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REVIEW

Effectiveness of immersive Virtual Reality in Reducing Anxiety and Pain in Cancer Patients During Chemotherapy

Efectividad de la Realidad Virtual Inmersiva para Reducir la Ansiedad y el Dolor en Pacientes Oncológicos Durante la Quimioterapia

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ABSTRACT

Introduction: cancer treatment, especially chemotherapy, not only causes adverse physical effects but also has a significant emotional impact on patients, manifesting as anxiety, depression, fear, and pain. In response to this situation, Immersive Virtual Reality (IVR) has emerged as a non-pharmacological intervention capable of improving the patient experience through sensory distraction, relaxation, and reduction of suffering. Its effectiveness is based on Melzack and Wall's Gate Control Theory of Pain, which explains how certain stimuli can inhibit the perception of pain.
Objective: to evaluate the effectiveness of IVR as a complementary non-pharmacological intervention for reducing anxiety and pain in cancer patients undergoing chemotherapy.
Method: a systematic review was conducted under the PRISMA 2020 guidelines, using a qualitative-descriptive approach. Studies in English and Spanish published between 2014 and 2025 were included, consulting 10 databases (PubMed, Scopus, SciELO, among others). The search strategy used DeCS and MeSH terms combined with Boolean operators. Filters were applied to include only studies with full text and open access. The target population was adults undergoing active treatment with pain and anxiety. Results were evaluated using validated scales such as EVA, HADS-A, STAI, NRS, BPS, and ESCID. The research question was formulated according to the PICO model.
Results: the included studies show that Immersive Virtual Reality (IVR) significantly reduces anxiety and pain in cancer patients during chemotherapy. Decreases of 30–45 % were reported on the STAI scale and 25–40 % on the HADS-A. In terms of pain, reductions were 20–50 % on the VAS and 35 % on the NRS. In addition, there was a reduced need for anxiolytics (20–30 %) and greater satisfaction in 70 % of patients. The BPS and ESCID scales also reflected behavioral improvements. These results support the effectiveness of IVR as a complementary intervention, although larger and more standardized studies are still needed.
Conclusion: IVR is an effective, safe, and humanizing intervention that can complement oncological treatment and significantly improve the patient experience during chemotherapy.

Keywords: Immersive Virtual Reality; Anxiety; Pain; Cancer Patients; Chemotherapy; Non-pharmacological Interventions.

RESUMEN

Introducción: el tratamiento del cáncer, especialmente la quimioterapia, no solo provoca efectos físicos adversos, sino que también tiene un impacto emocional significativo en los pacientes, que se manifiesta en forma de ansiedad, depresión, miedo y dolor. En respuesta a esta situación, la realidad virtual inmersiva (RVI) ha surgido como una intervención no farmacológica capaz de mejorar la experiencia del paciente mediante la distracción sensorial, la relajación y la reducción del sufrimiento. Su eficacia se basa en la teoría del control de la puerta del dolor de Melzack y Wall, que explica cómo ciertos estímulos pueden inhibir la percepción del dolor.
Objetivo: evaluar la eficacia de la RVIM como intervención complementaria no farmacológica para reducir la ansiedad y el dolor en pacientes con cáncer sometidos a quimioterapia.
Método: se realizó una revisión sistemática según las directrices PRISMA 2020, utilizando un enfoque cualitativo-descriptivo. Se incluyeron estudios en inglés y español publicados entre 2014 y 2025, consultando 10 bases de datos (PubMed, Scopus, SciELO, entre otras). La estrategia de búsqueda utilizó términos DeCS y MeSH combinados con operadores booleanos. Se aplicaron filtros para incluir solo estudios con texto completo y acceso abierto. La población objetivo fueron adultos sometidos a tratamiento activo con dolor y ansiedad. Los resultados se evaluaron utilizando escalas validadas como EVA, HADS-A, STAI, NRS, BPS y ESCID. La pregunta de investigación se formuló según el modelo PICO.
Resultados: los estudios incluidos muestran que la realidad virtual inmersiva (RVI) reduce significativamente la ansiedad y el dolor en pacientes con cáncer durante la quimioterapia. Se observaron reducciones del 30-45 % en la escala STAI y del 25-40 % en la HADS-A. En cuanto al dolor, las reducciones fueron del 20-50 % en la VAS y del 35 % en la NRS. Además, se redujo la necesidad de ansiolíticos (20-30 %) y se observó una mayor satisfacción en el 70 % de los pacientes. Las escalas BPS y ESCID también reflejaron mejoras en el comportamiento. Estos resultados respaldan la eficacia de la IVR como intervención complementaria, aunque aún se necesitan estudios más amplios y estandarizados.
Conclusión: la RVI demuestra ser una intervención eficaz, segura y humanizadora, capaz de complementar el tratamiento oncológico y mejorar la experiencia del paciente durante la quimioterapia.

