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#### Introduction

Immersive virtual reality (IVR) is being used in a variety of areas for different purposes across health care. For example, patients benefit from IVR as a distraction from acute pain, as an engaging approach for completing rehabilitation exercises, and to safely practicing coping skills. Additionally, IVR programs have been developed to provide medical and allied health students and practitioners opportunities to hone their skills. Because of the extensive research being conducted across the health care continuum, this compendium was developed to provide medical professionals with insights into the evidence base with particular focus on use in health care (see Table 1), physical rehabilitation (see Table 2), mental health care (see Table 3), peer support (see Table 4), pulmonary rehabilitation (see Table 5), clinical education (see Table 6), medical training (see Table 7), patient education (see Table 8), and palliative care (see Table 9).

#### Methods

To clarify the parameters of the article search and the criteria for inclusion in the compendium, the Literature Search Protocol was developed (see <u>Appendix A</u>). To show the full history of IVR, no restrictions were placed on publication dates. Only articles available in English were considered. The compendium includes research articles, review articles, meta-analyses, and practice guidelines, while books, magazine articles, news articles, opinion pieces, conference abstracts, and study proposals/proposed research protocols were excluded.

Searches were conducted in PubMed and Science Direct using the keywords immersive virtual reality and the topic area (health care, physical rehabilitation, mental health treatment, peer support, pulmonary rehabilitation, clinical education, medical training, patient education, and palliative care). Several topic areas had a small number of articles included in the compendium following these searches, so additional searches of Google Scholar were conducted for peer support, pulmonary rehabilitation, patient education, and palliative care. Articles identified in the searches were reviewed using the criteria in the Literature Search Protocol (see <u>Appendix A</u>) to determine whether or not they would be included in the compendium. Articles that did not have abstracts or were retracted prior to the search were not included in the compendium.

#### Results

Overall, 643 articles were included in the compendium, ranging in date of publication from 1995 – 2024. Tables 1 – 9 include citations and abstracts of the articles for each topic area. Duplicate articles within a topic area were removed, but articles that appeared in searches in multiple topic areas were maintained if relevant to that topic area.

### How to use this compendium

Each table includes the results of searches conducted for a topic area, so if you are interested in a particular topic, scroll through the articles listed in that table. If you are interested in a particular subject that may span multiple tables, consider using the search function of the document (CTRL+F) to find all potentially relevant articles across topics. Citations and DOI links are available for all articles to direct you to the full article.





# Table 1: Health Care

Citation	Abstract
Aebersold M, Rasmussen J,	New technologies such as immersive virtual reality provide opportunities to
Mulrenin T. Virtual Everest:	create realistic environments to increase the fidelity of experiences. This
Immersive Virtual Reality	innovation is to add an immersive virtual reality experience to enhance a 2D
Can Improve the Simulation	simulation. The innovation was implemented in a graduate leadership course.
Experience. Clinical	The class was divided into two teams and one team was exposed to the
Simulation in Nursing.	immersive virtual experience. After that, the class participated in a team-based
2020;38:1-4.	simulation called Everest V2 by the Harvard Business Publisher. Qualitative
doi:10.1016/j.ecns.2019.09.	theme analysis showed three themes that emerged from the reflection:
004	Communication, Team Dynamics, and Success versus Failure.
Ahmadi Marzaleh M, Peyravi	Background and aims: The COVID-19 pandemic has changed people's
M, Azhdari N, et al. Virtual	lifestyles as well as the way healthcare services are delivered. Undoubtedly, the
reality applications for	difficulties associated with COVID-19 infection and rehabilitation and those
rehabilitation of COVID-19	associated with quarantine and viral preventive efforts may exacerbate the need
patients: A systematic	for virtual reality to be used as a part of a complete rehabilitation strategy for
review. Health Sci Rep.	these individuals. Thus, the present research aimed to evaluate the potential
2022;5(6):e853. Published	uses of virtual reality for the rehabilitation of individuals suffering from COVID-
2022 Oct 3.	19. Methods: From 2019 to March 1, 2022, a systematic search was conducted
doi:10.1002/hsr2.853	in PubMed, Cochran Library, Scopus, Science Direct, ProQuest, and Web of
	Science databases. The papers were selected based on search terms and those
	that discussed the use of virtual reality in the rehabilitation of COVID-19 patients
	were reviewed. Each step of the study was reviewed by two authors. <b>Results:</b> A
	total of 699 papers were found during the first search. Three papers were chosen
	for further investigation after a thorough evaluation of the publications' titles,
	abstracts, and full texts. Cross-sectional studies, randomized controlled clinical
	trials, and case reports comprised 33%, 33%, and 33% of the publications,
	respectively. Based on the results, people suffering from COVID-19 were the
	focus of two papers (66%) that employed immersion virtual reality for cognitive
	rehabilitation, whereas one study (33%) used non-immersive virtual reality for
	physical renabilitation. In two papers (66%), virtual reality was also offered to
	patients in the form of a game. <b>Conclusion:</b> According to the results of the
	present research, virtual reality games may enhance functional and cognitive
	consequences, contentment levels among patients, and their ability to take
	charge of their own health care. In tight of the obstacles faced by COVID-19
	patients, alterations in the delivery of healthcare, and the significance of
	renabilitation in this group during quarantine, new techniques have been
	considered for these patients to maintain treatment, return to regular life, and





