; İ: inpatient; O: outpatient; MA: mean age; C: control; E:experimental

### Description of wound characteristics and dressing change

The included studies examined a range of wound types: surgical wounds [12, 15], necrotizing fasciitis and pressure ulcers [20], chronic wounds including venous, arterial, pressure, neurotrophic, and diabetic foot ulcers [13], venous stasis, diabetic ulcers, and breast wounds from surgical complications [21], venous leg ulcers [22], and diabetic foot, venous ulcers, and other wound types [25].

Most studies focused on dressing changes alone [12, 15, 20, 25], while others combined dressing change with debridement [13, 22]. Park et al., [21] specifically addressed wound debridement as the primary intervention (Table 2).

### Description of control and intervention

All studies compared the effectiveness of virtual reality with various control groups. Two studies used standard care as a control group [15, 25]. Two different studies identified patients who did not use VR during wound care as the control group [21, 22]. One study compared VR with analgesic intake only [12]. Other studies used a crossover study so that each participant experienced both the VR intervention and non-VR (standard care) conditions [13, 20].

Immersive VR was used in all seven included studies [12, 13, 15, 20–22, 25]. Active VR was preferred in two of these studies [15, 20] and passive VR was preferred in five [12, 13, 21, 22, 25]. VR contents used in the studies are given in Table 2.

### Quality appraisal results

The risk of bias scores for the methodological quality assessment of the studies are presented in Table 2.

### Outcomes regarding pain

#### *During dressing change*

The effect of VR on the pain level during dressing change varies according to the studies examined. Five studies evaluated the effect of VR on the level of pain experienced during dressing [12, 13, 15, 21, 22]. Ding et al., [15] and Zheng and Liu [12], reported that the pain scores measured at 5, 10, 15, and 20 min were significantly lower in patients who underwent VR during dressing changes after hemorrhoidectomy and perianal abscess drainage, respectively, compared to the control group, and that the pain level in the VR group decreased significantly over time ($p < 0.05$ for all time points; $p < 0.01$ for within-time reduction). In de Araújo et al., [13] and Spyrka et al., [22], it was reported that participants who underwent VR during chronic wound dressing and wound debridement for venous leg ulcers, respectively, felt statistically significantly less pain compared to the control group ($p < 0.001$). In contrast to the aforementioned studies, one study found no significant difference in pain between VR and control groups during wound debridement [21].

#### *Post-dressing change*

While one study showed that VR significantly reduced pain after dressing change [13], 5 studies reported that VR did not make a significant difference in post-dressing pain levels ($p > 0.05$) [12, 15, 20, 21, 25]. These findings were consistent with the results of the meta-analysis.

Figure 4 displays the forest plot showing the effect of virtual reality on pain. The meta-analysis of pain scores across three studies [15, 20, 25] revealed substantial heterogeneity ($I^2 = 86.19\%$, $Q(2) = 17.95$, $p = 0.0001$), indicating considerable variability in effect sizes between studies.

Despite this, the pooled estimate of the virtual reality effect on pain reduction was not statistically significant (estimate = 1.53, SE = 1.41, $p = 0.28$), with a wide confidence interval crossing zero (95% CI: -1.23 to 4.29). This suggests that, overall, the virtual reality did not produce a consistent or significant reduction in pain scores (Fig. 4). The funnel plot indicates minimal publication bias; however, the slight asymmetry suggests a possible underrepresentation of studies with negative or null findings. This variability in pain outcomes may reflect differences in study design, intervention protocols, or patient populations (Fig. 1).