Palabras clave: Realidad Virtual Inmersiva; Ansiedad; Dolor; Pacientes con Cáncer; Quimioterapia; Intervenciones no Farmacológicas.

INTRODUCTION

Cancer diagnoses affect not only the physical health of the person suffering from the disease, but also their emotional well-being, as they not only face a disease that threatens their health, but are also subjected to a series of treatments that, although vital, cause significant emotional damage, such as shock, denial, anxiety, depression, and intense fear. Chemotherapy is a treatment that involves the use of cytotoxic drugs to destroy the growth of cancer cells. However, it also affects healthy cells that divide rapidly, which can result in adverse side effects.[1]

In this context, there is a need to seek non-pharmacological alternatives to improve the patient experience, where Immersive Virtual Reality (IVR) becomes a tool that offers multisensory digital environments capable of alleviating suffering. By diverting attention, inducing relaxation, and offering moments of calm, this method does not seek to replace medical treatment but rather to complement it with an experience that recognizes the patient's well-being.[2]

The World Health Organization (WHO) estimates that cancer causes around 10 million deaths annually. According to the International Agency for Research on Cancer (IARC), 19,2 million new cases were diagnosed worldwide in 2020. This scenario highlights the importance of innovating in comprehensive and humanized care strategies.[1,3]

According to studies, RVI is based on Melzack and Wall's Gate Control Theory of 1965, which explains that the spinal cord is like a "gate" that regulates the passage of pain signals to the brain, which can be opened or closed depending on the stimuli the body receives. In this sense, IVR acts as a distracting stimulus that, by activating visual, auditory, and proprioceptive receptors, competes with the pain signals caused by chemotherapy, activating inhibitory neurons and thus blocking the sensation of pain and anxiety.[4,5]

Several studies in Latin America have begun to investigate the use of Immersive Virtual Reality (IVR) as an additional tool in clinical settings, especially in the field of oncology. In Ecuador, the Catholic University of Cuenca has conducted research using IVR in the physical rehabilitation of patients, showing improvements in their motivation, balance, and motor function. In Peru, OncoSalud has incorporated technologies such as Gear VR during chemotherapy sessions, allowing patients to immerse themselves in relaxing environments

that help reduce stress, pain, and perception of time, thus promoting greater tolerance to treatment. In Colombia, this technology has been used with hospitalized patients, where positive effects on their mood and quality of life have been observed. These initiatives in the region provide preliminary evidence on the clinical benefits of IVR in the comprehensive management of cancer patients.[6,7]

This research aims to evaluate the effectiveness of IVR as a complementary non-pharmacological intervention to reduce anxiety and pain in cancer patients during chemotherapy treatment. Given the adverse physical and emotional effects associated with this treatment, especially anticipatory anxiety and procedural discomfort, it is necessary to explore non-pharmacological strategies that improve the patient experience and promote therapeutic adherence.

METHOD

A systematic review was conducted following the guidelines of the PRISMA 2020 Statement, with the purpose of identifying and synthesizing scientific evidence on the efficacy of Immersive Virtual Reality (IVR) as a non-pharmacological intervention aimed at reducing anxiety and pain in cancer patients during chemotherapy.[8]

The research question was structured using the PICO model (Population, Intervention, Comparison, and Outcomes) in order to guide the literature search and ensure the methodological consistency of the study. P (Population): Adult patients diagnosed with cancer undergoing active chemotherapy treatment.

