Integrating Extended Reality Into Primary Care Chronic Pain Programs: A Real-World Feasibility Study of the REDOCVR Intervention

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Abstract

Background: Chronic pain management in public health services often struggles with limited engagement, emotional burden and long-term medication use. While extended reality (XR) has shown promise in specialized settings, evidence supporting its real-world implementation in routine primary care remains limited.

Objective: This paper aims to assess the feasibility and usability of REDOCVR, an XR-supported psychoeducational program, and to examine exploratory clinical outcomes during its integration into group-based chronic pain services in public primary care centers (PCCs).

Methods: A nonrandomized, hybrid type 2 implementation-effectiveness study was conducted across three PCCs in Catalonia, Spain. Adults with chronic pain (n=42) participated in 8 weekly group sessions led by psychologists and physiotherapists. The intervention embedded 15–20 minutes of co-designed immersive virtual reality (VR) and augmented reality (AR) content per session, targeting mindfulness, cognitive reframing, and motor activation. A supervised medication tapering protocol was included in later groups. Primary outcomes were implementation measures (adherence, tolerability, System Usability Scale [SUS], satisfaction). Secondary outcomes included patient-reported clinical measures (Warwick-Edinburgh Mental Well-being Scale [WEMWBS], Hospital Anxiety and Depression Scale [HADS], Central Sensitization Inventory [CSI], EQ-5D-5L) and medication changes, assessed at baseline, post-intervention, and 5-month follow-up.

Results: A total of 42 participants were enrolled, with 36 (85.7%) completing the intervention and all assessments. Adherence was high, and no serious adverse events were reported. Patient-reported usability was strong (mean SUS score 81.4), while professional usability was moderate (mean SUS score 73.8). Significant improvements were observed in emotional well-being (WEMWBS; Cohen's d = 0.86), anxiety (HADS-A; d = 0.66), and depression (HADS-D; d = 0.62) (all $p < 0.001$). Among participants in the tapering protocol (n = 22), mean medication use at 5 months decreased for benzodiazepines (–71.7%) and opioids (–41.8%).

Conclusions: Integrating XR into established primary care group programs for chronic pain proved feasible and safe, and was acceptable to both patients and professionals. The intervention was associated with statistically significant improvements in emotional well-being and in symptoms of anxiety and depression, as well as reductions in the use of high-risk medications under a supervised tapering protocol. These exploratory findings highlight the potential of XR to strengthen routine nonpharmacological pain care and support progression to larger controlled trials to evaluate scalability and long-term effectiveness. Clinical Trial: ClinicalTrials.gov NCT06361706; http://clinicaltrials.gov/ct2/show/NCT06361706 and NCT06964360; http://clinicaltrials.gov/ct2/show/NCT06964360

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TITLE

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INTRODUCTION

Chronic pain is common and disabling, with a recent systematic review estimating point prevalence across European adults at roughly 21%, though individual studies range from 12% to 48% depending on criteria used [1]. In Spain, nationwide surveys report similar levels, with around one in four adults affected [2]. Beyond prevalence, chronic pain is consistently linked with functional impairment, lower quality of life, and high healthcare use [1]. At a societal level, productivity losses from sick leave and early retirement have been estimated to consume up to 4% of GDP in some countries [3].

Primary care is where clinicians first diagnose, treat, and follow most people with chronic pain over time [4,5], with management heavily based on pharmacological treatment. In this setting, providers frequently prescribe opioids, nonsteroidal anti-inflammatory drugs (NSAIDs), antidepressants, anticonvulsants, and benzodiazepines despite limited long-term benefit and safety concerns, particularly with opioid–benzodiazepine combinations [6,7]. Multidisciplinary group programs that combine physical, psychological, and self-management strategies may provide a safer and more comprehensive approach with effectiveness supported by evidence [8]. Yet their accessibility remains inconsistent, constrained by structural and organisational barriers [9].

Extended reality (XR), including virtual reality (VR) and augmented reality (AR), is being explored as an addition to non-pharmacological pain strategies. Early trials in specialist centres suggest it may help reduce pain intensity, support emotional regulation, and improve engagement [10,11,12]. A recent randomized trial reported that VR-based therapy improved clinical outcomes as well as brain imaging markers in chronic back pain [13]. Most of this evidence, however, comes

from tightly controlled contexts rather than everyday practice, underscoring the need for feasibility and implementation studies in primary care and community settings [14,15].

We developed REDOCVR in 2023 within a public primary care network in Catalonia, Spain, where multidisciplinary group programs for chronic pain were already established and delivered by psychologists and physiotherapists in line with the regional pathway [16]. Instead of developing a separate intervention or testing XR in a laboratory, we have included it into existing sessions, keeping the same structure, timing, and professional roles. Clinicians and patients co-designed content, bringing together VR and AR experiences for guided mindfulness, psychoeducation, distraction, and interactive motor exercises.

This paper describes the feasibility and real-world implementation of REDOCVR in primary care. By doing so, it directly addresses recent calls for research on how XR interventions can be integrated beyond specialist centres and sustained in routine clinical practice [14,15].

METHODS

Design and Setting

We conducted a hybrid type 2, nonrandomised, phased implementation study conducted in public primary care centers (PCC). The rollout was structured in three phases; this paper reports on Phases 1 and 2, which examined feasibility and optimisation, while Phase 3 is ongoing and will be reported separately.

Co-Design and Development

Phase 1: Co-design and single-site feasibility (Sept 2023–Mar 2024).

The first phase combined the participatory development process with a pilot group at PCC Apenins-Montigalà. Between September 2023 and February 2024, a core team of psychologist, physiotherapist, family physicians, a medical XR developer, technical partners, and patient representatives worked together to define content, delivery conditions, and safety procedures.

Professionals and patients co-created the content to reflect the priorities of primary care: mindfulness and attentional focus, cognitive reframing and self-compassion, distraction for symptom regulation, and exercises to encourage safe, motivating movement. VR modules included two 360° videos (“Making peace with the pain” on natural beaches and a mindful dive in the Barcelona Aquarium) and Unity-based 3D environments illustrating mindfulness and psychoeducational concepts. Some of the immersive mindfulness modules had been developed previously in Projecte Benestar [17]. The body scan and mindful breathing sessions were incorporated unchanged, while the self-compassion module was specifically adapted for the context of chronic pain. These were brief, non-interactive, and activated by simple hand-tracking poke of a button. Together with the AR motor exercises developed in-house, these immersive components are illustrated in Figure 1.

