



Virtual Reality and Digital Therapeutics in Chronic Pain: Distraction, Reconceptualisation or Neither

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Abstract

Virtual reality and digital therapeutic platforms for chronic pain have moved from novelty to an increasingly evidenced clinical tool, but the mechanism by which they help remains contested: some applications rely primarily on attentional distraction, others on delivering pain neuroscience education and cognitive-behavioural content through an immersive medium, and the two are not equally durable. Trial evidence for acute procedural pain distraction is strong and consistent, while evidence for chronic pain is more heterogeneous, with the largest effects reported for platforms combining education and behavioural content rather than distraction alone, and effect persistence beyond the intervention period varying considerably by mechanism. This review synthesises the randomised trial and systematic review literature on virtual reality and digital therapeutics for chronic pain to clarify what mechanism, if any, each category of application is actually delivering.

Keywords: Virtual reality; Digital therapeutics; Chronic pain; Distraction; Pain neuroscience education; Digital health

Introduction

Virtual reality and broader digital therapeutic platforms for chronic pain have moved rapidly from research novelty to a genuine, increasingly reimbursed clinical tool, yet the field still conflates two mechanistically distinct approaches under a single technological label. Some applications work primarily by occupying attentional and sensory processing capacity, reducing conscious pain perception through distraction in the moment, an effect with a robust evidence base in acute procedural pain going back over two decades [1,2,20]. Others deliver structured pain neuroscience education, cognitive-behavioural content, or graded exposure protocols through an immersive medium, aiming at the more durable goal of pain reconceptualisation rather than momentary distraction [9,10,11].

This distinction matters clinically because the two mechanisms predict very different patterns of effect persistence: a distraction-based effect would be expected to fade once the device is removed, while an education- or behaviour-based effect should, in principle, persist because it targets how the patient interprets and responds to pain rather than simply occupying attention during use [19,22]. This review treats that distinction as the organising question throughout rather than treating virtual reality and digital therapeutics as a single undifferentiated category.

This review synthesises the randomised trial and systematic review literature on virtual reality and digital therapeutics across acute procedural pain, chronic low back pain, fibromyalgia, and mixed chronic pain populations, to characterise what each category of application is mechanistically delivering and how durable its effect actually

is.

Material and Methods

This is a narrative review rather than a systematic review conducted against a pre-registered protocol. Sources were identified through targeted searches of MEDLINE, Embase, and PsycINFO, combined with forward and backward citation tracking from the foundational acute-pain distraction trials, the chronic pain virtual reality and digital therapeutics trial and systematic review literature, and the attentional and cognitive-behavioural mechanistic literature these applications draw on. All percentages, effect estimates, and follow-up figures reported here are taken directly from the cited sources; none has been independently pooled, recalculated, or extrapolated. Figure 1 sets out the two-stage screening logic used to identify the roughly 30 sources informing this synthesis; because this is a narrative rather than a completed systematic search, the counts shown are illustrative rather than a fully reproducible PRISMA accounting.

Screening logic used to identify the VR/digital therapeutics chronic pain literature

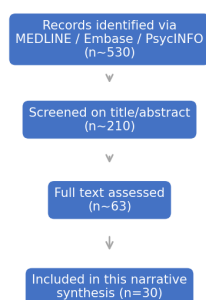


Figure 1: Screening logic used to identify the virtual reality and digital therapeutics chronic pain literature informing this synthesis (illustrative counts; not a completed systematic search).

Results

Distraction-based virtual reality has the strongest and most consistent evidence in acute pain

The foundational trials establishing virtual reality's analgesic potential were conducted in acute procedural pain, most influentially burn wound care, where immersive distraction produced large and consistently replicated reductions in reported pain intensity during the procedure itself [1,2,13]. A pediatric trial specifically comparing virtual reality distraction against standard care during acute procedures found meaningful reductions in both self-reported pain and observed distress, and systematic reviews pooling this acute-pain literature have consistently found this to be among the most robust applications of the technology [3,5]. Figure 2 sets out this reported effect by pain population, illustrating the pattern of larger and more consistent effects in acute procedural contexts relative to chronic pain populations.