### Outcomes regarding anxiety

#### *During dressing change*

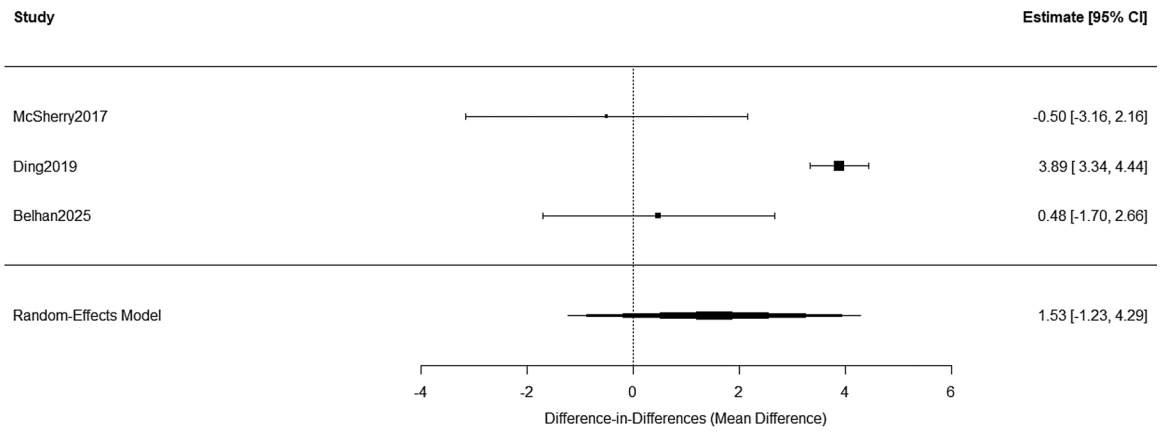
There was only one study in which VR was applied during wound debridement. In this study, there was no statistically significant difference ($p > 0.05$) in anxiety levels between the group that underwent VR during wound debridement and the control group [21].

#### *Post-dressing change*

We found three studies examining the effect of VR on anxiety after dressing or debridement. In these studies, no statistically significant difference was found between the VR-treated groups and the control groups in terms of anxiety levels after dressing or debridement [20, 21, 25]. These findings were consistent with the results of the meta-analysis.

Figure 5 displays the forest plot showing the effect of virtual reality on anxiety. The meta-analysis of anxiety scores from two studies [20, 25], showed no heterogeneity ($I^2 = 0\%$, $Q(1) = 0.86$, $p = 0.35$) and yielded a non-significant pooled effect estimate (estimate = -0.05, SE = 1.23, $p = 0.97$; 95% CI: -2.45 to 2.35), indicating a lack of evidence for virtual reality effectiveness on anxiety reduction (Fig. 5).

For anxiety outcomes, results appeared more consistent, although the pooled effect was not significantly




Random-Effects Model (k = 3; $tau^2$ estimator: REML)

| logLik | deviance | AIC | BIC | AICc |
|---|---|---|---|---|
| -4.5726 | 9.1451 | 13.1451 | 10.5314 | 25.1451 |

$tau^2$ (estimated amount of total heterogeneity): 4.9901 (SE = 5.9779)

tau (square root of estimated $tau^2$ value): 2.2338

$I^2$ (total heterogeneity / total variability): 86.19%

$H^2$ (total variability / sampling variability): 7.24

Test for Heterogeneity: Q(df = 2) = 17.9499, p-value = 0.0001

Model Results:

| estimate | SE | zval | p value | ci.lb | ci.ub |
|---|---|---|---|---|---|
| 1.5299 | 1.4084 | 1.0863 | 0.2773 | -1.2305 | 4.2904 |

**Fig. 4** Effect of VR versus no VR on pain intensity

improved by virtual reality. Funnel plot inspection again showed greater spread and heterogeneity compared with pain outcomes, with some indication that smaller studies tended to report larger effects (Fig. 2). While this may reflect a modest publication bias, it more likely suggests trial-specific differences influencing the observed outcomes. Further research using standardized methodologies is warranted to clarify these effects.

