

Systematic Review

Virtual Reality for Pain and Anxiety Management During Medical Procedures: A Systematic Review with Complementary Bibliometric Analysis

Daniel Fernández Cerero ¹, Marta Montenegro Rueda ^{2,*}  and José Fernández Cerero ³ 

¹ Department of Stomatology, University of Sevilla, 41009 Sevilla, Spain; dfcerero@us.es

² Department of Didactics and School Organisation, University of Granada, 52005 Melilla, Spain

³ Department of Teaching and Educational Organization, University of Sevilla, 41013 Sevilla, Spain; jfcerero@us.es

* Correspondence: mmontenegro@ugr.es

Abstract

Virtual Reality (VR) has emerged as a non-pharmacological intervention for managing pain and anxiety during medical procedures. This study presents a systematic review with complementary bibliometric analysis of the scientific literature on the clinical effectiveness of VR in healthcare settings. A structured search was conducted across five databases (Web of Science (WoS), Scopus, PubMed, EMBASE, and MEDLINE), identifying 627 records, of which 26 studies met the inclusion criteria. Data were extracted on study design, population, type of intervention, and clinical outcomes related to pain and anxiety. Most included studies reported reductions in perceived pain and/or anxiety when VR was used as an adjunctive intervention, particularly in pediatric and procedural contexts. However, findings were heterogeneous in terms of study design, VR modalities, and outcome measures, limiting quantitative synthesis. The bibliometric analysis indicates growing research interest, with a strong focus on clinical outcomes, while evidence related to implementation and healthcare system integration remains limited. Overall, VR appears to be a promising complementary tool for improving patient experience during medical procedures. However, further high-quality studies with standardized methodologies are needed to establish its effectiveness and facilitate future meta-analyses.

Keywords: virtual reality; healthcare; pain; anxiety; patient experience; medical procedures

1. Introduction

Pain and anxiety remain common challenges in clinical practice, particularly during invasive or stressful medical procedures [1]. These responses can negatively affect patient wellbeing, treatment adherence, satisfaction, and even recovery outcomes. Consequently, there is increasing interest in non-pharmacological strategies that can complement conventional treatments and improve patient experience during medical interventions [2].

Among the strategies, Virtual Reality (VR) has emerged as a promising tool for managing pain and anxiety in procedural setting [3]. VR provides immersive and interactive environments capable of redirecting patients' attention away from nociceptive stimuli and reducing emotional distress. Its clinical application has expanded across a wide range of healthcare contexts, including wound care, surgical procedures, oncology, rehabilitation, emergency care, and pediatric setting [4,5]. While VR has also been applied in areas such as rehabilitation, surgical training, and health education, its use during medical procedures



Academic Editor: Thomas Lindner

Received: 24 March 2026

Revised: 21 April 2026

Accepted: 22 April 2026

Published: 24 April 2026

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has gained particular attention due to its potential to modulate acute pain and anxiety responses in real time [6–8].

Previous research suggests that VR-based may contribute to reducing perceived pain and anxiety during medical procedures. Several randomized controlled trials and experimental studies have reported beneficial effects, particularly when VR is used as a distraction-based intervention during procedures such as venipuncture, wound dressing, or minor surgery [5,9,10]. However, findings are not always consistent. The effectiveness of VR appears to depend on multiple factors, including patient characteristics, type of procedure, level of immersion, and the design of the virtual environment [11,12].

Recent systematic reviews and meta-analyses have further explored the clinical effectiveness of VR interventions. Evidence indicates that immersive VR can significantly reduce pain and anxiety in certain procedural contexts, especially in pediatric populations and short-term interventions [13,14]. Nevertheless, these studies also highlight considerable heterogeneity across research designs, outcome measures, and intervention protocols, which limits the comparability of results and the ability to draw definitive conclusions regarding effect size and generalizability [13–15].

In parallel with the growing clinical interest in VR, the scientific literature in this field has expanded rapidly in recent years. This growth has resulted in an increasingly diverse and multidisciplinary body of research, encompassing clinical studies, technological innovations, and implementation-oriented approaches [16]. In addition to evaluating clinical effectiveness, recent research has emphasized the importance of understanding how VR interventions can be integrated into routine healthcare practice, considering factors such as usability, workflow compatibility, staff training, and patient acceptance [16,17].

In this context, it is important not only to examine the reported clinical effects of VR interventions on pain and anxiety during medical procedures, but also to understand how research in this area is structured and evolving. Bibliometric analysis provides a useful approach for exploring the development of a research field by examining publication trends, geographical distribution, and relationships between key concepts through keyword co-occurrence and thematic mapping [18]. This type of analysis complements traditional literature reviews by offering a broader perspective on the intellectual structure of the field and identifying emerging research directions.

The concept of VR, popularized in the late 1980s by Jaron Lanier [19], has evolved substantially, driven by advances in hardware (high-resolution headsets, motion sensors and haptic systems) and software (real-time graphics engines and artificial intelligence), which has enabled its gradual democratization and adoption in clinical settings [7,20]. Today, VR is understood as an interactive ecosystem capable of modulating the user's perception, attention, and emotional response—key mechanisms underlying its therapeutic application in pain and anxiety management [21,22].

In clinical practice, VR has demonstrated particular relevance in the management of acute procedural pain and anxiety. Evidence suggests that VR can reduce pain perception through mechanisms of cognitive distraction and attentional modulation, especially during short-duration medical procedures [8,23,24]. Although VR has also been successfully applied in rehabilitation (e.g., neurological and musculoskeletal conditions), surgical training, and health education [11,25–28], these applications differ from its role in procedural contexts, where the primary objective is the real-time reduction in pain and anxiety during medical interventions.

More recently, research has begun to focus on the factors that determine the effectiveness of VR-based interventions. In this regard, it has been shown that outcomes do not depend solely on the degree of technological immersion (e.g., immersive vs. non-immersive VR), but also on factors such as the sense of presence, interactivity, narrative design and

content personalisation [11,17,29]. The concept of “presence”—the subjective sensation of being within the virtual environment—has been identified as a key mediator of therapeutic effects, directly influencing emotional and cognitive engagement and, consequently, pain and anxiety reduction [30]. Furthermore, the contextual integration of VR into clinical workflows, particularly during procedures, is crucial for maximizing its impact [17,31].

Recent research also highlights the importance of identifying facilitators and barriers to implementation in specific populations. In pediatric patients, VR has demonstrated significant benefits in reducing anxiety and pain during medical procedures, although it requires adaptations in design and content to suit developmental characteristics [12,32]. In high-stress procedural contexts—such as emergency settings or invasive interventions—VR can act as a tool for emotional regulation, although its implementation may face logistical and clinical safety challenges [33,34].