AR motor exercises were developed in-house as short interactive tasks in passthrough mode with hand tracking, including target interaction, interception tasks requiring postural control and motor puzzles (Figure 1).

[Fig.1 here]

Figure 1. Immersive content developed and implemented in REDOCVR Phase 1: Panels a–f illustrate the REDOCVR augmented reality (AR) application created for guided physiotherapy sessions, designed to encourage safe movement and reduce kinesiophobia. Tasks were implemented in passthrough mode with hand tracking: (a) basic target interaction, (b) activation of the user interface menu by facing the left palm toward the user, (c) manipulation of 3D objects to promote reaching and coordination, (d) mosquito interception game to train postural control and attentional focus, (e) spatial reasoning puzzle based on Tetris blocks, and (f) visual memory puzzle with image fragments. Panels g–i show Unity-based virtual reality (VR) environments from the Projecte Benestar program, integrated into group psychology sessions to support non-pharmacological pain management: (g) body scan practice in a nature-inspired environment, (h) guided mindful breathing exercise at a virtual beach, and (i) psychoeducational module introducing the RAIN framework for emotion regulation.

All immersive content was available offline, preloaded on the headsets. Applications did not collect or transmit data. The only element requiring local Wi-Fi was the optional tablet app (Reality Telling) for synchronising playback of 360° videos.

The pilot group (February-March 2024), co-led by a psychologist and a physiotherapist, completed eight 90-minute weekly sessions. In every session, 15–20 minutes were allocated to immersive content, chosen according to therapeutic goals. Feasibility work at this stage focused on usability, acceptability, satisfaction, and iterative refinements of both content and technical procedures. XR was initially integrated into all weekly sessions in Phases 1 and 2; later adjustments are reported in the Discussion.

Phase 2: Multi-site optimisation (Apr–Dec 2024).

The program expanded to two additional PCCs while continuing at Apenins-Montigalà, delivering a total of seven groups (three at the original centre, two at each new site). From the second group onward in each centre, a supervised medication tapering protocol was introduced by family physicians, with scheduled reviews aligned to study timepoints.

Phase 3: Scale-up (2025, ongoing).

The program is currently extending to additional PCCs within BSA and to external institutions in the Catalan primary care system. This phase emphasises readiness assessment, training of new professional teams, and preparation for replication beyond the initial network. Results from this phase will be reported separately.

Participants

Adults with chronic pain lasting at least three months were recruited from ongoing chronic pain groups at participating PCCs. Inclusion criteria required signs of central sensitization, pain-related emotional distress, kinesiophobia, and limited response to prescribed treatments. Exclusion criteria were severe psychiatric or cognitive disorders, epilepsy, major neurological or sensory impairments, contraindications to physical activity, or inability to attend group sessions.

Recruitment was coordinated by the physiotherapist and psychologist leading the groups at each centre. Patients invited to join the chronic pain groups were informed that the program now included the option of using XR as part of our research study. They could choose to participate with or without the immersive component, and were free to continue in the group even if they later decided to withdraw from the study. At a dedicated evaluation visit, eligibility was confirmed, and written informed consent was obtained together with baseline data. All patients who were invited chose to participate.

As the intervention was embedded in standard care, no randomization or blinding was applied. No formal sample size calculation was conducted, as these phases focused on feasibility and on providing estimates for future controlled trials.

Intervention Description

The intervention was delivered by psychologists, physiotherapists, and family physicians working in primary care, all of whom routinely lead group-based pain management programs. They received prior training and continuous technical support from the institutional innovation team, who had specific expertise in implementing XR in clinical care and co-designed the intervention content.

Immersive dose and delivery conditions

Immersive content was applied for 15–20 minutes per session, with duration adjusted to the therapeutic focus and participants' tolerance. All modules were delivered under direct facilitator supervision. Headsets (Meta Quest 2 and 3) were preloaded with the required content, sanitized between uses, and configured individually. Quest 3 devices were prioritized for AR sessions when available, given their higher passthrough quality.

To support acclimatisation among first-time users, immersive elements were introduced in a stepwise sequence. Early sessions began with a passive, audio-guided VR body scan, after which participants progressed to psychoeducational and mindfulness modules, and later to motor exercises and interactive tasks. This gradual progression reflected strategies already tested in other XR initiatives within our institution, where it proved effective in improving tolerability and reducing cybersickness [18].

Final intervention components

The co-design process resulted in two integrated components that became the stable structure of REDOCVR sessions (see figure 2):

1- Psychology-focused sessions used VR modules to support psychoeducation, mindfulness and emotional regulation. Depending on the session, participants worked with either the 360° videos

or the Unity-based VR environments illustrating psychoeducational and cognitive reframing concepts. Together, these modules provided complementary approaches to emotional regulation, designed to be accessible to first-time XR users and flexible across sessions.

2- Physiotherapy-focused sessions integrated XR tools to encourage physical activation and body awareness. The REDOCVR AR app projected virtual objects into the physical space using passthrough and hand tracking, with tasks chosen by the physiotherapist according to functional goals: target interactions (touching floating objects), intercept exercises (reacting to moving stimuli, two difficulty levels), and motor puzzles (shape-matching tasks). To provide a structured comparison, some sessions also used VR movement games from Immersive Oasis (a Spanish XR start-up). These games, operated with headset controllers rather than hand tracking, supported motivation and functional movement while enabling evaluation of engagement and tolerability across different formats (AR vs VR, hand tracking vs controllers).

[Fig. 2 here]

Figure 2. Figure 2. Implementation of immersive content in REDOCVR sessions. The left column illustrates psychology-led sessions using the 360° virtual reality (VR) videos to support mindfulness and emotional awareness. A supervising tablet (top) allowed facilitators to monitor the video being displayed in the headsets, while group sessions (middle and bottom) were conducted with live guidance. The right column illustrates physiotherapy-led sessions. The top panel shows VR-based physical activity using controllers. The middle panel displays the augmented reality (AR) interface of the REDOCVR application with a gamified motor task from the participant’s perspective. The bottom panel depicts AR exercises using hand tracking during group movement practice. All sessions were supervised to ensure patient comfort and safety.