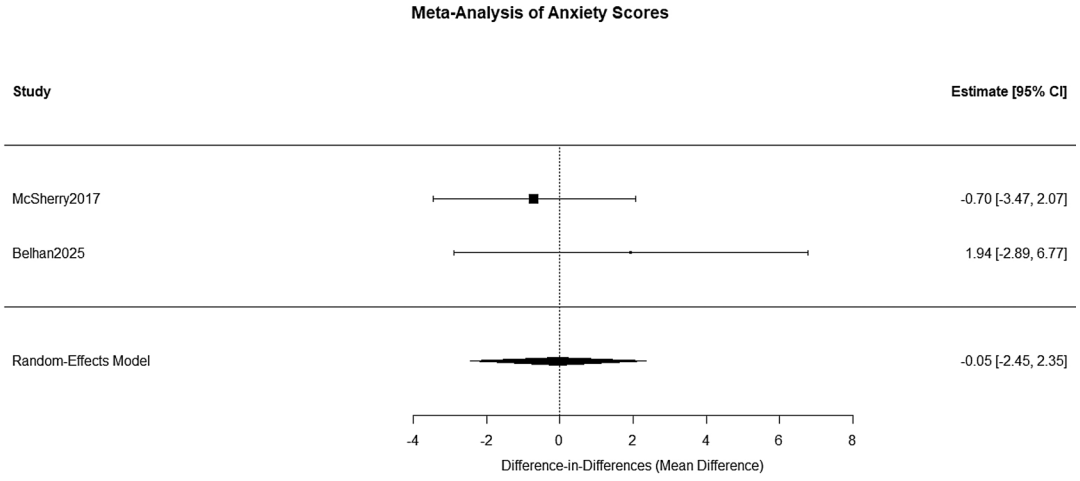
## Outcomes regarding vital signs

### *Heart rate*

There were three studies examining the effect of VR on heart rate during a wound care procedure [12, 13, 15]. In dressing changes after hemorrhoidectomy [15], and perianal abscess drainage [12], VR distraction was reported to have no significant effect on post-dressing heart rate ($p$ >0.05). However, one study found that participants using VR during chronic wound dressing had significantly lower heart rates both before ($p$ = 0.044) and after ($p$ = 0.001) dressing compared to the control group [13].

### *Blood pressure*

Only one of the seven studies had information on blood pressure. Virtual reality significantly decreased systolic blood pressure ($p$ = 0.012) and diastolic blood pressure ($p$ = 0.004) values after chronic wound dressing compared to the control group.




Random-Effects Model (k = 2; tau$^2$ estimator: REML)

logLik deviance AIC BIC AICc

-2.0483 4.0967 8.0967 4.0967 20.0967

tau$^2$ (estimated amount of total heterogeneity): 0 (SE = 5.7131)

tau (square root of estimated tau$^2$ value): 0

I$^2$ (total heterogeneity / total variability): 0.00%

H$^2$ (total variability / sampling variability): 1.00

Test for Heterogeneity: Q(df = 1) = 0.8626, p-value = 0.3530

Model Results:

estimate SE zval p value ci.lb ci.ub

-0.0480 1.2258 -0.0392 0.9688 -2.4505 2.3545

**Fig. 5** Effect of VR versus no VR on anxiety

#### *Oxygen saturation*

In this systematic review, three of the seven randomized controlled trials included findings on oxygen saturation. In these studies, it was determined that there was no significant difference in oxygen saturation levels measured during dressing change between patients who underwent VR and patients in the control group [12, 15]. Similarly, de Araújo et al., [13] found that there was no significant difference in oxygen saturation values before and after dressing between the groups using VR and not using VR.

#### *Body temperature*

Only one study examined the effect of virtual reality on body temperature in wound care. There was no significant change in body temperature levels between groups with and without virtual reality before and after dressing change ($p$ >0.05) [13].

