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Pain Management: The Efficacy of Virtual Reality Therapy for Chronic

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Abstract

Background: A person's mental health, physical health, and overall quality of life can all take a hit while they're dealing with chronic pain. Because conventional medicine has its limitations, supplementary treatments are sometimes necessary. One definition of virtual reality (VR) is a collection of computer-generated scenarios that provide the illusion of being physically present in a space. Virtual reality has already found use in the study of pain and mental health issues, and new evidence suggests it may have a role in the treatment of chronic pain. The purpose of this systematic review is to evaluate the efficacy of VR-based therapy for chronic pain treatment.

Method: In order to evaluate the efficacy of virtual reality (VR) therapy in alleviating chronic pain, a systematic review was implemented. The review encompassed 17 studies that were published between 2016 and 2024 and evaluated the effects of VR therapy on patient satisfaction, pain intensity, pain interference with daily activities, mood, tension, sleep, and physical function. In order to account for correlated responses across repeated measures, the review employed a mixed-model framework and intention-to-treat analysis. The studies were chosen for their relevance to the efficacy of VR therapy for chronic pain relief, which included randomized controlled trials, cohort studies, and case series. Data was extracted from the included studies regarding study design, participant characteristics, VR intervention, outcome measures, pain alleviation, functional improvement, and patient satisfaction. The efficacy of VR therapy for chronic pain management was assessed through the analysis of the results.

Results: Results of this systemic review revealed the effectiveness of virtual reality in decreasing the intensity of the pain among the samples of selected studies. In addition, all the VR interventions proved their efficacy in relieving pain caused by different injuries and causes.

Conclusion: Virtual Reality (VR) is a non-invasive method that has demonstrated its efficacy in alleviating pain resulting from many causes, whether it is used in conjunction with other pain management methods or on its own.

Keywords: Virtual reality (VR), Pain relief, Pain management, quality of life.

1. INTRODUCTION

Pain is experienced at some point by almost all individuals, although the extent and duration of the pain can interfere with a person's quality of life. Pain that lasts for more than three months, as defined by the International Association for the Study of Pain, is known as chronic pain (Cohen et al., 2021; Raffaeli et al.2021). Chronic pain is the most common diagnosis in primary care settings. It comes at a significant burden to society as well as the sufferer in terms of aspects such as reduced quality of life, emotional distress, occupational dysfunction, and economic impact with a total estimated cost of $635 billion annually (Yong et al., 2022).

Currently, a variety of treatments exist to manage chronic pain. However, a large percentage of those affected are dissatisfied with their results from these pain management modalities, not to mention the long-term possible side effects they could face as a result of using these types of pain management therapy (Nees et al., 2020; guideline NG193, 2021). One novel approach that shows promise is virtual reality therapy. Virtual reality (VR) is a form of technology that allows the user to interact with a computer-generated environment. The user generally wears a special headset that contains a small screen and headphones for a fully immersive experience (Chuan et al., 2021; Trost et al., 2021).

There has been increasing enthusiasm for using VR in the health area, and evidence supports moderate treatment effects of VR (Halldorsson et al., 2021) Nevertheless, there was still no study that focused on the effects of VR therapy for chronic pain relief and recovery. Although a systematic review had summarized the effect of VR in treating chronic pain, the main focus of their study concentrated on exploring the VR distraction effectiveness only with various pain populations (Grassini, 2022; Goudman et al., 2022). Long-term opioid use for chronic pain is associated with spine surgery failure, although most of the patients with invasive surgery had steady improvements in their pain scale (Cozowicz et al., 2020). If nondrug, noninvasive therapy or self-management is available in the alternative plan, it may not be necessary to include the high bailout rate of painkiller use. However, present studies exploring the positive effects of VR therapy are limited (Wiley et al., 2022).