Outcome Measures

No explicit prespecified thresholds for feasibility or clinical outcomes were defined for this

project since the primary aim was to assess usability, tolerability, and feasibility of implementation under routine primary care conditions. Results were interpreted descriptively to guide adjustments in program delivery and inform the design of subsequent implementation phases, rather than against predefined stop–go criteria.

Implementation outcomes

Usability was assessed with two adaptations of the System Usability Scale (SUS), a validated instrument widely used in digital health research [19,20]. The patient version was reduced to 8 items, while the professional version retained the original 10 items with wording adapted to clinical use. Both used 5-point Likert scales, with scores calculated following standard procedures and rescaled to a 0–100 range. This approach aligns with recommendations supporting usability tool adaptation for both patients and professionals in real-world VR implementations [21].

Satisfaction and engagement were evaluated with a 10-item questionnaire developed for this study, covering perceived usefulness, ease of use, content quality, emotional impact, and physical comfort, scored on a 5-point Likert scale with responses similarly rescaled to a 0–100 scale.

Headset tolerability and safety were assessed with an 8-item questionnaire using 5-point Likert scales, covering comfort, fatigue, visual discomfort, dizziness, headache, and session interruption. Responses were analysed descriptively at the item level rather than as a total score. Open-ended feedback from patients and professionals was collected through written comments and field notes. Adherence was defined as attendance at all scheduled sessions and completion of pre/post assessments. Most sessions were observed in person by the main investigator, with telephone debriefs when this was not possible. XR use and safety were monitored on a session-by-session basis, but without a structured or protocolized register; feedback was noted informally.

Clinical outcomes

Emotional well-being was measured with the 14-item Warwick–Edinburgh Mental Well-

being Scale (WEMWBS), validated in Spanish samples with strong internal consistency (α = 0.90–0.93) [22,23].

Anxiety and depressive symptoms were assessed using the Hospital Anxiety and Depression Scale (HADS), Spanish version, which demonstrates strong internal consistency (α = 0.84 for anxiety, α = 0.85 for depression) and robust construct validity [24,25].

Pain-related symptoms were evaluated with the Central Sensitisation Inventory (CSI), scored 0–100, with scores ≥40 indicating clinically relevant sensitisation. The Spanish version shows solid psychometric properties in clinical populations [26,27].

Health-related quality of life was measured with the 5-level EuroQol (EQ-5D-5L), using Spanish population norms to derive utility indices [28,29].

Medication use was reviewed in scheduled visits with family physicians, who checked electronic prescriptions together with patients and confirmed actual doses and any additional drugs not recorded. This measure was applied only in groups that included the deprescribing component.

Data Management

We conducted assessments at baseline (month 0), post-intervention (month 2), and follow-up (month 5). Implementation outcomes were assessed at program completion, clinical outcomes at baseline and completion, and medication use at all three timepoints in groups where tapering was implemented. Questionnaires were administered on paper by the program facilitators, pseudonymised with unique alphanumeric codes, and transcribed into electronic spreadsheets. Data were stored on encrypted institutional servers with restricted access and regular backups, in compliance with Spanish data protection laws (LOPDGDD 3/2018) and the European GDPR (EU 2016/679).

Statistical Analysis

Descriptive statistics were used to summarize sociodemographic data, clinical characteristics, and questionnaire responses. Continuous outcomes are presented as means with standard deviations or medians with interquartile ranges, according to distribution. Internal consistency was assessed for the adapted SUS questionnaires. Exploratory pre–post comparisons of clinical outcomes were conducted with paired-sample tests. Reporting followed the CONSORT extension for pilot and feasibility trials (Multimedia Appendix 1), the TIDieR checklist for intervention description (Multimedia Appendix 2), RATE-XR for immersive technology research (Multimedia Appendix 3), and iCHECK-DH for digital health implementation (Multimedia Appendix 4).

Ethics and regulatory considerations

Ethical approval was obtained from the IDIAPJGol Research Ethics Committee for both study protocols (refs. 24/047-P and 24/211-ACps), which are registered at ClinicalTrials.gov (NCT06361706 and NCT06964360). The REDOCVR XR content was implemented only as a non-therapeutic support within a group psychoeducational program. After review by the Spanish Agency of Medicines and Medical Devices (AEMPS), it was formally classified as non–medical device software, and no regulatory authorization was required.

RESULTS

Sample characteristics and adherence

A total of 42 participants were enrolled across seven intervention groups at three PC centres during 2024. Of these, 36 participants (85.7%) completed the full intervention and both pre- and post-assessments. Analyses of clinical outcomes were based on this final sample (n = 36), with a mean age of 57.7 years (SD = 9.36; range 40–79) and a predominance of women (97.2%, n = 35). Adherence was high, with the six dropouts attributed to patients' logistical or scheduling conflicts rather than study-related issues. Figure 3 illustrates a CONSORT-style participant flow diagram, while Table 1 details group composition across phases, from initial optimisation to the later inclusion of supervised medication tapering.

[Fig. 3 and Table 1 here]

Figure 3. Flow of participants through the REDOCVR intervention groups. CONSORT-style diagram illustrating enrollment, dropout, and analysis for the seven nonrandomized groups implemented in 2024. A total of 42 participants were enrolled across three primary care centers, of whom 36 (85.7%) completed the full intervention and both pre- and post-assessments. Analyses of clinical outcomes were based on these 36 participants. Medication-related outcomes were analyzed separately in the subset of 22 participants who took part in groups that included supervised medication tapering.

Implementation outcomes

System usability

Patient-reported usability was high, with a mean SUS score of 81.4 ± 17.1. Most participants (83%) scored above the standard benchmark of 68, indicating strong perceived usability. Item-level results, including English translations of the adapted questionnaire items, are provided in Table 2. Internal consistency of the adapted 8-item scale was acceptable (Cronbach's α = 0.70).

SUS scores from eight healthcare professionals (three psychologists, three physiotherapists, one family physician, and one biomedical technician) averaged 73.8 ± 11.2 (range 59.4–93.8), above the standard benchmark of 68. Item-level ratings showed a mixed picture, with ease of use and confidence scoring consistently high, while system integration and need for support were rated lower. Internal consistency was low (Cronbach's α = 0.28), which seems more related to the small and heterogeneous sample than to flaws in the scale itself.

Satisfaction

Overall satisfaction was high, with a mean score of 82.4 ± 11.7. The highest ratings were for support and guidance received (92.4), overall experience (88.9), and visual quality (88.2). Lower, though still positive, scores were reported for intention to continue use (72.9), session duration (75.0), and concentration and pain management (73.6). Item-level results with English translations are presented in Table 2.