### Outcomes of virtual reality on patient experience

#### *Satisfaction and enjoyment*

In McSherry et al., [20], more than 75% of the participants found VR useful in wound care and stated that it contributed positively to the dressing process. In de Araújo et al., [13] 64.7% of the participants were "extremely satisfied" and 35.3% were "very satisfied" with the use of VR. Similarly, Park et al., [21] reported that all patients in the VR group had a positive experience, VR had a relaxing effect on the wound care process and

could be recommended to others. In addition, the enjoyment scores of patients using VR increased.

#### *Discomfort and side effects*

de Araújo et al., [13] reported that only 5.8% (1) of the participants reported very mild discomfort. In Belhan et al., [25] mild side effects such as headache (2.8%), tired eyes (2.8%), blurred vision (2.8%) and general discomfort (2.8%) were observed due to the use of virtual reality glasses. Park et al., [21] reported dizziness in one patient and nausea in two patients due to VR use.

#### *Behavioral responses*

de Araújo et al., [13] reported that during dressing change, pain-related behavioral responses were significantly reduced in patients in the VR group compared to the control group. Reactions such as showing typical pain facial expression (VR: 11.8% vs. control: 52.9%; $p$ = 0.016), taking a protective position (VR: 5.9% vs. control: 41.2%; $p$ = 0.031) were significantly less in the VR group compared to the control group. There was no statistically significant difference between the VR and control groups in terms of changes in body movements and sweating during dressing change ($p$ >0.05).

## Discussion

This systematic review and meta-analysis assessed the available evidence on the effects of VR on pain during wound care procedures. The findings reveal that VR application differs in terms of multidimensional outcomes such as anxiety, vital signs and patient experience, especially pain.

Most of the studies included in this systematic review revealed that VR was effective in reducing pain during dressing change. However, regarding the post-dressing period, the effect of VR on pain was not statistically significant according to both the systematic review and meta-analysis findings. Similar to our study, a different study found that virtual reality application moderately reduced pain during dressing change [8]. Ko et al., [26] emphasized that pain was reduced and the need for additional local anesthesia was lower in adult patients who underwent VR during wound closure procedures in emergency departments. Unlike the findings of our study, a systematic review and meta-analysis conducted by Czech et al., [7] reported that there was a significant difference in pain levels between VR treatment and standard care during wound care procedures; this effect became more pronounced, especially when immersive VR was applied. Another systematic review and meta-analysis by Mazaheri et al., [27] also showed that VR was effective in reducing pain intensity compared to standard wound care. A meta-analysis by Senol Celik et al., [28] reported lower pain scores in patients undergoing VR in 11 of the 15 studies analyzed.

The meta-analysis demonstrated substantial heterogeneity in the effect of VR on pain ($I^2$ = 86%). This heterogeneity may be attributed to variations in wound types, VR content, and patient populations across the included studies. The observed discrepancies across studies may be explained by several methodological factors, such as the duration of VR application, the length of wound care procedures, patient age, and the type of wound (e.g., burn injuries). In addition, variations in the study designs included in the systematic review and meta-analysis may have further contributed to these inconsistencies [7, 27, 28]. Beyond methodological considerations, individual differences and patients' attitudes toward VR may also play a role in shaping its effectiveness in pain management.

The findings of this systematic review and meta-analysis reported that VR did not affect anxiety after dressing or debridement. A study in pediatric and adult patients with burn wounds found similar results to our study [29]. However, some studies reported positive effects of VR on anxiety. Anxiety was found to decrease in adult patients using VR during wound closure procedures in the emergency department [26]. In a different study, it was found that patients receiving VR-assisted wound debridement had less anxiety than patients receiving regular wound debridement [30]. Our systematic review encompasses both acute and chronic wound care; in contrast, the aforementioned randomized controlled trial examined the application of virtual reality exclusively during suturing and wound closure procedures in the emergency department [26]. None of the studies included in the meta-analysis involved direct wound closure procedures such as suturing, which may explain the observed differences in outcomes. Furthermore, in the other study, the limited sample size and the inclusion of patients with burn wounds may have contributed to variations in the effect of VR on anxiety [30]. Additionally, these discrepancies may be due to differences in VR application duration, the type of VR content used, and the methods employed to assess anxiety.