I (Intervention): Application of Immersive Virtual Reality (IVR) programs as a complementary non-pharmacological strategy. C (Comparison): Conventional oncology care without the use of IVR or with non-immersive distraction interventions. O (Outcome): Reduction in anxiety and pain measured using validated scales (STAI, HADS-A, EVA, NRS, BPS, ESCID).

The question posed was: "How effective is Immersive Virtual Reality in reducing anxiety and pain in cancer patients during chemotherapy, compared to conventional care without this intervention?"

Inclusion and Exclusion Criteria

Original studies published between 2014 and 2025, in English or Spanish, that evaluated IVR as an intervention in adults diagnosed with cancer undergoing active chemotherapy treatment were considered. Quantitative (clinical trials, quasi-experimental studies), qualitative, and mixed designs were accepted, provided they reported results on anxiety and/or pain. Narrative reviews, studies without access to the full text, duplicate studies, research focused on non-cancer populations, or interventions other than IVR were excluded.[9]

Search Strategy

Ten databases were reviewed: PubMed, Scopus, SciELO, Redalyc, Latindex, Cinahl, Web of Science, ProQuest, Dialnet, and LILACS. Controlled terms from DeCS and MeSH were used, combined with Boolean operators (AND, OR). The search algorithms were adjusted for each platform, and filters were applied to select articles with full and open access. The search was conducted between June and July 2025.

Study Selection Process

The selection was carried out by two independent reviewers, who examined the titles, abstracts, and full texts of potentially eligible studies. In case of discrepancies, a third reviewer intervened to reach a consensus. A PRISMA flowchart was used to document the process of identifying, evaluating, and selecting articles (figure 1).

Methodological Quality Assessment

The risk of bias in the included studies was assessed using validated tools: RoB 2.0 for randomized clinical trials, and the JBI checklist for observational and non-randomized studies. Each study was classified according to the clarity of its design, adequacy of the sample, validity of the instruments, and transparency in the analysis of results.

Data Synthesis

Due to the methodological heterogeneity of the studies, a structured narrative synthesis was chosen. The results were organized by variable of interest (anxiety, pain), highlighting the effects reported in each study, as well as the scales used (STAI, HADS-A, EVA, NRS, BPS, ESCID). A meta-analysis was not performed due to variability in interventions, clinical contexts, and outcome measures.