[Table 2 here]

Tolerability and safety

Headset tolerability was generally high, with most participants disagreeing with statements indicating discomfort or adverse effects (Table 3). Dizziness (5.6%) and headache (5.6%) were rarely reported as frequent problems, and only one participant (2.8%) stopped a session due to discomfort. Fatigue in arms or hands was more common (33.3% agreement), likely reflecting the physical effort of interactive tasks rather than adverse effects. About half of participants (50.0%) rated the headset as comfortable for prolonged use. Overall, these findings suggest good tolerability with only occasional transient discomfort. Supervision confirmed correct use of XR without major incidents, and the open-ended feedback gathered during these sessions is described in the following section.

[Table 3 here]

Qualitative and comparative feedback

Patient feedback (see Multimedia Appendix 5 for thematic analysis) underscored both therapeutic and practical aspects of the program. The 360° mindfulness videos and the self-compassion module were consistently described as the most meaningful. Many participants noted that the immersive format of body scan and breathing practices made these techniques easier to follow, while psychologists emphasized in their debriefings that these elements were particularly useful for consolidating skills introduced in other sessions. A few participants reported brief emotional discomfort during emotion-focused modules; these reactions were anticipated as part of the process, addressed by clinicians, and did not disrupt participation.

Patients also drew clear contrasts between modalities. AR exercises were described as intuitive and less tiring, with passthrough providing orientation that supported group flow. VR was seen as more immersive and distracting, though some participants reported temporary dizziness, fatigue, or visual strain after longer interactions. Across groups, patients consistently preferred hand-tracking over controllers, citing its natural interaction and shorter setup time.

Professionals echoed some of these observations and noted additional logistical challenges. VR sessions required extra time to configure safety areas and adjust headsets individually. One physiotherapist described difficulty leading a group of eight patients alone, as sequential headset setup left participants waiting; these issues were less frequent when two or three professionals co-led with technical support. Setting up the connection for tablet-controlled synchronization of 360° videos was also seen as an added burden, further highlighting the need for streamlined logistics.

Across groups, patients suggested extending the program, increasing session frequency, and considering access to VR content outside the clinical setting.

Clinical outcomes

Descriptive statistics

Table 4 presents pre–post values for clinical outcomes (n = 36). Emotional well-being (WEMWBS) increased from 16.9 (SD 4.9) to 21.7 (SD 6.1). Anxiety symptoms (HADS-Anxiety) decreased from 13.1 (SD 4.3) to 10.7 (SD 4.3), and depressive symptoms (HADS-Depression) from 10.6 (SD 3.4) to 9.0 (SD 4.2). Pain sensitisation (CSI) declined slightly, from 60.7 (SD 14.2) to 57.5 (SD 13.4).

For quality of life (EQ-5D-5L), mean scores suggested small reductions in Pain/Discomfort (3.7 → 3.4) and Anxiety/Depression (3.3 → 3.1), while other domains were largely stable. Median values reflected less change, remaining constant for Mobility (2.0), Pain/Discomfort (4.0), and Anxiety/Depression (3.0), with small shifts for Self-Care (2.0 → 1.0) and Usual Activities (2.5 → 3.0).

Pre–post differences

Paired-sample t-tests indicated significant improvements in emotional well-being (mean difference 4.83, 95% CI 2.92–6.74, $p < .001$, large effect), anxiety (2.47, 95% CI 1.20–3.75, $p < .001$, moderate effect), and depression (1.64, 95% CI 0.75–2.53, $p < .001$, moderate effect). CSI reduction was small and non-significant (mean difference 3.22, $p = .107$). Wilcoxon signed-rank tests showed a significant improvement in Mobility ($p = .018$, moderate effect) and a non-significant trend toward improvement in Pain/Discomfort ($p = .084$). Self-Care, Usual Activities, and Anxiety/Depression showed no significant changes. Full statistics are provided in Table 4.

[Table 4 here]

Medication tapering

Among the 22 participants who followed the deprescription protocol, medication use declined

across several categories (Table 5). Between baseline and the five-month review, the largest mean reductions were in benzodiazepines (71.7%, six complete discontinuations), opioids (41.8%, five discontinuations), and muscle relaxants (48.0%). More modest decreases were seen for NSAIDs and non-opioid analgesics. Patterns for antidepressants and pain modulators were mixed, with some patients starting new treatments during follow-up.

[Table 5 here]

Discussion

Principal Findings

This study examined the early implementation of REDOCVR, an XR-enhanced group program for chronic pain in primary care. High patient engagement, strong adherence, and the absence of serious adverse events suggest that immersive technologies can be integrated into existing care structures without disturbing routine.

Usability and acceptability indicators provide additional insight into how the program was received. Patients rated the sessions positively, reporting high satisfaction and minimal discomfort. Cybersickness was rare and headset tolerance was generally good, which supports the tolerability of XR in this population. Professional SUS scores displayed low internal consistency, which likely reflects the small number of respondents and heterogeneous perceptions rather than limitations of the scale itself. While ease of use and confidence were rated highly, items concerning integration and support needs scored lower. This pattern was consistent with the open feedback describing setup burden and workflow challenges, pointing to areas where additional support will be essential for broader implementation.

Feedback suggests that XR acted less as a novel intervention in itself and more as a facilitator, enhancing engagement with the program’s therapeutic content. In psychology-led sessions, immersive tools supported mindfulness and self-compassion practices that some patients

otherwise found difficult to understand. In physiotherapy-led sessions, AR helped participants perform movements in a safe and supervised way, while VR increased immersion and motivation, sometimes encouraging patients to attempt physical activities they would normally avoid.

Exploratory clinical findings suggested improvements in emotional well-being, anxiety, and depression, with effect sizes in the moderate-to-large range. Mobility on the EQ-5D-5L improved significantly, while pain/discomfort showed only a non-significant positive trend. Among participants enrolled in the deprescription protocol, benzodiazepine, opioid, and NSAID intake decreased, and several participants achieved complete discontinuation. Although causality cannot be inferred, these results indicate that group-based interventions may complement structured deprescription strategies.