Despite the growing body of evidence, significant gaps remain in the literature. Firstly, there is a lack of standardization in intervention protocols, which makes it difficult to compare studies and generalize findings [33,35]. Secondly, although short-term procedural effects are relatively well documented, evidence regarding long-term effectiveness remains limited and heterogeneous [23]. Finally, the integration of VR into healthcare systems poses challenges relating to cost, training of healthcare staff, technological interoperability and acceptance by patients and professionals [31,34,36].

Accordingly, the aim of this study is to conduct a systematic review with complementary bibliometric analysis of the scientific literature on the use of VR in healthcare settings, with a particular focus on its application in the management of pain and anxiety during medical procedures. Specifically, this study seeks to: (1) describe the current state and evolution of research on VR in medical contexts; (2) examine the reported effects of VR on pain and anxiety based on the available literature; and (3) identify the main types of VR tools and their areas of application. By combining a narrative synthesis of clinical findings with a bibliometric perspective, this study aims to provide a broader understanding of the role of VR in healthcare while acknowledging the variability and limitations of the existing evidence [13,16].

Accordingly, the following research questions guided the study:

Q1: What are the main research trends and publication patterns in the use of VR in healthcare for pain and anxiety management?

Q2: What evidence is reported in the literature regarding the use of VR for reducing pain and anxiety during medical procedures?

Q3: What types of VR tools and applications are most commonly used in this field?

2. Methods

2.1. Study Design

This study was conducted to systematically identify and synthesize the scientific literature on the use of VR in healthcare for pain and anxiety management. In addition, a complementary bibliometric analysis was performed research trends and thematic structures within the field.

The study followed a two-stage design:

1. Systematic review (primary analysis): focused on identifying and synthesizing empirical evidence regarding the effectiveness of VR interventions in reducing pain and anxiety during medical procedures.
2. Bibliometric analysis (complementary analysis): aimed at examining publication trends and thematic structures within the field.

This combined approach provides both a clinical interpretation of the available evidence and a broader understanding of the evolution of research in this domain. The methodology and study phases are illustrated in Figure 1.

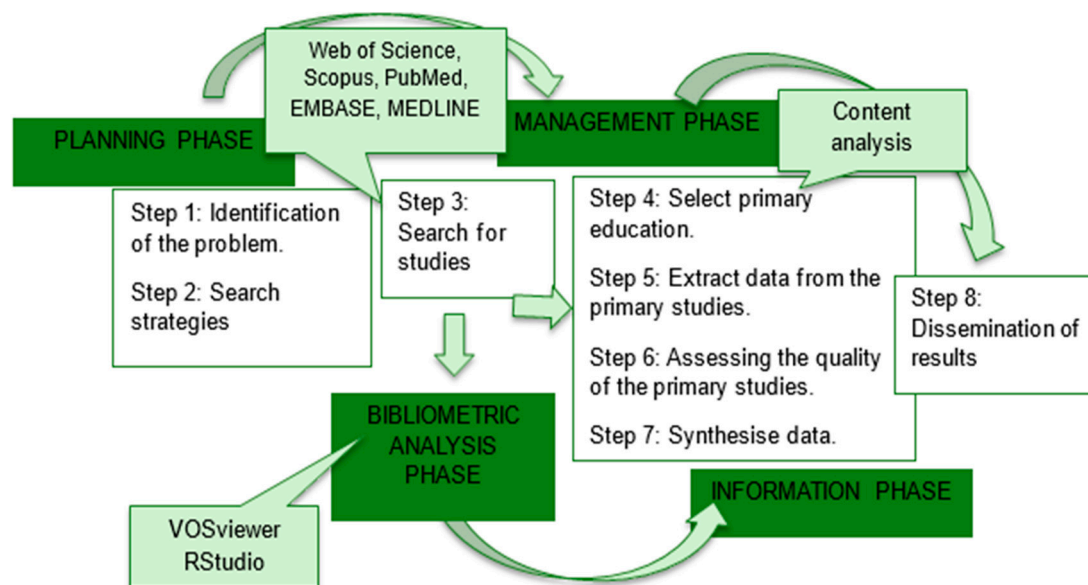


Figure 1. Study phases of the systematic review and bibliometric analysis.

The study was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 guidelines [37].

2.2. Search Strategy

A comprehensive literature search was conducted on 16 December 2023 across five major databases: Web of Science (WoS), Scopus, PubMed, EMBASE and MEDLINE. The search was subsequently updated in March 2026 to include studies published up to December 2025, ensuring the inclusion of the most recent evidence in this rapidly evolving field. The search strategy combined controlled vocabulary (e.g., MeSH and Emtree terms) and free-text terms, using Boolean operators (AND, OR) to structure the queries in the aforementioned databases. The search was applied to titles, abstracts, and keywords.

The core search string included combinations such as:

("virtual reality" OR "immersive virtual reality" OR "VR" OR "head-mounted display")
 AND
 ("pain" OR "pain management" OR "analgesia")
 AND
 ("anxiety" OR "fear" OR "distress")
 AND
 ("patient*" OR "clinical" OR "procedure*")

Search strategies were adapted to the syntax and indexing system of each database. In addition, the reference lists of included studies were manually screened to identify potentially relevant articles not captured in the initial search. A full version of the database-specific search strategies is available upon request. For the purpose of this review, VR was defined as the use of computer-generated environments designed to provide sensory immersion and user interaction. Studies were categorized according to the level of immersion as: (1) immersive VR (e.g., head-mounted displays with full visual occlusion), (2) semi-immersive or hybrid VR systems, and (3) non-immersive digital environments used as distraction tools.

2.3. Eligibility Criteria

Studies were selected based on predefined inclusion and exclusion criteria (Table 1).

Table 1. Inclusion and exclusion criteria.

Inclusion Criteria	Exclusion Criteria
Empirical studies evaluating VR interventions in healthcare settings	Editorials, narrative reviews, and conference abstracts
Studies reporting outcomes related to pain and/or anxiety	Studies without measurable clinical outcomes related to pain or anxiety
Randomized controlled trials (RCTs), quasi-experimental studies, or controlled clinical studies	Studies not involving VR as an intervention
Articles published between 2019 and 2025	Studies conducted outside healthcare contexts
Publications in English or Spanish	

The selected time frame (2019–2025) was chosen to capture the recent advances in VR technologies, particularly the increased accessibility and clinical adoption of immersive systems, ensuring that the review reflects current evidence in this rapidly evolving field.

2.4. Study Selection Process

The study selection process followed the PRISMA 2020 guidelines and consisted of a multi-stage screening procedure. First, all records identified through the database searches were exported to a reference management software, where duplicate entries were removed automatically and verified manually.