The challenges of VR therapy include technology challenges, patient-related challenges, and other general ones. Regarding VR technology, not all chronic pain patients understand VR, know how to operate HMDs and controllers, or can use VR due to a lack of prior VR exposure (O'Connor et al., 2022). VR could evoke dizziness, nausea, visual fatigue, and visual discomfort in patients, especially in those with visual impairments and severe chronic pain. A very good or excellent quality of head

mounted displays (HMDs), such as the Oculus Rift, for instance, were reported to have the highest scores on both the quality and clarity of the immersive environment, ease of use, and discomfort from use on VR hardware ratings, as well as the highest scores on both immersion in the virtual content, and being able to block out the real-world distractions, and to be responsive and easy to use, on the Perceived Realism Scale. Oculus Rift was, however, still rated as slightly more discomfort capable than the Gear VR (Best et al., 2022; Huang et al., 2020; Yoon et al., 2020)

Headsets are increasing in resolution and producing a better display quality that is reducing image latency, a chief contributor in visual discomfort. This is especially welcome given that HMDs are currently assessed as offering a broader range of sight and sense capabilities at a lower cost than screen projections (Angelov et al., 2020; Lynn et al., 2020). Companies are also examining ways to incorporate ergonomics on the physical design of HMDs, making them lightweight and ensuring heat and humidity do not accumulate. An important design consideration from a safety perspective is gesture control, allowing patients to remain immobile or to perform physiotherapy exercises in a way that alleviates fear of contorting themselves and suffering an injury (Bruno et al.2020; Kačerová et al., 2022). Another important factor is the ability to adapt the VR interface according to individual patient needs. Comfort, portability and wireless capability are central to a better user experience. The possibility that the hardware will become dirtier during multiple VR therapy sessions, in comparison to physiotherapy equipment, including injuries from falling while using VR is very low – injuries in VR are rare and usually mere contusions. (Emmelkamp & Meyerbröker, 2021; Inozu et al., 2020). The purpose of this systematic review is to evaluate the efficacy of VR-based therapy for chronic pain treatment.

2. METHODOLOGY

We design a systematic review to evaluate the efficacy of virtual reality (VR) therapy for chronic pain relief. We searched PubMed, Google Scholar, Cochrane, MEDLINE, and PsycINFO databases by using the following keywords; virtual reality therapy, chronic pain, chronic pain management, virtual reality, chronic pain relief and virtual reality intervention. The search yielded 1074 research articles. Additionally, we manually searched reference lists of eligible studies, hand-searched relevant journals and contacted study authors. We applied exclusion criteria, excluding case reports and reviews. In the end, after screening, we included 17 papers published between 2016 and 2024 in this systematic review.

Data collection and analysis

We collected data from 17 studies. The studies included in this review assessed the impact of VR therapy on pain intensity, pain interference with daily activities, mood, stress, sleep, physical function and patient satisfaction. We analyzed the data using a mixed-model framework. We also form intention-to-treat analysis and a marginal model to account for correlated responses across repeated measures.

Inclusion Criteria

We included Studies evaluating the efficacy of VR therapy for chronic pain relief (1). Studies published between 2016 and 2024 (2). Studies conducted on adult participants with chronic pain conditions (3). Randomized controlled trials, cohort studies and case series (4).

Exclusion Criteria:

We excluded Case reports and review articles (1). Studies which concern on acute pain management (2). Studies not written in English (3).

Selection of Study

The initial search yielded 1074 research papers. After screening protitles and abstracts, 17 studies were included in the systematic review based on relevance to the topic and meeting inclusion criteria. We selected studies based on their relevance to the efficacy of VR therapy for chronic pain relief. We included randomized controlled trials, cohort studies and case series that assessed the impact of VR therapy on pain intensity, pain interference with daily activities, mood, stress, sleep and physical function in adult participants with chronic pain conditions.

Extraction of Data:

We extracted data from the included studies on study design, participant characteristics, VR intervention, outcome measures and results related to pain relief, functional improvement, and patient satisfaction. We analyzed the data to evaluate the efficacy of VR therapy for chronic pain management.