Ambron E, Buxbaum LJ, Miller A, Stoll H, Kuchenbecker KJ, Coslett HB. Virtual Reality Treatment Displaying the Missing Leg Improves Phantom Limb Pain: A Small Clinical Trial. <i>Neurorehabil Neural</i> <i>Repair</i> . 2021;35(12):1100- 1111. doi:10.1177/1545968321105 4164	<b>Background:</b> Phantom limb pain (PLP) is a common and in some cases debilitating consequence of upper- or lower-limb amputation for which current treatments are inadequate. <b>Objective:</b> This small clinical trial tested whether game-like interactions with immersive VR activities can reduce PLP in subjects with transtibial lower-limb amputation. <b>Methods:</b> Seven participants attended 5-7 sessions in which they engaged in a visually immersive virtual reality experience that did not require leg movements (Cool! <sup>™</sup> ), followed by 10-12 sessions of targeted lower-limb VR treatment consisting of custom games requiring leg movement. In the latter condition, they controlled an avatar with 2 intact legs viewed in a head-mounted display (HTC Vive <sup>™</sup> ). A motion-tracking system mounted on the intact and residual limbs controlled the movements of both virtual extremities independently. <b>Results:</b> All participants except one experienced a reduction of pain immediately after VR sessions, and their pre session pain levels also decreased over the course of the study. At a group level, PLP decreased by 28% after the treatment that did not include leg movements and 39.6% after the games requiring leg motions. Both treatments were successful in reducing PLP. <b>Conclusions:</b> This VR intervention appears to be an efficacious treatment for PLP in subjects with lower-limb amputation.
Andersen NL, Jensen RO,	This study was aimed at comparing the learning efficacy of a traditional
Konge L, et al. Immersive	instructor-led lesson with that of a completely virtual, self-directed lesson in
Virtual Reality in Basic Point-	immersive virtual reality (IVR) in teaching basic point-of-care ultrasound
of-Care Ultrasound Training:	(PoCUS) skills. We conducted a blinded, non-inferiority, parallel-group,
A Randomized Controlled	randomized controlled trial in which final-year medical students were
Trial. Ultrasound in Medicine	randomized to an instructor-led (n = 53) or IVR (n = 51) lesson. Participants'
& Biology. 2023;49(1):178-	learning efficacy was evaluated by blinded assessors, who rated each
185.	participant's performance using the Objective Structured Assessment of
doi:10.1016/j.ultrasmedbio.	Ultrasound Skills (OSAUS) assessment tool. The mean total scores for
2022.08.012	participants were 11.0 points (95% confidence interval: 9.8–12.2) for the
	instructor-led lesson and 10.3 points (95% confidence interval: 9.0–11.5) for the
	IVR lesson. No significant differences were observed between the groups with
	respect to total score (p = 0.36) or subgroup objectives of the OSAUS score
	(p = 0.34  for familiarity, p = 0.45  for image optimization, p = 0.96  for systematic
	approach and p = 0.07 for interpretation). Maintenance costs for both courses
	were estimated at 400 euros each. Startup costs for the instructor-led course
	were estimated 16 times higher than those for the IVR course. The learning
	efficacy of an instructor-led lesson on basic US did not differ significantly from
	that of a self-directed lesson in IVR, as assessed using the OSAUS. The results
	suggest that IVR could be an equivalent alternative to instructor-led lessons in
	future basic US courses, but further research is warranted to clarify the role of
	IVR in PoCUS courses.





Arlati S, Di Santo SG, Franchini F, et al. Acceptance and Usability of Immersive Virtual Reality in Older Adults with Objective and Subjective Cognitive Decline. *J Alzheimers Dis*. 2021;80(3):1025-1038. doi:10.3233/JAD-201431 **Background:** Virtual reality (VR) has recently emerged as a promising means for the administration of cognitive training of seniors at risk of dementia. Immersive VR could result in increased engagement and performances; however, its acceptance in older adults with cognitive deficits still has to be assessed. Objective: To assess acceptance and usability of an immersive VR environment requiring real walking and active participants' interaction. Methods: 58 seniors with mild cognitive impairment (MCI, n = 24) or subjective cognitive decline (SCD, n = 31) performed a shopping task in a virtual supermarket displayed through a head-mounted display. Subjective and objective outcomes were evaluated. Results: Immersive VR was well-accepted by all but one participant (TAM3 positive subscales > 5.33), irrespective of the extent of cognitive decline. Participants enjoyed the experience (spatial presence 3.51±0.50, engagement 3.85±0.68, naturalness 3.85±0.82) and reported negligible side-effects (SSQ: 3.74; q1-q3:0-16.83). The environment was considered extremely realistic, such as to induce potentially harmful behaviors: one participant fell while trying to lean on a virtual shelf. Older participants needed more time to conclude trials. Participants with MCI committed more errors in grocery items' selection and experienced less "perceived control" over the environment. **Conclusion:** Immersive VR was acceptable and enjoyable for older adults in both groups. Cognitive deficits could induce risky behaviors, and cause issues in the interactions with virtual items. Further studies are needed to confirm acceptance of immersive VR in individuals at risk of dementia, and to extend the results to people with more severe symptoms.