Second, a two-phase screening process was conducted.

- Phase 1: Titles and abstracts were independently screened by two reviewers to assess relevance based on the eligibility criteria.
- Phase 2: Full-text articles were retrieved and assessed in detail for eligibility.

Studies were excluded if they did not meet the inclusion criteria regarding study design, clinical context, intervention type, or reported outcomes.

The selection process was conducted independently by two reviewers. Discrepancies were resolved through discussion, and when necessary, consultation with a third reviewer to reach consensus.

Reasons for exclusion at the full-text stage were documented.

The PRISMA checklist is provided as Supplementary Materials (Table S1).

2.5. Data Extraction

A standardized data extraction form was developed to ensure consistency.

The following variables were collected extracted from each study: author(s) and year; country; study design; sample size and population characteristics; clinical context and type of procedure; type of VR intervention (device, modality, and level of immersion); comparator or control condition; outcome measures (including scales used for pain and anxiety); timing of outcome assessment; and main findings, including statistical significance and direction of effect.

Data extraction was performed independently by two reviewers to ensure accuracy.

2.6. Quality Assessment

The methodological quality and risk of bias of the included studies were assessed using design-specific tools:

- Randomized controlled trials: evaluated using the Cochrane Risk of Bias tool (RoB 2).

- Non-randomized studies: assessed using the ROBINS-I tool (Risk of Bias In Non-randomized Studies of Interventions) (version 2016).

These tools were selected due to their widespread use and suitability for evaluating intervention studies. Each study was independently assessed by two reviewers, and disagreements were resolved through discussion until consensus was reached.

2.7. Data Synthesis

Due to substantial heterogeneity across studies in terms of populations, clinical contexts, VR modalities, outcome measures, and reporting of statistical data, a quantitative meta-analysis was not conducted.

Specifically, studies used different pain and anxiety scales, assessed outcomes at varying time points, and often did not report sufficient statistical parameters (e.g., means, standard deviations, or effect sizes) to allow standardized comparison.

Therefore, a narrative synthesis was conducted, focusing on the direction and consistency of findings across studies.

2.8. Bibliometric Analysis

A complementary bibliometric analysis was conducted to explore the evolution and structure of research on VR in healthcare for pain and anxiety management.

The analysis was performed using VOSviewer (version 1.6.20) and RStudio (version 2023.12.1) using the bibliometrix package (version 4.2.1). The following analyses were conducted: annual scientific production; geographical distribution of publications; keyword co-occurrence analysis; cluster analysis of research themes; and thematic mapping.

These analyses allowed the identification of dominant research topics, emerging areas, and structural relationships within the field.

2.9. Protocol Registration

The review protocol was registered in PROSPERO database (registration number: 1353286), ensuring transparency and methodological rigour.

3. Results

3.1. Study Selection

A total of 627 records were identified through database searching. After removing duplicates ($n = 398$), 229 records remained for title and abstract screening. Of these, 189 were excluded based on predefined criteria.

The full texts of the remaining 40 articles were assessed for eligibility, resulting in the exclusion of 14 studies due to reasons such as inappropriate study design, lack of relevant clinical outcomes, or absence of VR as an intervention.

Ultimately, 26 studies were included in the final review.

The study selection process is summarized in the PRISMA flow diagram (Figure 2).

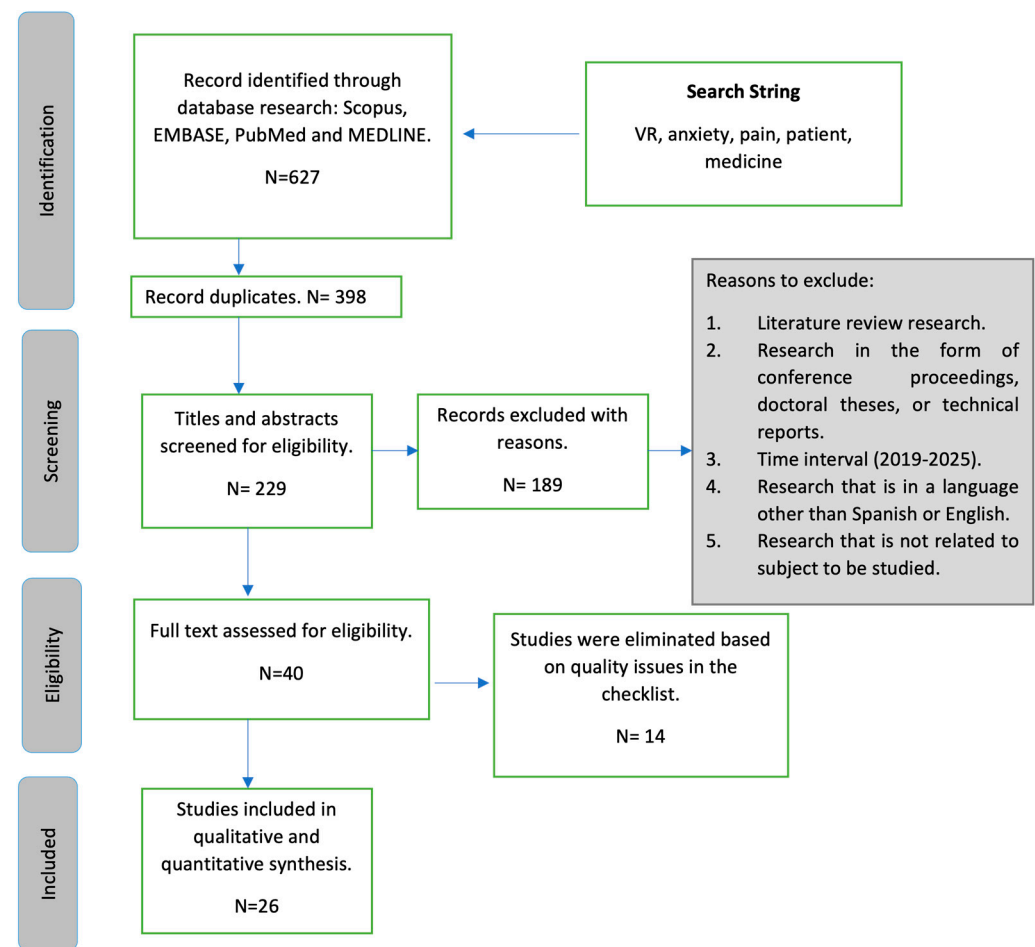


Figure 2. PRISMA flow diagram of the study selection process.