The effect of VR on heart rate during wound care procedures shows mixed results. Two studies reported that VR had no significant effect on post- dressing heart rate, while another study found that both pre- and post- dressing heart rates were significantly lower in patients using VR. Similarly, one study reported a reduced pulse rate in adult patients using VR during wound closure procedures [26]. In a systematic review and meta-analysis examining the efficacy of VR technology in controlling procedural pain in pediatric wounds, VR application was found to reduce pulse rate significantly more than the control group [31]. On the other hand, in a different

study, although the VR group showed significant changes in pulse rate over time in children undergoing burn dressing change, no significant change in pulse rate was observed in both groups compared to the standard group [32]. These differences may be attributed to factors such as the inclusion of only adult participants in our study, methodological differences between the studies included in the meta-analysis and other studies, variability in wound types, differences in VR content, and the location of wounds on the body [31, 32]. For instance, stress and pain responses can differ between adults and children, which may influence changes in heart rate. Furthermore, pain intensity may vary according to wound type and location, and therefore, the calming effect of VR on heart rate may be observed to different degrees. The intensity and duration of VR content may also modulate pain and discomfort, thereby affecting heart rate regulation.

Only one study included in the systematic review had information on blood pressure. Virtual reality was found to reduce systolic and diastolic blood pressure values after chronic wound dressing. In patients with wound closure procedure and septic wounds due to cancer, VR was also found to reduce blood pressure [26, 33]. These findings suggest that VR has the potential to reduce some physiological stress responses and show results that are consistent with the literature. The distracting and relaxing effects of VR may reduce stress levels, leading to decreased sympathetic nervous system activity and, consequently, a reduction in blood pressure.

In this systematic review, it was observed that virtual reality application had no significant effect on oxygen saturation levels during the dressing process. Similar to our study, it was found that there was no difference in oxygen saturation between the group using virtual reality and the group not using virtual reality in patients with septic wounds [33]. This similarity may be attributed to the fact that oxygen saturation is a relatively stable parameter that is primarily dependent on respiratory functions and oxygenation capacity, and thus is not directly influenced by VR applications.

In this systematic review and meta-analysis, the number of studies reporting data on body temperature is quite limited. As a result of the literature search, only one study addressing this issue was identified, and in this respect, our study appears to be consistent with the literature [33]. The fact that both studies included patients with chronic wounds may be one of the main reasons for the observed similarity. In chronic wounds, physiological parameters such as body temperature, which are homeostatically regulated, tend to remain relatively stable; this may explain why VR applications did not produce a significant change in body temperature.

In this systematic review, although the number of studies directly addressing patient experience is limited, it was observed that virtual reality application positively affected the patient experience in the reviewed studies. It was determined that patients found the VR application entertaining, were satisfied with this experience, evaluated VR as useful and found it recommendable to other patients in a similar situation. These findings are consistent with the literature. In a systematic review and meta-analysis conducted by Mazaheri et al., [27], it was reported that virtual reality improved patient experience in the wound care process. In a different study, it was found that patients were satisfied with using VR during burn care and would recommend the use of VR to a patient in a similar situation [34]. VR alters patients' perception of time, allowing them to temporarily detach from the clinical environment, while simultaneously providing an intriguing and enjoyable experience. Therefore, the consistent findings across different studies may be attributed to the multifaceted effects of VR.

In some studies of virtual reality applications, a small number of patients reported mild discomfort and side effects. A small number of participants experienced temporary and mild complaints such as headache, eye strain, blurred vision, dizziness, nausea and general discomfort. In a similar study, nausea was reported in patients due to VR use [35]. In one study, only one patient undergoing a wound closure procedure complained of mild dizziness after using VR [26]. These findings indicate that VR applications are generally well tolerated; however, individual sensitivities, as well as factors such as the duration and content of the application, may contribute to the occurrence of mild side effects in some patients.