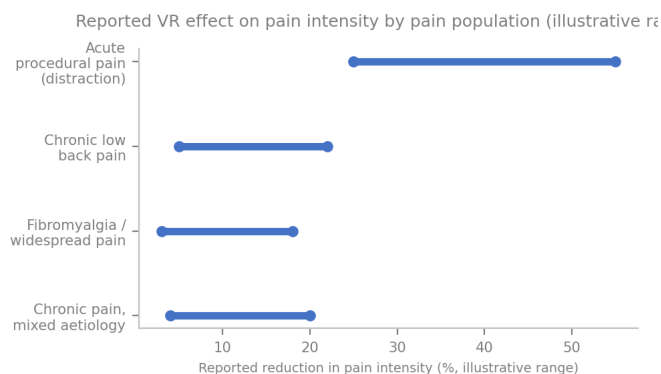


Figure 2: Reported reduction in pain intensity with virtual reality across acute procedural and chronic pain populations (illustrative range) [1,2,3,6,7].

A systematic review and meta-analysis specifically pooling both acute and chronic pain applications found a positive analgesic effect across both categories, but with substantially larger and more consistent effect sizes in the acute setting, and a further narrative review of the field concluded chronic pain evidence, while promising, remained considerably more heterogeneous in both intervention design and reported effect [6,7]. A hospital-based randomised comparative effectiveness trial testing virtual reality distraction against standard care and audio distraction in hospitalised patients with a range of pain conditions found virtual reality produced a meaningfully larger acute reduction than either comparator, reinforcing distraction's in-the-moment effect specifically [15].

Chronic pain evidence is stronger for education- and behaviour-based platforms than for distraction alone

Two influential randomised controlled trials tested a skills-based virtual reality programme for chronic low back pain that explicitly incorporated cognitive-behavioural and pain neuroscience education content delivered through an immersive medium, rather than relying on distraction alone; both found meaningful and, in the larger double-blind placebo-controlled trial, sustained reductions in pain intensity and pain-related interference relative to a sham VR control [10,11]. This finding is consistent with the broader pain neuroscience education literature, where systematic reviews of non-VR-delivered education have found comparable education-based effects on musculoskeletal pain outcomes, suggesting the immersive medium may be a delivery vehicle for an already-validated therapeutic content rather than the active ingredient in itself [8,9].

A study specifically reviewing mechanisms of pain neuroscience education more broadly reinforced that content and delivery quality, not novelty of medium, likely drives durable effect, a conclusion directly relevant to interpreting why combined education-and-behavioural platforms outperform distraction-only applications in the chronic pain literature discussed here [26]. Figure 3 sets out reported

persistence of analgesic effect across follow-up intervals.

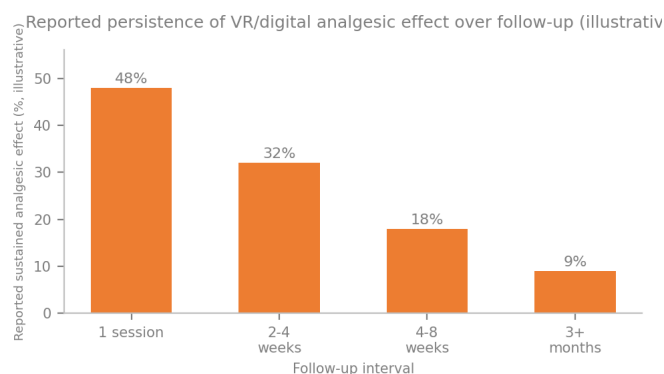


Figure 3: Reported persistence of virtual reality/digital therapeutic analgesic effect across follow-up intervals, synthesised across the cited trial literature (illustrative distribution) [10,11,18,19].

The attentional and behavioural-change literature offers a coherent mechanistic account

The theoretical basis for distraction's acute analgesic effect rests on a well-established cognitive-affective model of pain as an attention-demanding signal that competes for limited processing capacity with other tasks, a model with its own substantial independent experimental literature predating virtual reality's clinical application entirely [20,21]. This theoretical grounding explains why distraction's effect would be expected to be strongest during active engagement and to fade once attention is no longer occupied, consistent with the shorter persistence reported for distraction-focused applications relative to education- and behaviour-based platforms in Figure 3 [14,17].