3.2. Characteristics of Included Studies

The 26 studies included in this review were published between 2019 and 2025 and were conducted across multiple countries, including the United States, Canada, Turkey, Spain, the United Kingdom, Australia, China, Iran, Portugal, Germany, Iraq, Indonesia, South Korea, and France.

Most studies employed randomized controlled trial (RCT) designs, although quasi-experimental and mixed-methods studies were also identified. The clinical contexts varied considerably and included: wound care and dressing changes, venipuncture and vascular access, surgical and preoperative procedures, outpatient hysteroscopy, labour and obstetric care, emergency settings, and chronic wound managements.

A substantial proportion of studies focused on pediatric populations, although adult populations were also represented. Sample sizes varied across studies, reflecting differences in study design and feasibility constraints.

Regarding interventions, immersive VR systems were the most frequently used, particularly head-mounted displays (HDMs) such as Oculus devices, Samsung Gear VR, Pico systems, and smartphone-based platforms. These interventions were typically applied as distraction-based techniques during medical procedures.

As summarized in Table 2, immersive VR was associated with the most consistent positive outcomes, whereas hybrid and non-immersive systems showed more variable effects.

Table 2. Characteristics of VR interventions.

VR Type	Number of Studies	Examples	Observed Effect
Immersive VR (HMD)	Majority	Oculus, Pico, smartphone VR	Strongest effects on pain and anxiety
Hybrid/semi-immersive	Few	Projector-based VR	Moderate effects
Non-immersive/comparison	Few	Tablet/video	Less consistent effects

A detailed summary of the included studies, including study design, population characteristics, interventions, comparators, and outcome measures, is presented in Appendix A.

In addition to randomized and controlled studies, the sample also included pilot studies, feasibility studies, and study protocols. These were considered separately in the interpretation of results, as they do not provide direct evidence of clinical effectiveness.

3.3. Effects of Virtual Reality on Pain and Anxiety

Most of the included studies reported reductions in perceived pain and/or anxiety when VR was used as an adjunctive intervention during medical procedures.

- Pain

A total of 12 studies reported statistically significant reductions in pain, particularly in procedural contexts such as wound care, venipuncture, and surgical interventions [19,37,38]. These findings are consistent with previous evidence suggesting that immersive distraction can modulate pain perception by redirecting attention away from nociceptive stimuli [39,40].

However, four studies did not report significant effects on pain, highlighting variability in outcomes across different clinical settings and populations [41]. This inconsistency may be related to differences in intervention characteristics, such as immersion level, duration of exposure, and type of comparator.

- Anxiety

Similarly, 11 studies reported significant reductions in anxiety, especially in pediatric populations and pre-procedural contexts [40–43]. VR interventions appeared particularly effective in reducing anticipatory anxiety and procedural distress.

Nevertheless, five studies found no statistically significant differences, suggesting that the effectiveness of VR for anxiety management may depend on contextual and individual factors, including baseline anxiety levels and intervention design.

- Patient Experience and Engagement

Beyond clinical outcomes, most studies reported improvements in patient satisfaction, engagement, and overall procedural experience, even in cases where reductions in pain or anxiety were not statistically significant [44].

These findings suggest that VR may contribute to enhancing the subjective experience of care, independently of measurable clinical outcomes.

Overall, the direction of evidence suggests a beneficial effect of VR interventions, particularly in pediatric populations, short-duration procedures, and distraction-based clinical contexts.

In contrast, studies involving adult populations or more complex procedures showed greater variability in outcomes, indicating that contextual and individual factors may play a more significant role.

Despite generally positive trends, the heterogeneity of study designs, interventions, and outcome measures limits the comparability of results and precludes definitive conclusions regarding effect size.

A summary of clinical findings is presented in Table 3.

Table 3. Summary of clinical findings.

Outcome	Number of Studies (Significant Reduction)	Number of Studies (No Significant Effect)	General Interpretation
Pain	13	4	Stronger evidence in procedural and pediatric contexts
Anxiety	12	5	More consistent in pre-procedural and pediatric settings
Patient satisfaction/engagement	Majority positive	Few neutral	VR improves experience even without clinical effect

3.4. Risk of Bias Assessment

The methodological quality of the included studies varied across the sample.

Among the randomized controlled trials, several studies presented low or moderate risk of bias, although limitations were identified, particularly in relation to lack of blinding procedures, small sample sizes, and variability in outcome assessment.

Blinding was often not feasible due to the nature of VR interventions, which may have influenced subjective outcomes such as pain and anxiety.

Non-randomized studies showed a higher risk of bias, mainly due to: potential confounding factors, absence of control groups, and inconsistencies in outcome assessment.

These methodological limitations should be considered when interpreting the findings, as they may affect the internal validity and generalizability of the results.

3.5. Results of Bibliometric Analysis

The bibliometric analysis showed the development and structure of research on VR in healthcare for pain and anxiety management.

3.5.1. Temporal Distribution of Publications

The analysis showed that scientific production remained relatively stable between 2019 and 2022, with a slight increase in publications in 2023, reflecting sustained and growing interest in VR a clinical and technological resource in healthcare (Figure 3).

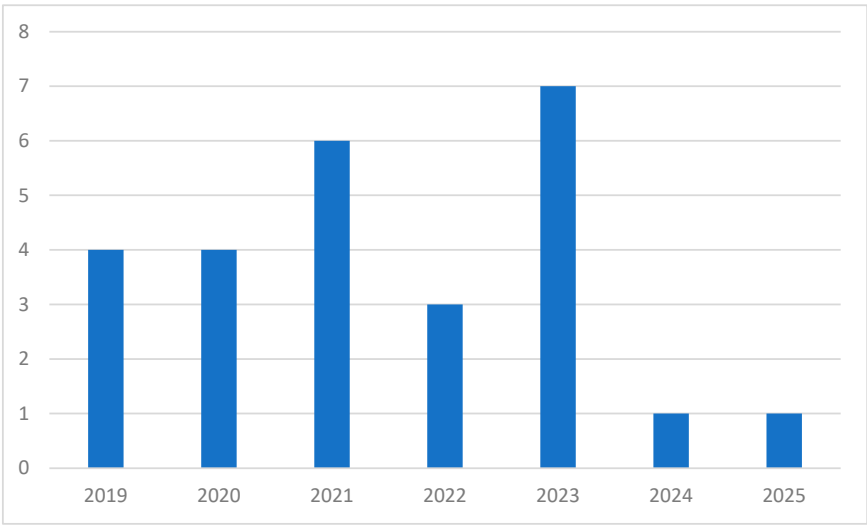


Figure 3. Annual scientific production on Virtual Reality in healthcare for pain and anxiety management (2019–2025).