This systematic review included a study examining behavioral responses to pain during dressing change. In particular, behaviors such as showing a typical pain facial expression and taking a protective position were significantly less pronounced in patients who underwent VR. Although similar studies are not available in the literature, the reduced observation of behaviors such as typical pain facial expressions and protective positioning in patients who underwent VR may be attributed to the analgesic effect of VR observed in the study. The reduction in pain may suggest that VR exerts a calming effect at the behavioral level.

The use of VR in wound care may offer significant opportunities in terms of pain reduction and enhancing positive patient experiences. The portability of VR devices may further increase the feasibility of implementing this technology in wound care settings. However, several challenges may hinder its widespread adoption. These include the lack of training and guidance for healthcare professionals on VR use, the cost of VR devices, and issues related to device sterilization. Therefore, for the successful integration of VR into clinical practice, it is important to gather healthcare

professionals' perspectives, conduct pilot studies to assess the feasibility of VR in wound care, provide training for healthcare providers, develop guidelines for VR use, and perform cost-effectiveness analyses.

### Limitations

This systematic review and meta-analysis had some limitations. First, the number of randomized controlled trials included in this systematic review and meta-analysis was limited ($n = 7$). This limitation may restrict the generalizability of the meta-analysis results and indicates the need for further studies to confirm the effects of VR interventions on wound care in larger patient populations. Second, the various methodological approaches (parallel group and crossover studies) in the included randomized controlled trials may lead to significant variability. Differences in patient populations (e.g. inpatient vs. outpatient, different age groups), wound types (diabetic wound, venous ulcer, surgery, burns, etc.), VR content, VR type (active vs. passive) and duration of VR intervention may influence the observed outcomes. Third, meta-analyses could not be performed due to limited reporting of specific vital signs. This limited our ability to draw firm conclusions about the physiological effects of VR beyond pain and anxiety. Fourth, the subjective nature of patient satisfaction and enjoyment measures may bias the results.

This systematic review and meta-analysis provides several recommendations for future research to further clarify the role of VR in wound care. A large number of randomized controlled trials are needed to examine the effect of VR on pain, anxiety and vital signs when used throughout the wound care process. Future research should systematically investigate the content of VR and the optimal duration and timing of VR application during different wound care procedures. It is also recommended to conduct studies that can demonstrate that VR features work best for specific wound types, patient characteristics and patient populations.

## Conclusion

This systematic review and meta-analysis summarizes the effects of VR during wound care procedures. Most studies reported that VR effectively reduced pain during dressing changes; however, the meta-analysis showed no significant effect on post-dressing pain or anxiety. Considerable heterogeneity in pain outcomes was observed, which may be attributed to differences in age groups, wound types, and VR content. VR had inconsistent effects on heart rate, decreased blood pressure, and had no significant impact on oxygen saturation or body temperature. Overall, VR positively influenced patient experience and was generally well tolerated, with minor side effects reported occasionally. While VR appears promising for pain management and improving patient experience, further research is needed to confirm its effects in wound care.

## Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12912-025-03984-z.

Supplementary Material 1

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### Author contributions

S.Ç.Ö, M.S, Study conception and design, collected data, analyzed and interpreted data, drafted the article, critical review of the manuscript. All the authors have carefully reviewed the article and approved the final draft.

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### Data availability

All data generated or analyzed during this study are included in this published article [and its supplementary information files].

## Declarations

### Ethics approval and consent to participate

Not applicable.

### Consent for publication

Not applicable.

### Competing interests

The authors declare no competing interests.

### Author details

[1]Department of Internal Medicine Nursing, Faculty of Health Sciences, Sakarya University, Sakarya 54050, Türkiye
[2]Department of Nursing Science, University of Turku, Turku, Finland
[3]Central Hospital of Satakunta, Wellbeing Services County of Satakunta, Pori, Finland

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