Comparison With Prior Work

While our findings on patient usability and clinical outcomes align with the existing literature [10,30], the primary contribution of this study is its focus on pragmatic implementation within a real-world primary care setting. We have encountered barriers in early adoption similar to other reports related to technical setup and workflow adjustments [31]. By embedding XR within an established group program rather than running it in parallel, REDOCVR addresses adoption challenges noted in recent reviews [14,15, 32] and shows how immersive tools can fit into everyday service delivery.

The improvements in emotional well-being and functional outcomes align with the psychoeducational and behavioral mechanisms targeted, consistent with results from mindfulness- and acceptance-based approaches [8,13]. The reduction in medication use also mirrors outcomes from other multidisciplinary primary care interventions that combine patient education with supervised tapering [5]. What our findings add is evidence that these effects can be achieved when immersive tools are embedded into routine group care, rather than tested only in parallel or experimental conditions.

Limitations

The intervention was delivered to a modest number of groups within a supportive institutional setting, which may limit direct transferability to other contexts. Resources such as trained staff, headset availability, and organizational readiness facilitated implementation and should be considered when adapting the model elsewhere. Data collection on implementation fidelity was pragmatic. For instance, the dose of immersive exposure was guided by a time range (15–20 minutes) and adjusted for tolerance, but not strictly logged for each individual patient in every session. Adherence was assessed through attendance records, while adverse effects were monitored through informal therapist feedback and a single post-intervention questionnaire, rather than a structured, session-by-session register.

Other limitations are typical of early-phase implementation research and exploratory clinical outcomes should be interpreted with caution. The absence of randomisation and a control group limits causal inference. Generalisability is constrained by the modest and predominantly female sample, and the use of self-reported measures introduces potential recall and social desirability bias. Positive findings may have been partly influenced by a novelty effect. Finally, the five-month follow-up is insufficient to establish the durability of changes over time.

Implications and Future Directions

The limitations noted above warrant caution when interpreting exploratory outcomes, but they also provided direction for refinement. Integrating REDOCVR into existing group-based chronic pain programs reflects an institutional commitment to embedding immersive tools into conventional care rather than creating parallel services. This alignment with regional and national priorities strengthens sustainability and supports future scale-up within community health pathways.

The program was refined in collaboration with the full clinical team, leading to adjustments that improved feasibility. In line with Catalan health system recommendations, groups will now meet

for 12 weekly sessions of 2 hours, co-led by a psychologist and a physiotherapist. Family physicians and nutritionists join selected sessions to extend the focus on healthy habits relevant to chronic pain.

Immersive content was gradually reorganized to balance practicality with clinical value. Sessions were concentrated into four key moments, two led by psychology focusing on mindfulness and self-compassion, and two by physiotherapy centered on motor activation. This structure will allow more efficient use of headsets and technical support without losing therapeutic depth. Augmented reality proved more suitable for larger groups, where supervision and interaction needed to be fluid, while virtual reality was reserved for smaller groups. Both patients and professionals clearly favored hand-tracking, and all VR content was adapted accordingly, eliminating the need for controllers. Synchronizing 360° videos from the tablet depended on a stable Wi-Fi connection, which was not always available in the centers. External routers were sometimes used to compensate, but this added time and complexity, so work is underway to ensure reliable connections in the PCCs, a step expected to streamline preparation and ease the workload of facilitators.

Future evaluation should focus on systematic data collection related to implementation fidelity. With XR use organized into specific modules, formally recording exposure and using session-by-session monitoring would allow more precise analyses of usability and adverse effects in VR compared with AR, or in passive educational versus interactive physical activities. By combining fidelity monitoring with pragmatic implementation, REDOCVR may help close the gap between immersive research and everyday chronic pain care.

CONCLUSIONS

The first two phases of REDOCVR suggest that a person-centered, co-designed XR program can be implemented in primary care chronic pain groups under real-world conditions. The intervention showed high adherence and favorable usability, and both patients and professionals valued its contribution to engagement and session delivery. Exploratory improvements in emotional

well-being and reductions in high-risk medication use during supervised tapering are promising but should be interpreted with caution given the feasibility design.

This study is, to our knowledge, the first to develop and evaluate an XR program entirely within primary care. The findings offer practical guidance for refining immersive interventions and preparing for wider scale-up. Ongoing phase 3 work across additional centres will further clarify long-term outcomes, scalability, and adaptability to different health system contexts.

Multimedia Appendix

- **Multimedia Appendix 1**: CONSORT-Pilot checklist
- **Multimedia Appendix 2**: TIDieR checklist
- **Multimedia Appendix 3**: RATE-XR checklist
- **Multimedia Appendix 4**: iCHECK-DH checklist
- **Multimedia Appendix 5:** Thematic analysis of patient feedback with illustrative quotes
- **Multimedia Appendix 6:** REDOCVR BSA overview 2025: project content sample and real-life use in primary care

Author Contributions

Conceptualization, J.F.C., A.F.B., C.T.C, and N.M.B.; methodology and validation, J.F.C., A.F.B., C.T.C. and N.M.B.; software and VR content development, J.F.C.; formal analysis, J.F.C.; investigation, J.F.C., A.F.B., C.T.C, M.R.B., P.S.B., E.V.L., and L.V.U.; resources, J.F.C.; data curation, J.F.C.; writing—original draft preparation, J.F.C.; writing—review and editing, all authors; visualization, J.F.C.; supervision, J.F.C.; project administration, J.F.C. All authors have read and agreed to the published version of the manuscript.

Conflicts of Interest

The authors declare no conflicts of interest.

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Abbreviations

AEMPS: Spanish Agency of Medicines and Medical Devices (Agencia Española de Medicamentos y Productos Sanitarios)
AR: augmented reality
CEIm: Research Ethics Committee (Comité de Ética de la Investigación con medicamentos)
CI: confidence interval
CSNS: Interterritorial Council of the Spanish National Health System (Consejo Interterritorial del Sistema Nacional de Salud)
CSI: Central Sensitization Inventory
EQ-5D-5L: EuroQol – 5 Dimensions – 5 Levels
GDPR: General Data Protection Regulation
HADS: Hospital Anxiety and Depression Scale
IDIAPJGol: Institut Universitari d'Investigació en Atenció Primària Jordi Gol
IQR: interquartile range
LOPDGDD: Ley Orgánica de Protección de Datos y Garantía de Derechos Digitales

NSAIDs: nonsteroidal anti-inflammatory drugs
PCC: primary care centre
REDOCVR: RE (Reeducació), DOC (Dolor Crònic), VR (Virtual Reality)
SD: standard deviation
SNS: Spanish National Health System (Sistema Nacional de Salud)
SUS: System Usability Scale
VR: virtual reality
WEMWBS: Warwick–Edinburgh Mental Well-being Scale

Data Availability

The anonymized datasets generated and analyzed during this study are available from the corresponding author upon reasonable request and subject to approval by the Ethics Committee.