3.5.2. Geographical Distribution

The geographical distribution of publications indicates that the United States is the leading contributor in this field, followed by countries such as Canada, Turkey, Spain, and the United Kingdom.

Additional contributions from Australia, China, Iran, and Portugal highlighting the global expansion of research activity in VR applications in healthcare (Figure 4).

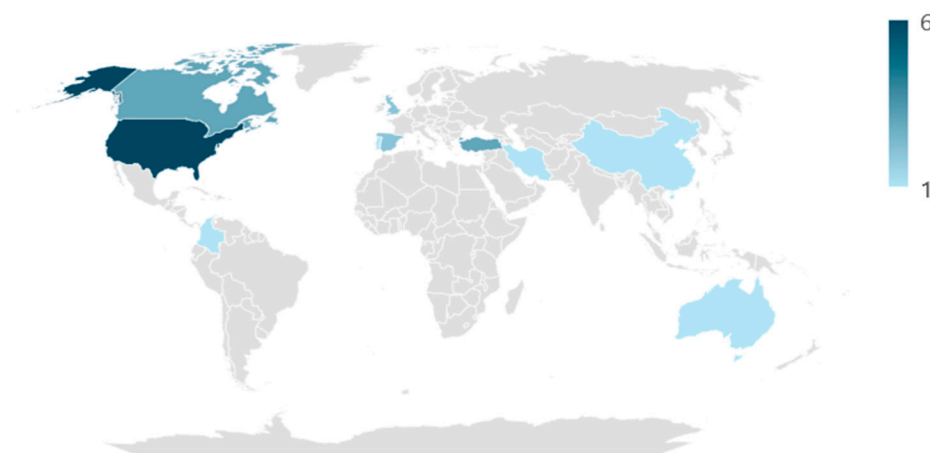


Figure 4. Geographical distribution of publications on Virtual Reality in healthcare for pain and anxiety management.

3.5.3. Keyword Co-Occurrence and Thematic Structure

The co-occurrence analysis of keywords revealed that the most frequently associated terms include “virtual reality”, “pain”, “anxiety”, and “patient”, indicating a strong focus on clinical applications of VR for symptom management.

Cluster analysis identified three main thematic groups:

- Clinical outcomes related to pain and treatment.
- Technological aspects of VR systems and software
- Applications in specific medical conditions, such as oncology

These clusters reflect the multidisciplinary nature of the field (Figure 5).

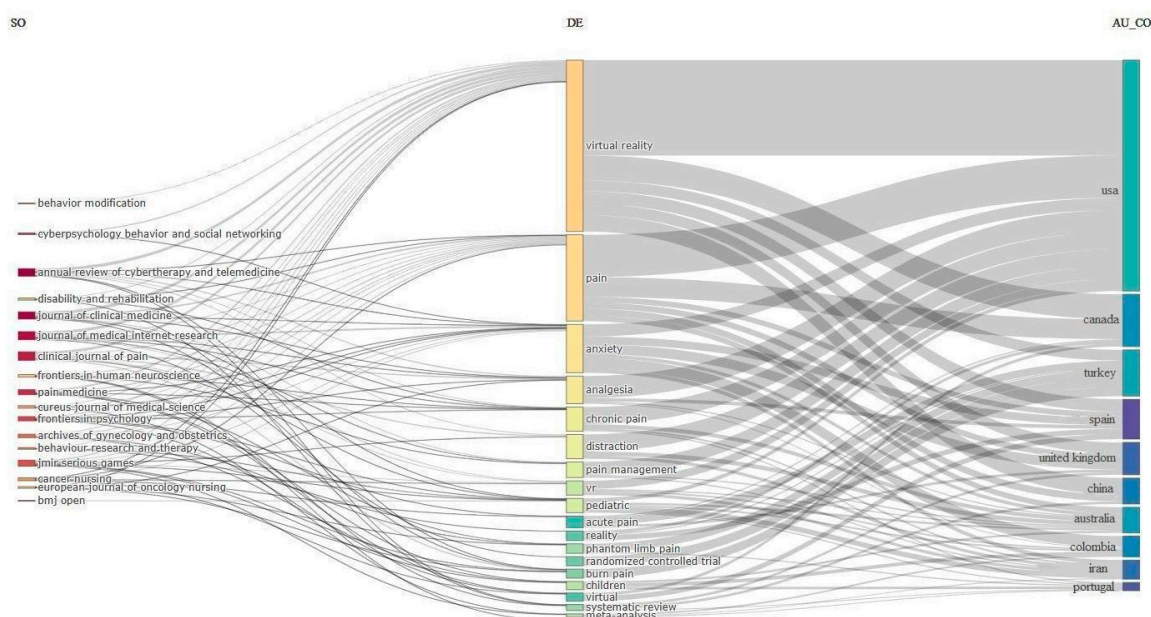


Figure 5. Keyword co-occurrence network and thematic structure of the reviewed literature.

3.5.4. Thematic Map

The thematic analysis revealed that anxiety and fear represent central driving themes within the field, while pain and distraction-based approaches constitute foundational areas of research [45].

Emerging themes include patient satisfaction, user experience and implementation strategies, suggesting a growing interest in the practical application of VR in healthcare settings (Figure 6).