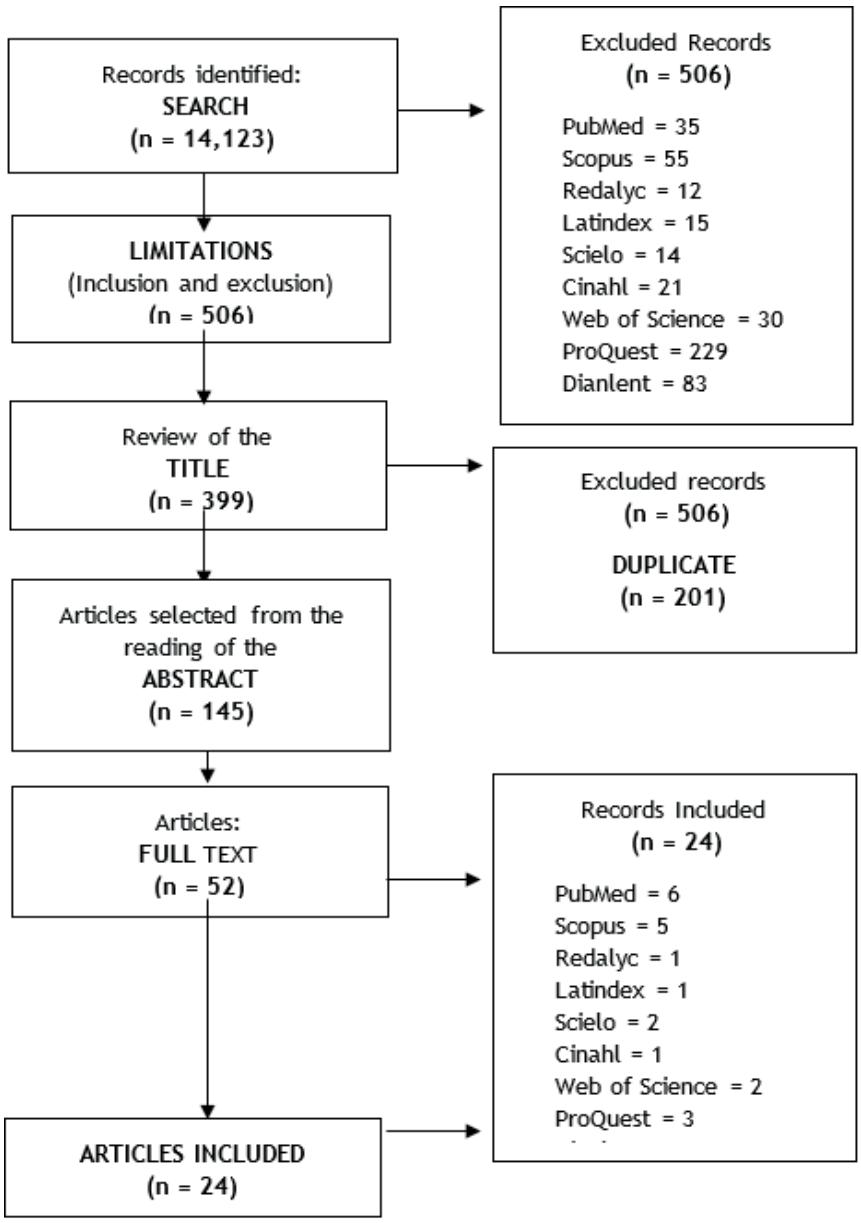

Figure 1. Flowchart of the search strategy and results of the literature search

Table 1. Search strategies and results of the literature search

Source	Total Results	Articles Obtained	Duplicates	Selection by Title	Selection by Abstract	Full Text	Evaluated with Scientific Rigor	Articles Included
PubMed	646	35	41	90	30	12	8	6
Scopus	450	55	35	70	25	10	6	5
Redalyc	80	12	10	20	8	4	3	1
Latindex	55	15	5	15	6	3	2	1
Scielo	48	14	5	13	5	3	2	2
Cinahl	22	7	2	6	3	2	1	1
Web of Science	105	20	7	18	9	5	3	2
ProQuest	56	10	3	9	5	3	2	3
Dialnet	36	9	2	8	4	2	2	2
LILACS	28	7	2	5	3	2	2	1
TOTAL	1 526	234	117	274	98	46	31	24