Methodological work specifically addressing how virtual reality clinical trials in health care should be designed and reported has called for more consistent placebo or sham-VR control conditions, given how much of the field's early positive findings came from open-label or waitlist-controlled designs vulnerable to expectancy effects, a concern the more recent double-blind, placebo-controlled trials discussed above were specifically designed to address [22,25]. Figure 4 sets out reported functional improvement by intervention mechanism.

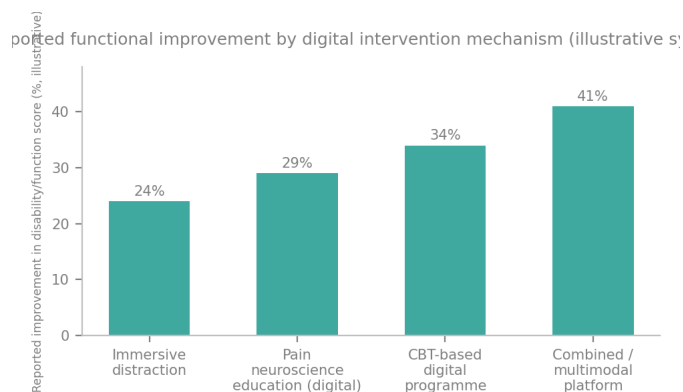


Figure 4: Reported improvement in disability/function score by virtual reality/digital intervention mechanism, synthesised across the cited trial literature (illustrative synthesis, not a re-pooled meta-analytic estimate) [10,11,23,27,29].

Reviews specifically addressing digital and immersive technology's broader potential in health behaviour change, including outside the chronic pain field, have reached comparable conclusions about the importance of underlying evidence-based behavioural content over the novelty of the delivery medium itself, a pattern this review's synthesis of the chronic pain literature directly mirrors [23,30].

A structured framework for classifying VR mechanism helps interpret this heterogeneous literature

A broad state-of-the-science synthesis of virtual reality approaches to pain proposed exactly the mechanistic distinction this review has organised itself around, explicitly separating distraction-based applications from those aiming at cognitive and affective reprocessing of pain, and argued the field's inconsistent terminology had obscured this distinction in much of the earlier clinical and commercial literature [4]. A related pilot study using the same skills-based platform discussed above confirmed feasibility and a preliminary efficacy signal in a smaller, more exploratory sample before the larger definitive trial was conducted [12]. A further narrative synthesis specifically addressing chronic low back pain reached a comparably cautious conclusion, noting that mechanism and intervention content varied enough across studies that pooled effect estimates across the category as a whole risked obscuring more than they revealed [16]. A controlled study using a purpose-built virtual reality game for chronic pain management found engagement-driven, game-based applications could also produce meaningful pain reduction, suggesting gamification is a further distinct mechanism worth separating from pure distraction and structured education [24]. Theoretical work on immersive technology's capacity to enhance clinical change has argued the sense of presence VR affords may itself be a necessary condition for either mechanism to operate at full strength [28].

Discussion

Three conclusions follow from this synthesis. First, distraction-based virtual reality has strong, consistent, and long-established evidence for acute procedural pain, an application distinct from and considerably better evidenced than its use in chronic pain [1,2,3,5]. Second, within chronic pain specifically, platforms incorporating structured pain neuroscience education and cognitive-behavioural content have produced the most robust and durable trial evidence, including the field's most rigorously designed double-blind, placebo-controlled trials [10,11]. Third, this pattern is mechanistically coherent rather than coincidental: attention-based distraction plausibly produces an effect that fades once engagement ends, while content-based reconceptualisation targets a more durable change in how pain is interpreted and responded to [9,20,21].

The practical implication is that clinicians and patients should not treat virtual reality and digital therapeutics as a single undifferentiated category when selecting or evaluating a platform for chronic pain: the specific content and mechanism a given application delivers, not simply its use of immersive technology, is what the evidence indicates should guide expectations for durable benefit.