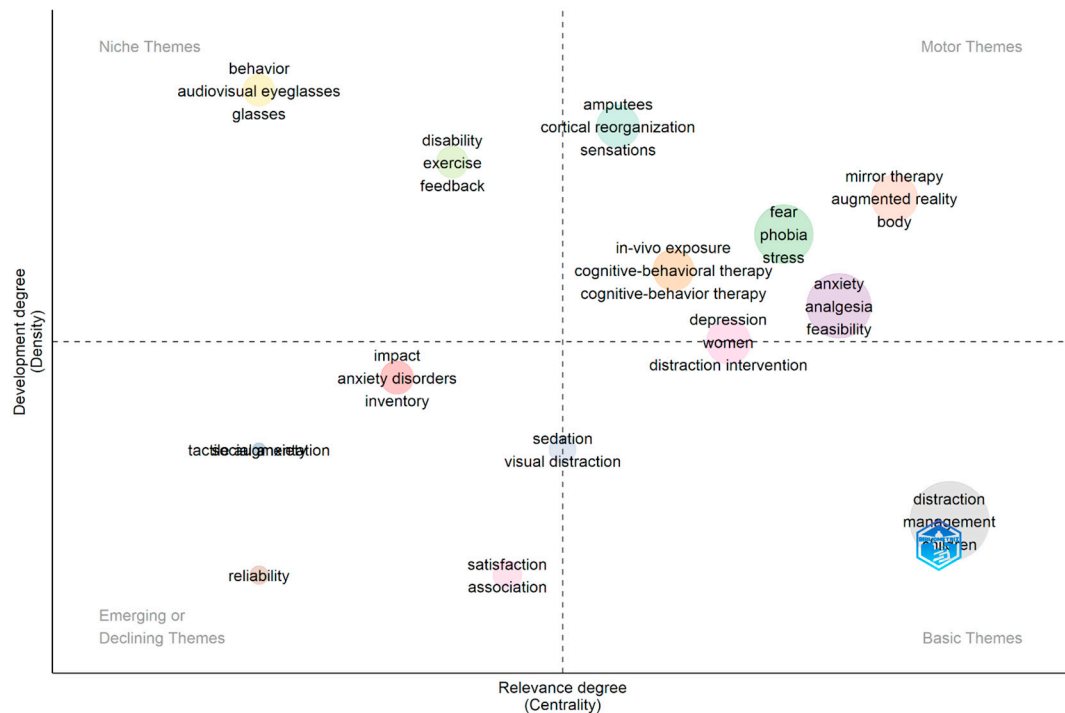


Figure 6. Thematic map of research topics in Virtual Reality for pain and anxiety management.

3.5.5. Density and Network Visualization

As shown in Figure 7, VOSviewer was used to analyze keyword relationships within the reviewed literature. The resulting semantic map illustrates the grouping of terms into thematic clusters:

- Cluster 1 (green) is closely linked to the clinical benefits of VR in medical procedures, including terms such as “pain”, “treatment”, and related outcome concepts.
- Cluster 2 (blue) is associated with the technological dimension of the field, including terms related to VR systems, software, and digital tools.
- Cluster 3 (red) reflects specific clinical application areas, including terms such as “chemotherapy”, “cancer”, and “breast cancer”.

The density map (Figure 8) places “virtual reality”, “pain”, and “anxiety” at the core of the literature, while more peripheral topics include: chronic pain, oncology, pediatric care, and implementation.

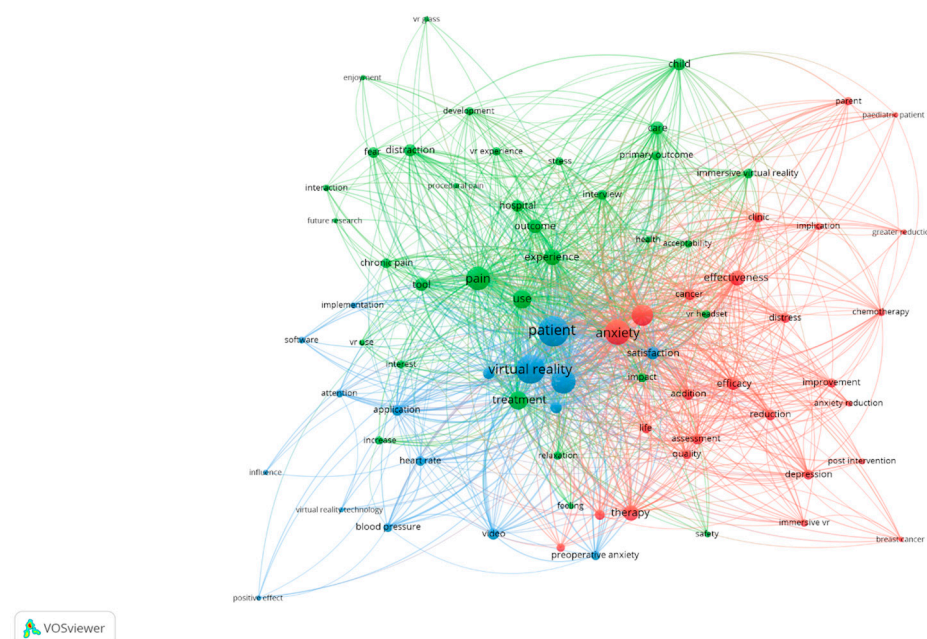


Figure 7. Keyword co-occurrence clusters identified using VOSviewer.

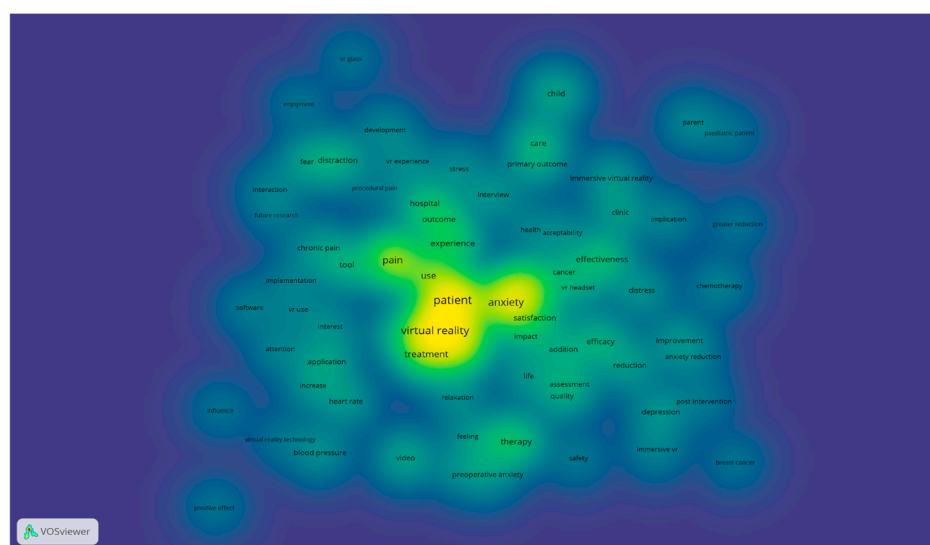


Figure 8. Density map of the most frequent keywords in the reviewed literature.

These findings indicate that while clinical effectiveness remains the primary focus, there is an increasing interest in expanding VR research toward implementation and real-world application.

4. Discussion

This study set out to explore the application of virtual reality (VR) in healthcare, specifically in the management of pain and anxiety, by combining a systematic review of the literature with a bibliometric analysis of research trends. The results offer a comprehensive perspective that integrates both clinical and research-oriented insights. From a clinical standpoint, the findings contribute to understanding the effectiveness of VR-based interventions, while from an academic perspective, they shed light on the development, patterns, and structural evolution of research in this emerging field.

4.1. Clinical Effectiveness of VR for Pain and Anxiety

This study examined the use of VR in healthcare for the management of pain and anxiety through a systematic review, supported by a bibliometric analysis. Focusing on the clinical dimension, the findings highlight the effectiveness of VR-based interventions in reducing pain and anxiety across different patient populations and healthcare settings. These results provide valuable insights into the therapeutic potential of VR, while situating its clinical application within the broader context of ongoing research developments in the field.