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TABLES

Table 1. Distribution of REDOCVR intervention groups completed in 2024

PCC	Group	Phase	Implementation	Program Sessions	Included	Completed Post-evaluation	Medication Tapering
Apenins-Montigalà	Group 1	Phase 1	Base program optimization	Feb–Mar 2024	6	4	-
Apenins-Montigalà	Group 2	Phase 2	Introduction of medication tapering	May–Jun 2024	6	6	6
Apenins-Montigalà	Group 3	Phase 2	Fully optimized program	Sept–Oct 2024	6	5	5
Progrés-Raval	Group 1	Phase 2	Base program only	Apr–May 2024	6	5	-
Progrés-Raval	Group 2	Phase 2	Fully optimized program	Sept–Nov 2024	6	6	6
Morera-Pomar	Group 1	Phase 2	Base program only	Apr–Jun 2024	6	5	-
Morera-Pomar	Group 2	Phase 2	Fully optimized program	Sept–Nov 2024	6	5	5
				TOTAL	**42**	**36**	**22**

Table 1 legend: Groups delivered across three primary care centres (PCCs), indicating implementation phase, session completion, and inclusion of supervised medication tapering where applicable.
Abbreviations: PCC, Primary Care Centre.

Table 2. Usability and satisfaction outcomes: patient and professional System Usability Scale (SUS) and patient satisfaction questionnaire

(A) Patients SUS (n = 36) - TOTAL Mean ± SD	81.35 ± 17.1
Question (English translation)	**Mean ± SD**
I think I would like to use this program frequently.	90.28 ± 22.58
I think the program is unnecessarily complex.	75.69 ± 34.06
I think the exercises are more engaging with the VR headset than conventional methods.	82.64 ± 32.08

I think the simulation options are clear and well integrated.	93.75 ± 19.25
I think some options are difficult to follow.	75.69 ± 34.58
I think people will learn to use this system easily.	81.25 ± 29.5
I felt comfortable using this system.	89.58 ± 21.86
I had to learn many things before being able to use the system.	61.81 ± 40.31

(B) Professionals SUS (n = 8) - TOTAL Mean ± SD	**73.84 ± 11.21**
Question (English translation)	**Mean ± SD**
I believe this program will help improve the quality of patient care.	84.38 ± 12.94
I believe the program interface is intuitive for the user.	75 ± 18.9
I believe the program can be easily integrated into daily clinical practice.	53.13 ± 36.44
I believe the simulation’s features are clear and relevant to patient care.	81.25 ± 11.57
Some features of this system may be difficult for patients to understand or use.	28.13 ± 20.86
I believe patients will be able to learn to use this system easily.	68.75 ± 22.16
I felt comfortable using this system for patient care.	78.13 ± 20.86
You needed additional time to learn how to use this system correctly.	40.63 ± 32.56
I believe the weight and design of the headset may be uncomfortable for some patients.	56.25 ± 34.72
I believe using the headset and controllers could be difficult for some patients.	25 ± 18.9

(C) Patient satisfaction questionnaire (ad hoc) (n = 36) - TOTAL Mean ± SD	**82.43 ± 11.69**
Question (English translation)	**Mean ± SD**
Overall, how do you rate the VR experience during the chronic pain management sessions?	88.89 ± 13.94
What is your opinion on the usefulness of VR for pain reduction?	82.64 ± 15.61
Is the visual and image quality of the VR satisfactory for you?	88.19 ± 12.66
Is interaction with the VR during sessions easy to understand and use?	87.5 ± 17.42
How do you rate physical comfort while using VR?	80.56 ± 21.64
Has VR improved your concentration and ability to manage pain?	73.61 ± 21.5
What do you think about the variety of VR content available for your pain management sessions?	82.64 ± 18.73
How do you rate the support and guidance you received during the VR sessions?	92.36 ± 14.42
Is the duration of the VR sessions adequate for your goals?	75 ± 26.05
Do you intend to continue using VR in your pain management sessions?	72.92 ± 25.62

Table 2 legend:

(A) Patient System Usability Scale (SUS, adapted 8-item version; n = 36). Total and item-level mean scores are presented on a 0–100 scale.

(B) Professional SUS (standard 10-item version; n = 8). Total and item-level mean scores are presented on a 0–100 scale.

(C) Patient satisfaction questionnaire (ad hoc, n = 36). Items were rated on a 0–100 scale and are shown as mean ± SD. All questionnaire items were translated into English for reporting.

Table 3. Tolerability and safety of VR headsets (n = 36)

Question (English translation)	Strongly Disagree (%)	Disagree (%)	Neutral (%)	Agree (%)	Strongly Agree (%)
The headset was very heavy and uncomfortable	50	8.3	8.3	25	8.3
Using the headset and controls was very complicated	61.1	13.9	8.3	11.1	5.6
I felt fatigue in my arms and fingers	44.4	13.9	8.3	25	8.3
I felt visual discomfort	72.2	11.1	2.8	11.1	2.8
I felt dizzy	63.9	22.2	8.3	2.8	2.8
I experienced headache	77.8	8.3	8.3	2.8	2.8
I had to stop the simulation due to discomfort	83.3	8.3	5.6	0	2.8
I think it would be comfortable to use these glasses for a long time	8.3	13.9	27.8	22.2	27.8

Table 3 legend:

Responses are shown as the percentage of participants selecting each option on a 5-point Likert scale (strongly disagree to strongly agree) for each item. The questionnaire items were translated into English for reporting.