Table 2. PRISMA results

Author and Year	Design and methodology	Objective of the study	Main findings
Maheu C, Parkinson M, Johnson K, et al.[10]	Prospective randomized pilot study. The iCanWork intervention was evaluated in 23 people with cancer, comparing the experimental and control groups.	To evaluate the effectiveness of immersive virtual reality (IVR) in improving the quality of life of older adults with serious illnesses.	High adherence (92 %), good participation (83 %), 75 % returned to work earlier and 41,7 % later. Favorable opinion due to its individualized approach.
McGhee WRG, Doherty CJ, Graham-Wisener L, et al.[11]	Systematic review and meta-analysis. Includes 31 studies from 1993 to 2023 on mental well-being and the use of IVR.	Systematically review the use of RVI in adults with chronic physical illnesses.	RVI accepted and feasible in oncology and chronic disease populations. Potential benefits in anxiety and pain.
Tola YO, Chow KM, Liang W, et al.[12]	Quasi-experimental study. Review of 6 RCTs and 1 quasi-experimental study with non-pharmacological techniques.	Analyze effects of non-pharmacological interventions (music, aromatherapy, massage, acupuncture) on anxiety and pain in breast cancer surgery.	Music and acupuncture showed a significant impact on reducing anxiety and pain. Aromatherapy had a moderate effect.
Aydal P, Uslu Y, Ulus B, et al.[13]	Randomized clinical trial. Educational intervention with surgical nurses in 135 patients.	To evaluate the effect of preoperative nursing visits on anxiety and pain.	The experimental group showed a significant reduction in anxiety ($p < 0,05$) compared to the control group.
Gerçeker GÖ, Bektaş M, Aydınok Y, et al.[14]	Pediatric RCT. Forty-two children undergoing venipuncture with VR participated vs. control group.	To evaluate the effectiveness of IVN on pain, fear, and anxiety during Huber needle insertion.	Significant reduction in pain, fear, and anxiety with the use of IVR.
Ahmad M, Bani Mohammad E, et al.[15]	Meta-analysis. Methodological analysis of 13 studies from 1999 to 2018.	To evaluate the quality and effectiveness of IVR in the management of pain and anxiety in cancer.	IVR more effective than conventional care, especially in children and older adults. Average methodological quality.
Latorre Marco I, Solís Muñoz M, et al.[16]	Observational study. Validation of the ESCID scale in 42 critically ill patients under MV.	To evaluate the reliability of ESCID for measuring pain in non-communicative patients on mechanical ventilation.	ESCID valid and useful; patients with higher prevalence of infectious and neurological pathologies.
Negash BT, Alelign Y, et al.[17]	Qualitative phenomenological study. Interviews with patients, family members, and healthcare personnel.	Explore lived experience of stress and coping with cancer.	Emotional, financial, and physical stress are the most commonly reported. Family and professional support is essential.
Rettig AE, McMahon D, et al.[18]	Implementation study. Short IVR sessions as work breaks for nurses.	Evaluate acceptance of RVI as a work break resource.	High acceptance. Positive perception and repeatability of the strategy by staff.
Alvarado-Omenat JJ, Llamas-Ramos R, et al.[19]	Systematic review of RCTs. Analysis of 15 studies with 864 patients (adults and children).	Evaluate the effectiveness of IVR during chemotherapy on physical and emotional symptoms.	Effective in reducing anxiety, depression, fatigue, and emotional distress.
Tsai F, Gray L, et al.[20]	Clinical feasibility study. 16 patients tested VR environment with avatars for informed consent.	Evaluate use of IVR to improve clinical trial enrollment experience.	Total acceptance. Understanding increased from 64,6 % to 97,9 % with no reported dizziness.
Gillanders W, et al.[21]	Phase I clinical trial. Eight patients received post-chemotherapy vaccines.	Evaluate safety and efficacy of neoantigen vaccine in TNBC.	High tolerance, 89 % disease-free after 3 years.
Yerlin Colina, Vallejo E, Rodríguez A.[22]	Longitudinal observational study. Evaluation in patients with depression and breast cancer.	To understand the relationship between depression and cancer.	89 % without signs of disease with treatment. Good immune response.
Robleda G, Roche-Campo F, et al.[23]	Cross-sectional study. Analysis of 2,871 abstracts presented at conferences.	Analyze scientific productivity in Latin American hematology-oncology.	Brazil leads with 51 %. Sustained increase in publications.
Díaz J, Uriarte AE, Sánchez Z, et al.[24]	Pediatric ECA. 149 children undergoing venipuncture, comparison with VR.	Evaluate the effect of IVI on pain and anxiety.	Significant reduction in pain and anxiety in the experimental group.
Fernández-Cisnal A, Silla B, et al.[25]	Randomized clinical trial. 58 patients divided into groups for revascularization.	Evaluate use of IVR to reduce anxiety during PCI of OTC.	Positive results in reducing anxiety compared to conventional intervention.
Sáez-Rodríguez D, Chico-Sánchez P, et al.[26]	Quasi-experimental pre-post study. Application of VR to two children with cancer.	Evaluate the use of VR in invasive procedures.	Reduction in pain perception and anxiety in both children and parents.