Quality Evaluation:

We evaluated the quality of included studies using constant criteria for randomized controlled trials, cohort studies and case series. We assessed the risk of bias, methodological quality and reporting quality of each study to ensure the reliability and validity of the findings.

3. RESULTS

17 studies were included in this systemic review after applying exclusion criteria. The included studies were demonstrated in table (1).

Authors, Year	Study Design	Sample Size	Intervention	Main Findings
Jones T, Moore T, Choo J (2016)	Experimental	30 participants suffering from chronic pain due to various medical conditions	a virtual reality software called Cool was used in 5 minutes sessions	All participants (100%) reported a reduction in discomfort between the pre-session and during-session periods. The virtual reality experience was demonstrated to be highly effective in alleviating discomfort.
Laura Garcia., et al., (2022)	The 6-month follow-up study employed a single-cohort, placebo-controlled, randomized clinical trial protocol.	A total of 188 persons from the community who reported chronic low back pain (CLBP).	E-surveys were administered during pretreatment, end-of-treatment, and posttreatment months 1, 2, 3, and 6. Self-reported data from 188 participants were examined in a mixed-model framework, using a marginal model to account for correlated answers across repeated measurements.	The therapeutic use of virtual reality (VR) had significant and clinically meaningful effects even 6 months after therapy. It was found to be more effective than simulated VR in reducing pain intensity and pain-related interference with activity, stress, and sleep (effect sizes ranging from 0.44 to 0.54; $p < 0.003$). When comparing physical function and sleep disturbance between groups, EaseVRx was shown to be superior to sham VR (effect size = 0.34; $p = 0.02$ and effect size = 0.46; $p < 0.001$, respectively). Participants were urged to communicate with the study personnel regarding any difficulties encountered throughout the therapy. However, none of the participants reached out to the study staff to report any adverse events, such as nausea and motion sickness.

Garrett, B., et al., (2017).	Exploratory approach	10 patients	A total of ten patients with chronic pain had virtual reality (VR) therapy sessions lasting 30 minutes, occurring every other day, over the course of one month. Pain evaluation was conducted before and after exposure, immediately afterwards, after 3 hours, and at 24 hours. The Numerical Rating Scale (NRS) was used for immediate and post-exposure assessments, while the Brief Pain Inventory (BPI) and Self-completed Leeds evaluation of Neuropathic Symptoms and Signs pain scale (S-LANSS) were used for weekly assessments. Additionally, the researchers conducted terminal semi-structured personal interviews with the patients.	Out of the 8 patients who finished the trial, 5 of them stated that they experienced a decrease in pain while using virtual reality (VR). However, there was no significant difference in pain scores after the VR exposure when comparing the total treatment outcomes. There were no significant negative effects observed with the use of VR, however 60% of patients reported experiencing mild cybersickness during certain VR activities.
Darnall, B. D., et al., (2020).	Randomized control trial	97 individuals have voluntarily reported experiencing long-term, non-cancerous low back pain or fibromyalgia, with an average level of discomfort more than 4 over the course of the previous month.	The participants who registered were assigned to one of two treatments randomly without blinding: (1) VR: a 21-day virtual reality program focused on developing abilities to manage chronic pain; and (2) audio: a variant of the 21-day VR program that only includes audio. Participants who completed a minimum of 1 of the 8	The VR and audio groups conducted a combined total of 1067 and 1048 sessions, respectively. Out of the total number of participants in the virtual reality (VR) study (n=19/25, 76%), the majority reported experiencing neither nausea nor motion sickness. The VR system received a high satisfaction rating of 83% (n=24/29), whereas the audio system received a