The results of this review suggest that VR is frequently associated with reductions in perceived pain and anxiety during medical procedures. Most of the included studies reported positive effects, particularly when VR was used as a distraction-based intervention in contexts such as wound care, venipuncture, surgical procedures, and oncology treatments [42–45]. These findings are consistent with previous literature indicating that immersive distraction techniques can modulate the perception of pain and emotional distress by redirecting attention and reducing cognitive processing of nociceptive stimuli [11,12].

In particular, immersive VR systems appear to enhance this effect by engaging multiple sensory channels simultaneously, thereby increasing the sense of presence and reducing awareness of the clinical environment [11,14,18]. Several studies included in this review reported stronger effects when immersive head-mounted display systems were used compared with less immersive approaches [13,15,18].

With regard to anxiety, VR interventions were especially effective in pediatric and pre-procedural contexts, where anticipatory stress and fear are common [15,20,46]. The ability of VR to provide controlled and engaging environments may facilitate emotional regulation and reduce distress during medical procedures [16].

However, the findings were not entirely consistent across studies. Some studies reported improvements in patient satisfaction and engagement without statistically significant reductions in pain or anxiety [19,41,42]. This variability suggests that the effectiveness of VR may depend on several factors, including the level of immersion, type of procedure, duration of exposure, and individual patient characteristics [47].

Overall, while the direction of the evidence is generally positive, the heterogeneity of the included studies limits the ability to draw definitive conclusions regarding the magnitude of the effect.

4.2. Comparison with Previous Literature

The findings of this review are broadly consistent with recent systematic reviews and meta-analyses reporting beneficial effects of VR on pain and anxiety reduction in clinical settings [8,9]. These studies indicate that VR interventions can produce clinically meaningful reductions, particularly in short-term procedural contexts.

However, previous reviews also highlight substantial variability in effect sizes and study quality, which limits the strength of pooled estimates [8]. The results of the present review are in line with this observation, as variability across studies prevented the performance of a quantitative meta-analysis.

In contrast to previous reviews, this study incorporates a bibliometric perspective, providing additional insight into how research in this field is structured and evolving [45]. This complementary approach allows for the identification of dominant research themes and emerging areas, beyond clinical effectiveness alone.

4.3. Interpretation of Heterogeneity

A key finding of this review is the substantial heterogeneity across studies, which represents one of the main challenges in interpreting the effectiveness of VR interventions.

This heterogeneity is evident in several aspects, including differences in populations, clinical contexts, VR modalities, and outcome measures [13–21,47]. Studies involving pediatric populations tend to report more consistent positive effects, whereas those involving adult populations or more complex procedures show greater variability [17,40,48].

Differences in the level of immersion may be particularly relevant, as immersive VR systems are generally associated with stronger effects due to greater sensory engagement [3,11]. Additionally, variability in the design of VR content, including interactivity and narrative elements, may influence the effectiveness of interventions [40–44,49].

This methodological variability highlights the need for standardized protocols and outcome measures to improve comparability across studies and enable future meta-analyses [8,9,50–55].

4.4. Implications for Clinical Practice

From a clinical perspective, VR appears to be a promising complementary tool for managing pain and anxiety during medical procedures. Its non-pharmacological nature makes it particularly relevant in contexts where reducing reliance on pharmacological interventions is desirable [5,56–59].

VR interventions may contribute to improving patient experience, enhancing comfort, and facilitating procedural compliance, particularly in pediatric and high-stress clinical settings [38,39]. These benefits are consistent with findings from several studies included in this review, which reported improvements in patient engagement and satisfaction [34,37].

However, the successful implementation of VR in clinical practice requires consideration of several practical factors, including cost, staff training, technological usability, and integration into clinical workflows [6]. Evidence regarding these aspects remains limited, highlighting a gap between experimental research and real-world application [6,40].

4.5. Bibliometric Insights and Research Trends

The bibliometric analysis revealed that research on VR in healthcare for pain and anxiety management has shown sustained growth in recent years, with contributions from multiple countries and disciplines.

The predominance of terms such as “virtual reality”, “pain”, and “anxiety” reflects a strong focus on clinical outcomes [45]. At the same time, emerging themes related to implementation, patient experience, and technological development suggest a gradual expansion of research toward more applied perspectives [6,45].

However, a notable finding is the gap between research trends and available evidence. While there is increasing interest in implementation and healthcare integration, most empirical studies continue to focus on short-term clinical outcomes rather than long-term effectiveness or real-world application.

4.6. Limitations of the Study

Several limitations should be acknowledged. First, the search was restricted to publications in English and Spanish, which may have resulted in the exclusion of relevant studies published in other languages.

Second, although multiple databases were consulted, it is possible that some relevant studies were not captured.

Third, the heterogeneity of the included studies prevented the performance of a quantitative meta-analysis and limited the ability to estimate overall effect sizes [8,9].

Additionally, variability in VR interventions and outcome measures reduces comparability across studies.

4.7. Future Research Directions

Future research should focus on conducting high-quality randomized controlled trials with standardized outcome measures to allow more robust comparisons and potential meta-analyses [8,9].

In addition, further studies are needed to explore long-term effectiveness, cost-effectiveness, and scalability of VR interventions [6,40].

Research should also examine how VR can be effectively integrated into clinical practice, addressing barriers and facilitators to implementation [6].

5. Conclusions

This study provides a comprehensive overview of the use of VR in healthcare for pain and anxiety management, combining a systematic review of clinical evidence with a complementary bibliometric analysis.

The findings suggest that VR is a promising non-pharmacological intervention, particularly in procedural and pediatric contexts, where consistent reductions in pain and anxiety have been reported. In addition, VR appears to improve patient experience and engagement during medical procedures.

However, the available evidence is characterized by substantial heterogeneity in study design, intervention characteristics, and outcome measures, which limits comparability across studies and prevents definitive conclusions regarding effect size.

From a broader perspective, the bibliometric analysis highlights the rapid growth and multidisciplinary nature of research in this field. Despite this expansion, important gaps remain regarding the standardization of VR interventions, long-term effectiveness, and integration into routine clinical practice.

Future research should focus on high-quality randomized controlled trials with standardized methodologies, as well as implementation studies addressing real-world feasibility, scalability, and cost-effectiveness.

Overall, VR represents a valuable complementary tool in healthcare for pain and anxiety management, although further robust evidence is required to support its widespread clinical adoption.

Practical Implications

VR may represent a complementary tool in clinical practice for managing pain and anxiety during medical procedures. Based on the findings of this review, its application appears particularly relevant in procedural contexts involving short-duration interventions and in pediatric populations, where distraction-based strategies are more effective.