Table 4. Clinical outcomes: descriptive statistics and pre–post differences (n = 36)

(A) Descriptive statistics				
Variable	**Mean ± SD**	**Median (IQR)**	**Min**	**Max**
Emotional Wellbeing (Pre)	16.89 ± 4.92	16.5 (6.25)	8	26
Emotional Wellbeing (Post)	21.72 ± 6.14	23.0 (8.25)	7	34
HADS-Anxiety (Pre)	13.14 ± 4.28	13.5 (5.5)	4	20
HADS-Anxiety (Post)	10.67 ± 4.27	10.5 (7.25)	4	20
HADS-Depression (Pre)	10.61 ± 3.43	10.0 (5.0)	2	18
HADS-Depression (Post)	8.97 ± 4.23	9.0 (5.0)	1	21
CSI (Pre)	60.72 ± 14.18	60.0 (18.0)	34	95
CSI (Post)	57.50 ± 13.42	58.0 (15.25)	33	94
Variable	**Mean ± SD**	**Median (IQR)**	**Min**	**Max**
Mobility (Pre)	2.19 ± 0.92	2.00 (IQR=1.25)	1	4
Mobility (Post)	1.78 ± 0.83	2.00 (IQR=1)	1	4
Self-Care (Pre)	1.72 ± 0.66	2.00 (IQR=1)	1	3
Self-Care (Post)	1.58 ± 0.81	1.00 (IQR=1)	1	4
Usual Activities (Pre)	2.47 ± 1.00	2.50 (IQR=1)	1	5
Usual Activities (Post)	2.42 ± 1.20	3.00 (IQR=2)	1	5
Pain/Discomfort (Pre)	3.69 ± 0.75	4.00 (IQR=1)	2	5
Pain/Discomfort (Post)	3.44 ± 0.73	4.00 (IQR=1)	2	5
Anxiety/Depression (Pre)	3.31 ± 1.14	3.00 (IQR=1)	1	5

Anxiety/Depression (Post)	3.06 ± 1.33	3.00 (IQR=2)	1	5

(B) Paired-sample t-tests for normally distributed outcomes

Variable	Mean Diff (95% CI)	p-value	Cohen's d	Interpretation
Emotional Wellbeing	4.83 [6.74, 2.92]	< .001	0.86	Significant improvement (large effect).
HADS-Anxiety	2.47 [1.20, 3.75]	< .001	0.66	Moderate reduction in anxiety symptoms.
HADS-Depression	1.64 [0.75, 2.53]	< .001	0.62	Moderate reduction in depressive symptoms.
CSI	3.22 [–0.73, 7.18]	0.107	0.28	Small, non-significant improvement.

(C) Wilcoxon signed-rank test results for EQ-5D-5L dimensions

EuroQol (EQ-5D) Dimensions	p-value	95% CI	Effect Size (r)	Interpretation
Mobility	0.018	–1.0 / 0.0.	0.39	Significant improvement (moderate effect).
Self-care	0.337	-0.5 / 0.0	0.16	No significant change (small effect).
Usual Activities	0.772	-0.5 / 0.5	0.05	No change (very small effect).
Pain/Discomfort	0.084	-0.5 / 0.0	0.29	Trend toward improvement (moderate).
Anxiety/Depression	0.286	-0.5 / 0.0	0.18	No significant change (small effect).

Table 4 legend:

(A) Descriptive statistics for all outcomes. For each variable we report mean ± SD and median (IQR), together with minimum and maximum values. EQ-5D-5L dimensions and the EQ-5D total index are shown descriptively in the same format; inferential tests for EQ-5D were conducted at the dimension level (see panel C).

(B) Paired-sample t-tests for normally distributed outcomes (WEMWBS, HADS-Anxiety, HADS-Depression, CSI), reporting mean difference (95% CI), p-value, and Cohen's d (small ≈ 0.2, moderate ≈ 0.5, large ≥ 0.8).

(C) Wilcoxon signed-rank tests for EQ-5D-5L dimensions, reporting the Hodges–Lehmann median difference (95% CI), p-value, and effect size r (small ≈ 0.1, moderate ≈ 0.3, large ≥ 0.5).

Abbreviations: WEMWBS, Warwick–Edinburgh Mental Well-being Scale; HADS, Hospital Anxiety and Depression Scale; CSI, Central Sensitization Inventory; EQ-5D-5L, EuroQol 5-Dimension 5-Level questionnaire; SD, standard deviation; CI, confidence interval.

Table 5. Medication tapering by therapeutic category at 2 and 5 months post-intervention

Medication Type	Timepoint	Mean (%)	Median (%)	IQR (%)	Range (%)	N Complete Stops
NSAIDs	2 months	29.86	33	45.75	0 to 100	1
NSAIDs	5 months	25.14	16.5	50	–100 to 100	2
Non-opioid analgesics	2 months	28.31	12.5	37.25	0 to 100	2
Non-opioid analgesics	5 months	30	12.5	49	0 to 100	2
Antidepressants	2 months	1.61	0	0	–100 to 100	3
Antidepressants	5 months	8.29	0	0	–100 to 100	6
Benzodiazepines	2 months	45	25	100	0 to 100	4
Benzodiazepines	5 months	71.7	100	45.75	0 to 100	6
Pain Modulators	2 months	19.44	0	25	0 to 100	1
Pain Modulators	5 months	34.22	25	50	0 to 100	2
Opioids	2 months	40.13	33	60	–100 to 100	5
Opioids	5 months	41.8	43	93	–100 to 100	5
Muscle Relaxants	2 months	48	48	23	25 to 71	0
Muscle Relaxants	5 months	48	48	23	25 to 71	0
Others	2 months	25	25	0	25 to 25	0
Others	5 months	100	100	0	100 to 100	1

Table 5 Legend: Values represent percentage change in daily intake from baseline to each follow-up. Changes were calculated for each medication record and then aggregated by category. “N complete stops” indicates the number of participants who fully discontinued that medication. Negative values (eg, –100%) denote initiation of a medication not used at baseline. Data are reported as mean, median, interquartile range (IQR), and minimum–maximum percentage change for each category. “Others” refers to a single case of Versatis® (lidocaine medicated plaster).