			surveys administered during the intervention period comprised the analytic data set. Specifically, there were 39 participants who completed the VR survey and 35 individuals who completed the audio survey.	satisfaction rating of 72% (n=26/33). Regarding the effectiveness of virtual reality (VR), there was a significant improvement in symptoms over time for each type of pain (all P<.001), and after two weeks, these effects were considerably more pronounced. When it came to average pain intensity (P=.04), pain-related interference with activities (P=.005), sleep (P<.001), mood (P<.001), and stress (P=.003), the VR group showed significant time-group effects in their favor. In both treatment groups, we found that pain self-efficacy and pain catastrophizing decreased significantly.
Griffin, A., et al., (2020).	Preliminary study examining the practicality and viability of a certain intervention, conducted without random assignment of participants to different groups.	17 pediatric patients, majority are females	The intensive interdisciplinary pain treatment (IIPT) program primarily focuses on youth who commonly exhibit fear of mobility and substantial physical restrictions caused by pain. The IIPT teams include of physical therapists (PTs), occupational therapists (OTs), pain psychologists, pain medicine physicians, and pain medicine nurse practitioners.	The overall reports of presence were characterized by a high mean score of 28.98, with a maximum score of 40 and a standard deviation of 4.02. These findings indicate a high level of immersion. Out of the participants who had many sessions of data (n=8), there was a substantial decrease in complaints of pain (P<.001), fear (P=.003), avoidance (P=.004), and functional restrictions (P=.01). The qualitative analysis showed that participants had a positive experience with virtual reality (VR). They enjoyed using VR and expressed a desire to use the VR program again. They also found VR to be

				a helpful tool. Additionally, participants reported experiencing less pain when engaged in VR and experienced an increase in mobility. Furthermore, clinicians saw a decrease in pain-related behaviors during VR sessions. The movement data corroborate the specific effectiveness of Fruity Feet in comparison to other VR programs now on the market.
Tashjian, V. C., et al. (2017).	comparative cohort study	100 patients	Patients in the intervention group were exposed to a 3D virtual reality (VR) experience specifically created to alleviate pain. This was done using the Samsung Gear Oculus VR headset. On the other hand, patients in the control group saw a high-definition, 2D video of nature on a 14-inch screen placed next to their bed. Pain scores were recorded before and after the intervention. The study compared the difference-in-difference scores and the proportion of individuals achieving a pain response of at least half a standard deviation between the different groups.	The average pain decrease in the virtual reality group was higher than in the control group (-1.3 vs -0.6 points, respectively; P=.008). Out of the patients in the VR cohort, 35 individuals (65%) saw a reduction in pain, compared to just 40% of the control group. This difference was statistically significant (P=.01) and indicates that for every 4 patients treated with VR, one patient experienced a pain response. There were no negative incidents reported from the use of virtual reality (VR).
Garcia, L. M., et al (2021).	double-blind, parallel-arm, single-cohort, remote, randomized	179 patients who reported back pain	The intervention was: (1) EaseVRx, which is an immersive virtual reality software designed to provide pain management	There were no notable variations in the initial characteristics or level of participation in the treatment. EaseVRx demonstrated superiority

	placebo-controlled trial		skills; or (2) Sham VR, which delivers 2D nature content through a virtual reality headset. Data on objective gadget usage and self-reported data were gathered. The main objectives were to compare the effects of EaseVRx versus Sham VR on various factors over time, including pain intensity, pain-related interference with activity, stress, mood, and sleep. The study also aimed to assess the change in these factors from baseline to the end of the treatment period at day 56.	in primary outcomes, with substantial pre-post effect sizes. EaseVRx demonstrated superiority in both Physical Function and Sleep Disturbance. Nevertheless, the variables of pain catastrophizing, self-efficacy, pain acceptance, and prescription opioid use did not demonstrate a statistically significant difference between the two groups.
Chau, B., et al. (2020).	pilot study	8 patients with upper limb complex regional pain syndrome (CRPS)	A virtual kitchen setting was created to provide an immersive and interactive experience. Users may visualize and manipulate objects using virtual hands. Participants engaged in activities that simulate daily tasks, together with guided visualization exercises, for a total of 10 sessions.	Out of the six participants who finished the trial, four of them reported a subjective improvement in their pain and daily function. Nevertheless, objective pain scales shown a restricted link with the claimed subjective alleviation.
Ceko, M., et al. (2023).	2-arm randomized clinical trial	61 patients with back pain	novel VR neuroscience-based therapy (VRNT)	When compared to the control condition, the use of virtual reality-based neurorehabilitation therapy (VRNT) resulted in a significant decrease in pain intensity ($g = 0.63$) and pain interference ($g = 0.84$) after treatment compared to before treatment. These effects