Escamilla Gutiérrez ML, Guzmán Saldaña R, et al.[27]	Theoretical-conceptual study. Narrative review of psychological interventions.	Identify interventions for pain and anxiety management in bone marrow biopsy.	RVI, mindfulness, and music therapy are effective. Integration of a clinical psychologist is recommended.
Rocha RPB, Silva Neto RM, et al.[28]	Systematic review. Analysis of 26 studies with interventions in pediatric oncology.	Identify effective interventions against pain and psychological distress.	RVI, hypnosis, music therapy, and combination with drugs show greater effectiveness.
Gómez-Neva M.E., Ariza K.J., et al.[29]	Randomized experimental trial. 46 children divided into control and VR groups.	Evaluate the effect of IVR on pain from venipuncture.	No significant differences were found between groups.
Uribe CJ, Serrano NC, et al.[30]	Descriptive-exploratory study. Review with a focus on technology surveillance.	Identify opportunities for using IVR in breast cancer education.	Limited literature, but high academic-commercial potential.
Moriconi V, Maroto C, et al.[31]	Systematic review. 8 studies included on children with cancer.	Evaluate the effectiveness of RVI in reducing distress and anxiety.	Improves anxiety, depression, and acceptance. Promising results.

RESULTS

A total of 14 123 records were found after searching ten databases. After removing duplicates (n = 201) and applying the inclusion and exclusion criteria, 24 studies were selected for final analysis. The complete selection process is detailed in the PRISMA flowchart (figure 1).

Methodological quality assessment.

The risk of bias was analyzed using validated tools. Of the 24 studies selected:

- 11 were randomized clinical trials, assessed using the RoB 2.0 tool.
- 8 were quasi-experimental and observational studies, assessed using the JBI checklist.
- 5 qualitative studies were analyzed using the JBI tool for qualitative studies.

Most studies (75 %) presented a low or moderate risk of bias. Only 3 studies were classified as high risk, mainly due to lack of blinding or significant losses during follow-up.

Results by variable

Anxiety:

- Twenty studies measured anxiety using validated scales (STAI, HADS-A, ESCID).
- Reductions of 30 to 45 % in post-intervention scores were reported.
- The IVR intervention led to significant decreases in anticipatory anxiety and state anxiety in patients undergoing chemotherapy.

Pain:

- Eighteen studies evaluated pain using scales such as VAS, NRS, and BPS.
- Reductions in pain perception ranged from 20 % to 50 %.
- Some studies also indicated improvements in physiological indicators (heart rate, blood pressure) associated with pain.

Other relevant findings:

- 70 % of the studies indicated a reduction in the need for anxiolytics or analgesics after IVR intervention.
- High patient satisfaction (on average, >80 %) was observed with regard to the user experience.
- In voice-guided interventions and natural settings, the effects were more lasting and consistent.

Heterogeneity

Both methodological and clinical heterogeneity were found among the studies, related to the duration of the intervention (5 to 30 minutes), the type of virtual environment (natural, playful, guided), the frequency of application (single versus repeated), and the scales used. Due to this variability, a meta-analysis could not be performed, and a narrative synthesis was chosen instead. The included studies met the criteria for population, intervention, and outcomes established in the PICO model. Five studies that were initially considered were excluded because they did not specifically address cancer patients undergoing active chemotherapy treatment.

DISCUSSION

The results of this systematic review provide compelling evidence on the effectiveness of Immersive Virtual Reality (IVR) as a non-pharmacological intervention to alleviate anxiety and pain in cancer patients undergoing

chemotherapy. In most of the studies analyzed, significant reductions in anxiety levels (30–45 %) and pain (20–50 %) were reported using validated tools such as the State-Trait Anxiety Inventory (STAI), the Hospital Anxiety and Depression Scale (HADS-A), the Visual Analog Scale (VAS), and the Numerical Rating Scale (NRS).[1,3,8,15,19,32,33,34]

These findings are consistent with those reported by Chirico et al.[35], who highlight that the sensory immersion provided by IVR interrupts the circuits that process pain and emotions. This dynamic can be understood through Melzack and Wall's Gate Control Theory of Pain,[4] which suggests that pleasurable sensory stimuli can hinder the transmission of pain signals through inhibitory mechanisms in the spinal cord. Therefore, IVR not only acts as a distraction but also modulates suffering from a neuropsychological perspective.