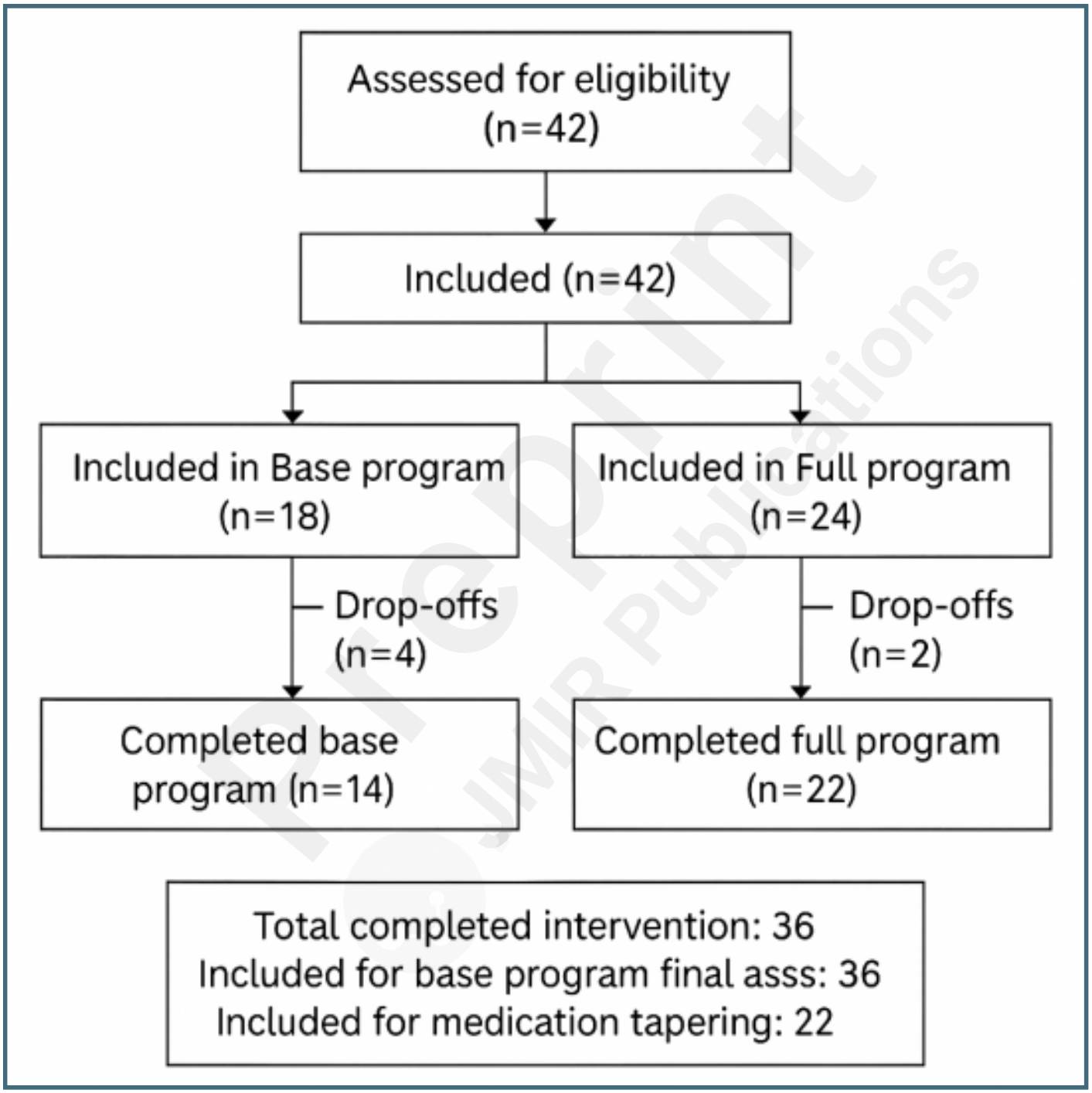
Supplementary Files

Figures

Immersive content developed and implemented in REDOCVR Phase 1: Panels a–f illustrate the REDOCVR augmented reality (AR) application created for guided physiotherapy sessions, designed to encourage safe movement and reduce kinesiophobia. Tasks were implemented in passthrough mode with hand tracking: (a) basic target interaction, (b) activation of the user interface menu by facing the left palm toward the user, (c) manipulation of 3D objects to promote reaching and coordination, (d) mosquito interception game to train postural control and attentional focus, (e) spatial reasoning puzzle based on Tetris blocks, and (f) visual memory puzzle with image fragments. Panels g–i show Unity-based virtual reality (VR) environments from the Projecte Benestar program, integrated into group psychology sessions to support non-pharmacological pain management: (g) body scan practice in a nature-inspired environment, (h) guided mindful breathing exercise at a virtual beach, and (i) psychoeducational module introducing the RAIN framework for emotion regulation.

Implementation of immersive content in REDOCVR sessions. The left column illustrates psychology-led sessions using the 360° virtual reality (VR) videos to support mindfulness and emotional awareness. A supervising tablet (top) allowed facilitators to monitor the video being displayed in the headsets, while group sessions (middle and bottom) were conducted with live guidance. The right column illustrates physiotherapy-led sessions. The top panel shows VR-based physical activity using controllers. The middle panel displays the augmented reality (AR) interface of the REDOCVR application with a gamified motor task from the participant's perspective. The bottom panel depicts AR exercises using hand tracking during group movement practice. All sessions were supervised to ensure patient comfort and safety.

Flow of participants through the REDOCVR intervention groups. CONSORT-style diagram illustrating enrollment, dropout, and analysis for the seven nonrandomized groups implemented in 2024. A total of 42 participants were enrolled across three primary care centers, of whom 36 (85.7%) completed the full intervention and both pre- and post-assessments. Analyses of clinical outcomes were based on these 36 participants. Medication-related outcomes were analyzed separately in the subset of 22 participants who took part in groups that included supervised medication tapering.



Multimedia Appendixes

CONSORT Checklist (Feasibility Extension).
URL: http://asset.jmir.pub/assets/459eafedeed92c890e67072e1910fe69.pdf

TIDieR Checklist.
URL: http://asset.jmir.pub/assets/2417923efa40e347ae27fc89c4ffd8cf.pdf

RATE-XR Checklist.
URL: http://asset.jmir.pub/assets/ecfd6a8a76157bf72db54542f5a21e0a.pdf

iCHECK-DH Checklist.
URL: http://asset.jmir.pub/assets/81f79cbd4c4e1fc7f025f28219e3cf3b.pdf

Thematic analysis of patient feedback with illustrative quotes.
URL: http://asset.jmir.pub/assets/560cd472173b5e108a033f7b2523cdab.pdf

REDOCVR BSA overview 2025: project content sample and real-life use in primary care.
URL: http://asset.jmir.pub/assets/38d645d5115c0213a4f7fdd087840851.mp4

TOC/Feature image for homepages

Patients in a primary care setting wearing VR headsets during a supervised group session, illustrating the integration of extended reality into routine pain management programs.