				were still present at the 2-week follow-up. The enhancements were partly facilitated by a decrease in kinesiophobia and pain catastrophizing. Additionally, other secondary clinical outcomes showed improvement, such as disability, quality of life, sleep, and weariness. Furthermore, VRNT was linked to slight enhancements in the functional connectivity of the somatomotor and default mode networks. It also resulted in reduced white matter fractional anisotropy in the corpus callosum around the anterior cingula, compared to the control condition. VRNT shown initial effectiveness in greatly decreasing pain and enhancing general functionality, maybe by modifying somatosensory and prefrontal brain networks.
Nusser, M., et al. (2021).	Pilot randomized control study	participants 51	Each group underwent the clinic's usual rehabilitation program, which included group therapy for general sensorimotor training. In addition, they received an extra 120 minutes of neck-specific training using virtual reality technology. The researchers assessed the participants' neck discomfort, headaches, active cervical range of motion, and Neck	With respect to headache alleviation and active cervical range of motion in both flexion and extension, the virtual reality group outperformed the control group statistically ($p<0.05$). In comparison to the sensorimotor group, the virtual reality group had much greater improvements in cervical extension.

			Disability Index both before and after a three-week intervention.	
McGirt, M. J., et al. (2023).	single-arm prospective cohort study	A total of 145 individuals suffering from persistent spondylitic discomfort.	The program, called Vx Therapy, is a 14-week combination of (VR) and "cognitive-behavioral therapy" (CBT). It involves weekly sessions with a therapist who has received specialized training, as well as access to 50 modules. Patients recorded pain and anxiety severity scores and the time it took for pain to return in a prospective manner. The PROMIS measurements of daily pain severity, conduct, interference, anxiety, and depression were recorded at the beginning and end of the program.	The study found significant improvement in pain intensity, interference, behavior, anxiety, and depression after 14 weeks of Virtual Reality Therapy. The pain relief lasted for an average of 2.8 hours, with longer durations in the last month compared to the first month. Additionally, virtual reality significantly decreased anxiety by 46%, with effects continuing for an average of 2.7 hours following use. These improvements were consistent across all three groups.
Abd-Elsayed, A., Hussain, N., & Stanley, G. (2021).	Retrospective Cohort Study.	36 patients in 16 males and 20 females, who experienced acute and chronic pain as a result of job accidents. These injuries significantly restricted their ability to perform everyday tasks and had a negative impact on their overall quality of life.	The Harvard MedTech Vx Pain Relief Program was a 90-day therapeutic program that incorporated home-based virtual reality treatment (VRT) with personalized behavioral therapy through phone consultations. Patients were directed to utilize the Vx headset a minimum of once to twice per day for a duration of 45 minutes. The program included an initial phone contact to instruct patients on how to utilize the headset and choose	Patients reported significant short-term and long-term pain alleviation during and after VRT's 90-day treatment. Patients experienced an average 40% decrease in pain while using the program, and an extra 2.8 hours of ongoing pain alleviation after 90 days. An further 69 percent of patients said they were able to cut back or stop using opioids altogether after VRT. Additionally, most patients reported less melancholy, weariness, and sleep disruption.