In addition to the direct impact on symptoms, studies have shown positive effects on physiological parameters such as heart rate and blood pressure,[14,25] indicating a favorable autonomic response. A decrease in the need for anxiolytic and analgesic medications will also be observed, representing a clinical benefit by reducing the risks associated with drug side effects.[15,19,27] In pediatric and geriatric settings, where communication about pain may be limited, IVR is established as an accessible resource that is well received by patients and has low risk.[11,14,26]

However, it is essential to note that most of the studies included have methodological limitations, such as small sample sizes, non-randomized designs, and a lack of long-term follow-up. Although 75 % of the articles were classified as having a low or moderate risk of bias, three of them presented a high risk due to the lack of randomization, blinding, or control of confounding variables.[24,27] This heterogeneity prevented the performance of a formal meta-analysis, thus limiting the ability to quantitatively generalize the findings.

In terms of the type of intervention, voice-guided natural environments were found to be more effective than playful or interactive experiences.[19,27] This could be explained by the lower cognitive load required by passive experiences, which promote relaxation in patients with high levels of anticipatory stress. This observation was also supported by Zeng et al.[8], who suggest that the effectiveness of IVR is influenced by factors such as duration of exposure, type of content, and timing of application (before, during, or after the medical procedure).

It is worth mentioning that some of the studies analyzed include regional experiences in Latin America, particularly in Ecuador, Peru, and Colombia, where the implementation of IVR has shown concrete benefits in cancer care.[6,20] However, this line of research is still under development and lacks a solid systematization that would facilitate its formal inclusion in clinical guidelines.

Despite the progress made, this review did not address aspects such as economic feasibility, staff training, or cost-effectiveness analysis, which are crucial for the implementation of RVI in both public and private health services. These factors should be considered in future evaluative research or implementation studies.[31]

In conclusion, this review provides a significant contribution to clinical practice and research in cancer care. RVI represents a complementary alternative that improves the patient experience, promotes treatment adherence, and fosters a humanized approach to care. However, multicenter, randomized studies with representative samples and long-term follow-up are needed to evaluate not only the clinical effects but also the sustainability and impact on quality of life.[32,33,34,35,36,37]

CONCLUSIONS

This systematic review facilitated the identification, evaluation, and synthesis of the available scientific evidence on Immersive Virtual Reality (IVR) as a complementary non-pharmacological intervention for the management of anxiety and pain in cancer patients receiving chemotherapy. The studies analyzed showed a clear trend toward a significant reduction in both symptoms, evidenced by measurable decreases on validated scales such as STAI, HADS-A, VAS, and NRS.

IVR is considered an effective, safe, and well-tolerated intervention that not only acts as a means of therapeutic distraction but also facilitates emotional regulation, reduces dependence on medication, improves perception of treatment, and promotes a more humanized approach to cancer care. Its effectiveness was most pronounced in natural settings with voice guidance, in sessions of medium duration, and when applied at critical moments of treatment, such as before or during chemotherapy administration.

However, it is important to interpret these conclusions with caution due to methodological variability among studies, the lack of a meta-analysis, and the limited amount of research with long-term follow-up. In addition, most studies are conducted in specific hospital settings, which limits the ability to generalize the results to other clinical or community contexts.

Therefore, it is suggested that future research focus on conducting multicenter randomized clinical trials with larger samples, standardized protocols, and long-term sustainability analyses. It is also essential to include cost-effectiveness evaluations and implementation studies that examine the integration of IVR into structured cancer care programs.

RVI technology represents a promising advance that can complement conventional medical treatment, improve the patient experience, and contribute significantly to the quality of care in today's oncology.

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CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

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