VR interventions may contribute to improving patient comfort, reducing procedural distress, and enhancing overall patient experience. These benefits may also facilitate procedural compliance and potentially reduce the need for pharmacological interventions in certain contexts.

However, the implementation of VR in routine clinical practice requires careful consideration of several factors. These include the selection of appropriate VR systems (e.g., level of immersion), integration into clinical workflows, staff training, and patient acceptance. In addition, variability in intervention design and outcome measures highlights the need for standardized protocols to ensure consistent application.

From an organizational perspective, further evidence is needed regarding cost-effectiveness, scalability, and long-term impact on healthcare processes. Therefore, while VR shows clear potential as a supportive clinical tool, its widespread adoption should be accompanied by structured implementation strategies and further evaluation in real-world settings.

Supplementary Materials: The following supporting information can be downloaded at: <https://www.mdpi.com/article/10.3390/app16094193/s1>, Table S1: PRISMA 2020 Checklist.

Author Contributions: Conceptualization, D.F.C., M.M.R. and J.F.C.; methodology, D.F.C., M.M.R. and J.F.C.; software, D.F.C., M.M.R. and J.F.C. and M.M.R.; validation, D.F.C., M.M.R. and J.F.C.; formal analysis, D.F.C., M.M.R. and J.F.C.; investigation, D.F.C., M.M.R. and J.F.C.; resources, D.F.C., M.M.R. and J.F.C.; data curation, D.F.C., M.M.R. and J.F.C.; writing—original draft preparation, D.F.C., M.M.R. and J.F.C.; writing—review and editing, D.F.C., M.M.R. and J.F.C.; visualization, D.F.C., M.M.R. and J.F.C.; supervision, D.F.C., M.M.R. and J.F.C. All authors have read and agreed to the published version of the manuscript.

Funding: This work was funded by the Spanish Ministry of Science and Innovation, within the framework of the State R&D&I Programs oriented to the Challenges of Society (PID2022-138346OB-I00).

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: No new data were created or analyzed in this study. Data sharing is not applicable to this article.

Conflicts of Interest: The authors declare no conflicts of interest.

Appendix A

Table A1. Articles included in the systematic review.

Study (Author, Year)	Country	Design	Population/Context	Procedure	VR Type	Comparator	Outcome Measures	Main Result
Hoffman et al. (2019) [14]	USA	Pilot study	Children with severe burn wounds	Wound cleaning	Immersive VR (HMD)	Standard care	Pain (VAS)	Significant pain reduction
Caruso et al. (2020) [51]	USA	RCT	Pediatric inpatients	Vascular access	Immersive VR	Standard care	Pain, satisfaction	No significant pain reduction
Ding et al. (2019) [13]	China	Clinical study	Post-surgical patients	Dressing changes	Immersive VR	Standard care	Pain	Significant reduction
Gerçeker et al. (2019) [52]	Turkey	RCT	Children (5–12)	Blood draw	VR glasses	Standard care	Pain, anxiety	Significant reduction
Özkan & Polat (2020) [15]	Turkey	Controlled study	Children	Venipuncture	VR glasses	Standard care	Pain, anxiety	Significant reduction
Khadra et al. (2020) [3]	Canada	RCT crossover	Children with burns	Hydrotherapy	Hybrid VR	Standard care	Pain	Significant reduction
Deo et al. (2021) [17]	UK	RCT	Women	Hysteroscopy	VR glasses	Standard care	Pain, anxiety	Significant reduction
Xiang et al. (2021) [18]	USA	RCT	Pediatric burns	Dressing	Smartphone VR	Standard care	Pain	Significant reduction
de Araújo et al. (2021) [19]	Portugal	Clinical study	Chronic wound patients	Dressing	Oculus Go	Standard care	Pain	Positive effect
Semerici et al. (2021) [20]	Turkey	RCT	Pediatric oncology	Port access	VR headset	Standard care	Pain	Significant reduction
Wong et al. (2021) [38]	USA	RCT	Women in labour	Labour	VR glasses	Standard care	Pain	Significant reduction
Ferraz-Torres et al. (2022) [41]	Spain	Comparative	Pediatric	Procedures	Oculus Go	Standard care	Pain, anxiety	Significant reduction
Butt et al. (2021) [39]	USA	Intervention	Adolescents	Emergency care	VR vs. iPad	Passive distraction	Anxiety	VR more effective
Zolfaghari et al. (2022) [40]	Australia	Feasibility	Adolescents	Emergency	VR	Standard care	Anxiety	Positive effect
Amiri et al. (2023) [42]	Iran	Comparative	Surgery patients	Pre/post-surgery	VR	Video	Anxiety	Mixed results
Sewell et al. (2023) [43]	UK	RCT	Women	Hysteroscopy	VR	Standard care	Anxiety	Significant reduction
Bosso et al. (2023) [44]	Switzerland	RCT	Adults	Minor procedures	3D vs. 2D VR	Comparison	Pain, anxiety	No difference
Lind et al. (2023) [45]	Germany	RCT	Cardiac patients	TAVR	VR headset	Standard care	Pain, anxiety	Significant reduction
Shutnan et al. (2026) [47]	Iraq	RCT	Post-PCI patients	Recovery	Immersive VR	Standard care	Anxiety	Significant reduction
Hoffman et al. (2020) [53]	USA	RCT	Children with severe burns	Wound debridement	Immersive VR	Standard care	Pain	Significant reduction
Le May et al. (2021) [54]	Canada	Pilot RCT	Pediatric patients	Medical procedures	Immersive VR	Standard care	Pain, fear	Significant reduction

Table A1. Cont.

Study (Author, Year)	Country	Design	Population/Context	Procedure	VR Type	Comparator	Outcome Measures	Main Result
Arifin et al. (2023) [55]	Indonesia	RCT	Surgical patients	Surgery under regional anesthesia	Immersive VR	Standard care	Anxiety	Significant reduction
Öz & Demirci (2024) [56]	Turkey	RCT	Women undergoing outpatient gynecological procedures	Outpatient gynecological procedures	VR headset	Standard care	Anxiety	Positive effect
Ryu et al. (2022) [57]	South Korea	RCT	Children	Venipuncture	Immersive VR	Standard care	Anxiety, pain	Significant reduction
Fouks et al. (2022) [58]	France	RCT	Women	Office hysteroscopy	Immersive VR	Standard care	Pain, Anxiety	No Significant reduction
Piskorz et al. (2018) [59]	Poland	Pilot RCT	Pediatric	Procedures	HMD + tablet	Standard care	Pain	Improvement observed

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