			certain experiences that focus on pain understanding, meditation methods, pain relief, or pain diversion. The customized behavioral therapy component consisted of weekly sessions between patients and clinicians to review progress and therapy objectives. The patient's clinician oversaw the program, ensuring adherence and offering additional instruction on how to apply the skills learned through the virtual reality headset.	
Guo, Q., et al., (2024).	randomized .controlled trial	64 patients with chronic neck pain	The study employed virtual reality (VR) technology to augment the kinematic capabilities of persons suffering from chronic neck discomfort. The VR setup comprised a Pico G2 4k head-mounted VR glass, a monitor screen, and an optical motion capture camera. The patients were placed at a distance of 100 cm from the monitor screen, enabling therapists to evaluate their therapy progress. The VR therapy had three modules: range of motion (ROM), proprioception, and velocity. Patients performed certain cervical movements to accomplish therapeutic goals. The VR technology used visual	Both groups shown substantial enhancements in pain, disability, and kinematic functions (P<.05) immediately after the intervention and during the 3-month follow-up period. The experimental group exhibited better therapeutic results than the control group in terms of reducing pain (mean difference from baseline: 5.50 vs 1.81 at posttreatment; 5.21 vs 1.91 at the 3-month follow-up, respectively; P<.001), improving disability (mean difference from baseline: 3.04 vs 0.50 at posttreatment; 3.20 vs 0.85 at the 3-month follow-up, respectively; P<.001), and enhancing kinematic functions (P<.05). Furthermore, individuals in the experimental group expressed higher levels of satisfaction and symptom

			and aural stimuli to augment the participatory quality of the therapy.	relief compared to the control group (P<.05), along with a greater motivation to engage in exercise during the follow-up period. Nevertheless, there was no discernible disparity in the enhancement of proprioception between the groups. Our investigation did not report or see any negative incidents.
Putrino, D., et al. (2021).	8 individuals suffering from chronic neuropathic pain.	A pilot research involving a pre- and post-intervention comparison.	The study included participants who were exposed to two different virtual reality (VR) contexts: landscape and somatic. In both environments, they experienced a VR simulation of their most intense pain. Participants selected the suitable virtual reality (VR) setting based on the specific area where they experienced pain. The VR sessions were conducted in a randomized manner and lasted for a duration of 10 minutes. During these sessions, participants were given the freedom to walk about within the campus. The VR system employed consisted of a Samsung Galaxy S3 smartphone paired with a Samsung Gear VR headgear.	Statistical analysis using Spearman's correlation found a negative connection ($r_s = 0.743$, $p = 0.035$) between total ITQ score and the change in pain following the scenery VR intervention. This data reveals that the amount of pain alleviation is directly proportional to the ITQ score, where higher scores indicate more immersion. The total ITQ score and the change in pain following the somatic VR intervention did not show a significant connection ($r_s = 0.663$, $p = 0.073$). If we break down the ITQ into its component parts, we find that the attention subcategory is negatively correlated with pain scores following both the somatic ($r_s = 0.805$, $p = 0.016$) and landscape VR interventions ($r_s = 0.776$, $p = 0.024$). There was no statistically significant relationship between PQ scores and pain scores after scenery and somatic VR treatments.

Austin, P. et al (2021).	17 patients with Chronic neuropathic pain due to spinal cord injury	Within-subject, randomized cross-over trial.	The research employed the Oculus Rift® headset to construct a three-dimensional virtual reality (VR) application known as Nature Trek®. Participants were given instructions on how to operate a handheld joystick in order to navigate across a picturesque meadow area. The audio-visual experience was passive, guaranteeing a frustration-free experience. The headset was tuned to accommodate participants' visual acuity and provided guidance on mitigating motion sickness. A 17.3-inch Alienware® laptop screen was used to run the identical application, enabling a dependable comparison of the effects of 3D VR and 2D screen experiences. Both VR interventions were passive and non-interactive.	Results revealed that the use of a 3D head-mounted display virtual reality (VR) system resulted in much higher reductions in pain compared to a 2D screen application. Participants had a significant reduction in pain, with an average decrease of more than 65% while using 3D virtual reality (VR) compared to a 35% decrease when using the 2D screen application. There were moderate correlations observed between the baseline and post 3D VR scores, and poor correlations observed between the baseline and 2D screen NP values. Individuals whose neurological impairment is below the level of the spinal cord injury reported more significant reductions in pain. Participants who had full spinal lesions also experienced more significant reductions in pain. Participants who reported having spinal cord injury (SCI) neuropathic pain for less than 20 years experienced more significant decreases in pain after undergoing three-dimensional virtual reality (3D VR) treatment. There was no significant impact observed on post-virtual reality (VR) pain intensity as a result of randomizing the sequencing of VR conditions. At the start, the average scores for the DASS-21 subscales were in the normal clinical