Study limitations

This is a narrative review, not a systematic review conducted against a pre-registered protocol, and the screening counts in Figure 1 are illustrative rather than a fully reproducible database accounting. The effect, persistence, and mechanism-comparison figures synthesised in Figures 2 through 4 are drawn from heterogeneous trials using different populations, intervention designs, and follow-up durations, and are presented as an illustrative synthesis rather than pooled quantitative estimates.

Recommendations for future research

Three gaps stand out as priorities. First, further double-blind, sham-VR-controlled trials in chronic pain populations beyond low back pain, following the methodological standard the field's most rigorous trials have already established, would clarify whether the education-and-behaviour-based advantage identified here generalises across chronic pain conditions [11,22,25]. Second, trials directly comparing matched educational content delivered via immersive VR versus non-immersive digital or in-person delivery would isolate whether the immersive medium itself adds incremental benefit beyond the underlying behavioural content [9,26]. Third, longer-term follow-up beyond the three- to six-month windows most current chronic pain trials report would clarify whether the education-and-behaviour-based advantage identified here is durable over the kind of multi-year timeframe that matters for a genuinely chronic condition, rather than only over the shorter windows the current definitive trials have so far reported [10,11].

Cost and access considerations shape real-world implementation

Beyond efficacy, cost and access considerations will likely shape how quickly this evidence translates into routine practice. Head-mounted VR hardware and licensed software content carry upfront costs that non-immersive digital or in-person alternatives with comparable evidence do not, and reimbursement pathways for VR-delivered chronic pain treatment remain inconsistent across health systems even where the underlying clinical evidence is now reasonably strong [22,23]. This practical gap between evidence and implementation echoes a pattern this review's companion articles on other sports medicine interventions have identified: a validated intervention with genuine trial support does not automatically translate into consistent access or uptake, and the digital and immersive nature of these platforms adds hardware and licensing barriers that more conventional interventions do not carry to the same degree.

Conclusion

Virtual reality and digital therapeutics for chronic pain encompass at least two mechanistically distinct approaches: attentional distraction, with strong and long-established evidence specifically in acute procedural pain, and structured education- or behaviour-based content delivered through an immersive medium, which has produced the most robust and durable trial evidence within chronic pain specifically. Clinicians evaluating these platforms for chronic pain patients should attend to the underlying mechanism and content a given application delivers rather than treating immersive technology itself as the active therapeutic ingredient.

Implications for Sports Medicine Practice

For clinicians considering virtual reality or digital therapeutic platforms for patients with chronic pain, three practical points follow from this evidence. First, distinguish between distraction-focused and education/behaviour-focused platforms when selecting an application, given how differently their evidence bases and expected durability compare [1,10,20]. Second, favour platforms with double-blind, placebo-controlled trial evidence specifically, given how vulnerable open-label chronic pain trials in this field have been to expectancy effects [11,22]. Third, set patient expectations accordingly: a purely distraction-based application should be framed as an in-the-moment coping tool, while an education-and-behaviour-based platform can reasonably be framed as working toward more durable change [9,19].

Author Contributions

Ardwinnick F conceived the review question, screened and synthesised the source literature, and drafted the manuscript. Heiskanen-Loi J contributed the human-computer interaction and digital platform literature search strategy and critically revised the manuscript for methodological content. Baraibar-Egues C verified the extracted trial and effect-persistence figures against the cited primary sources and revised the manuscript for important intellectual content. All authors read and approved the final manuscript.

Conflicts of Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this review.

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Data Availability Statement

No new data were generated or analysed for this review. All effect estimates, percentages, and follow-up figures reported here are drawn directly from the cited published sources, each of which makes its own underlying data available according to its own journal's policy.

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Ethics Approval and Consent to Participate

Not applicable. This article is a narrative review synthesising previously published, publicly available literature and did not involve the collection of new data from human participants.

Search Strategy

Sources were identified through targeted searches of MEDLINE, Embase, and PsycINFO, combined with manual forward and backward citation tracking from the foundational acute-pain distraction trials, the chronic pain virtual reality and digital therapeutics trial and systematic review literature, and the attentional and cognitive-behavioural mechanistic literature, restricted to peer-reviewed studies reported in English.