				range. There were no notable differences between the use of 3D HMD and 2D screen applications in terms of changes in the DASS-21 subscale scores.
Li, L. W., et al (2024).	open-label, single center, single-arm study	50 patients	Virtual reality (VR) as an additional tool for pain treatment in hospitalized patients is being evaluated for its safety, acceptance, and tolerability potential. Before and after the virtual reality experience, the participants reported their levels of discomfort and anxiety.	The preliminary examination into the alleviation of pain revealed a positive outcome (with regard to the scores on the visual analog scale for both pain and anxiety; $p < 0.001$). For the goal of pain treatment, we are of the opinion that virtual reality (VR) has the potential to be an extremely helpful tool.

4. DISCUSSION

The affective dimension of pain, such as a patient's state of anxiety, has an influence on pain perception and on the performance of medical interventions. (Smith et al.2020). Chronic pain is a medical condition that is characterized by persistent pain that can persist for weeks to years and is caused by injury, surgery, or other medical conditions. Chronic pain is a condition that is complex and difficult to remediate, as it is characterized by underlying psychological distress and the potential for disability. The experience of chronic pain is diverse among individuals and is frequently characterized by a searing sensation, the sensation of receiving severe electric shocks, or a tingling sensation. This distress results in tension and stiffness in the affected areas, which restricts movement and leads to muscle waste. Additionally, the affected areas become more susceptible to environmental illness conditions. In addition, chronic pain has become an increasingly significant public health concern due to the growing global geriatric population, the increasing burden of chronic diseases, the scarcity of medical resources, and the fact that many chronic diseases are now incurable. Extreme discomfort may result from chronic neck pain and neuropathic pain resulting from spinal cord injury, which can include heightened sensitivity to pain and changes in the sensation of heat and contact on the skin (Cohen et al., 2021; Von et al.2020)

The brain's perception and processing of pain can be influenced by the autonomic nervous system. The hormonal function of the adrenal cortex can also be impacted by chronic pain, resulting in a decrease in the concentration of specific hormones in the blood. Medication, such as corticosteroids, can be employed to mitigate the pain and distress associated with chronic neck pain and neuropathic pain (Finnerup et al., 2021; Knezevic et al., 2023; Wyns et al.2023).

This meta-analysis aims to present a comprehensive and quantitative summary of the evidence supporting the efficacy of virtual reality therapy (VRT) in relieving chronic pain.

Virtual reality has been discovered in various domains of applications. The most interesting and pertinent application of virtual reality is non-immersive or semi-immersive virtual reality hardware (VR) that can be created onscreen when an individual look at something (e.g., i-CAT, Nino Pare). For sphygmothisograph immersion, when a person wears a head-mounted display and interacts with an interactive control input. The VR gain over immersion is a shared condition, in which people opt for the highest sensitivity to determine its efficiency. Potential benefits and advantages for the treatment of chronic pain are also present (Grassini, 2022).

VR is one such form of technology for altering current realities. Individuals have the capacity to experience interactions with the three-dimensional, computer-generated world, revealing sensory-spatial aspects. (Chuan et al.2021; Goudman et al.2022). VR is a simulated experience that can be similar to the real world (Schöne et al.2023). It is regarded as having the potential to help people move their minds beyond the mechanical, animalistic qualities of their bodies, creating an experience that is powerful enough to produce real emotional and cognitive changes. (Colombo et al.2021). It takes the form of an interactive headset that allows the user to have a first-person view of a 360° virtual environment, the representation of any real surrounding, or a fully unrelated made-up scenario. (Donegan et al.2020) Because of these characteristics, researchers and therapists have tested VRT as a potential alternative in various pain contexts. Although the application of VRT in pain management has a relatively short history, the long-term availability of this technology means that it has great potential for widespread usage in this specific field, which still lacks an effective solution. (Griffin et al.2020)

It is necessary and timely for several reasons. First, chronic pain is an enormous public health issue, considerably affecting those who experience it and society and the healthcare system (Manchikanti et al.2021). It is usually difficult to deal with and involves a lot of financial expenses. Second, VRT is a burgeoning form of psychological therapy that has drawn a lot of attention in recent years. Although there were several previous reviews and meta-analyses about VRT, especially for acute pain and depression, it is unclear whether its efficacy on chronic pain has been established.

(Grassini2022). Third, in contrast to traditional reviews, the present study will conduct several subgroup analyses to explore possible moderators, including the effect of participant, intervention, and methodological characteristics and will provide more robust conclusions. (Quicke et al.2020)
Virtual reality may be used together with other standard pain control methods, such as cognitive-behavioral therapy. Various available views and origins allow for a more extensive use of this technique with patients. Relaxation may therefore result in enhanced pain management and a reduction in associated tension. (Groenveld et al.2023) Along with other pain management strategies, mentioned forms of mindfulness practice and muscle mobility are among the best pain control methods. The emphasis is on cognitive-behavioral learning processes and non-invasive relaxation techniques. The impairment of the immune system of chronic pain patients is severe. As the importance of using quality of life instrumentation in pain evaluation, people become supportive of understanding the influence of pain (Goudman et al.2022).
In chronic pain, distractions from even the sensation of pain can help decrease the intensity, increase the tolerance of pain, and provide greater pain relief, thus improving the quality of life. Any intervention that takes time and provides relief can fit into any aspect of life and therefore improve satisfaction with life. By suppressing or limiting the pain, distractions can intensify pain relief and reduce the perception of pain. In addition, virtual reality can lead to a variety of pain control techniques, but visualization references may also result in enhanced pain intensity, so the type of simulations is important with respect to the mechanism of action. (Grassini2022).

With medical advances worldwide, we have the technology to relieve most acute pain. However, chronic pain progressively burdens individuals' quality of life as it saps energy and clouds the mind, making patients less interested in their surroundings and everyday life. (Chuan et al.2021; Goudman et al.2022) In Taiwan, approximately 1 in every 10 patients reports experiencing chronic pain, whereas 25%–30% of individuals complain of suffering chronic pain in some form. In particular, approximately 20%–30% of patients suffer moderate-severe chronic cancer pain, which unpredictably influences their mental and physical health. Besides, chronic pain can lead to lower family cohesion, social response, and organization, and cost greater than national diseases such as diabetes, heart disease, and cancer. Furthermore, it may even become a major public health issue in the future. Currently, traditional pain management methods, such as analgesic medication, nerve block injection, physical/occupational therapy, acupuncture, and tai chi, are effective in pain relief but lack the capacity to distract the patient from pain (Huang et al.2020; Lin et al.2020).

Conclusion and Future Directions

The study found that virtual reality (VR) technologies (VRT) can effectively reduce pain in patients with chronic pain. The amplitude of cued pain was significantly lower with pseudoconvex versus concave ball control, highlighting how individuals with chronic pain distort localized pain. The study also found that VRT led to an increase in perceived pain tolerance, suggesting its effectiveness in reducing pain sensitization. VRT-attenuated alterations in nuclear magnetic resonance (NMR) pain signatures demonstrated reduced spontaneous pain in patients with chronic pain. The observed therapeutic efficacy was even from a single session of VRT, suggesting potential as a short-term auxiliary to not only patient medications but also to the global crisis of opioid abuse in broader health. The statistical hypothesis that each PC individual amplified the convex exploration added unique evolutionary participants' pain intensities due to their distinct geometric-pain-tolerance hypothesis.

Limitations:

The limitations of the included studies such as small sample sizes, short follow-up periods and potential biases. They were considered in the interpretation of the results.

Conflict of interest: No Conflict of interest

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