Ayed I, Ghazel A, Jaume-i-Capó A, Moyà-Alcover G, Varona J, Martínez-Bueso P. Vision-based serious games and virtual reality systems for motor rehabilitation: A review geared toward a research methodology. *International Journal of Medical Informatics*. 2019;131:103909. doi:10.1016/j.ijmedinf.2019. 06.016 Background: Nowadays, information technologies are being widely adopted to promote healthcare and rehabilitation. Owing to their affordability and use of hand-free controllers, vision-based systems have gradually been integrated into motor rehabilitation programs and have greatly drawn the interest of healthcare practitioners and the research community. Many studies have illustrated the effectiveness of these systems in rehabilitation. However, the report and design aspects of the reported clinical trials were disregarded. Objective: In this paper, we present a systematic literature review of the use of vision-based serious games and virtual reality systems in motor rehabilitation programs. We aim to propose a research methodology that engineers can use to improve the designing and reporting processes of their clinical trials. **Methods:** We conducted a review of published studies that entail clinical experiments. Searches were performed using Web of Science and Medline (PubMed) electronic databases, and selected studies were assessed using the Downs and Black Checklist and then analyzed according to specific research questions. Results: We identified 86 studies and our findings indicate that the number of studies in this field is increasing, with Korea and USA in the lead. We found that Kinect, EyeToy system, and GestureTek IREX are the most commonly used technologies in studying the effects of vision-based serious games and virtual reality systems on rehabilitation. Findings also suggest that cerebral palsy and stroke patients are the main target groups, with a particular interest on the elderly patients in this target population. The findings indicate that most of the studies focused on postural control and upper extremity exercises and used different measurements during assessment. Conclusions: Although the research community's interest in this area is growing, many clinical trials lack sufficient clarity in many aspects and are not standardized. Some recommendations have been made throughout the article.





Bailey AL, Kirsh S, Rawlins CR, Persky S, Clancy C. Early Scaling of Immersive Technology Within the Veterans Health Administration. *NEJM Catalyst*. 2024;5(4). doi:10.1056/CAT.23.0356 Over the past several years, accelerated by the Covid-19 pandemic, immersive technologies — including virtual reality and augmented or mixed reality, also known collectively as extended reality — have shown mounting promise in their ability to enhance clinical care delivery and support clinical staff. These immersive systems can be used alongside standard of care in several areas and, at minimum, be used as additional ways to augment evidence-based therapies. These noninvasive and easy-to-use tools have demonstrated the ability to effectively channel patient experience into therapeutic activities, facilitate home-based care, provide valuable longitudinal patient data, and enhance treatment adherence. Given this promise, immersive health care applications have spread across the U.S. Veterans Health Administration (VA), building additional evidence for efficacy and laying implementation groundwork. To date, VA has documented more than 40 indications for immersive technology utilization within the organization, with more in the pipeline. Early exploration of immersive technology in VA began with 5 sites and 10 staff engaged in a Community of Practice and has now grown to 172 sites and more than 2,400 engaged VA staff. The most uptake and impact have been seen in pain management, physical rehabilitation, and mental health care, including anxiety, depression, and posttraumatic stress disorder. Crucial to further scaling the use of immersive technology, VA has developed standardized resources, such as knowledge networks, implementation guides, electronic health record templates, and standard operating procedures. VA continues to offer opportunities for more heads in headsets, because this is an effective way to demonstrate to veterans and staff how immersive technology can enhance care. Key to future success in VA will entail increasing equitable access, growing the scope of content, standardizing training for staff and patients, and improving processes for synthesizing and analyzing relevant data to optimize these tools. Through these activities and continued planning, VA is poised to define the landscape of immersive technology in health care and inform adoption beyond VA.





Barry KS, Nimma SR, Spaulding AC, Wilke BK, Torp KD, Ledford CK. Perioperative Outcomes of Immersive Virtual Reality as Adjunct Anesthesia in Primary Total Hip and Knee Arthroplasty. *Arthroplast Today*. 2022;18:84-88. Published 2022 Oct 22. doi:10.1016/j.artd.2022.09.0 15

Background: Immersive virtual reality (IVR) is utilized as an adjunct to anesthesia to distract patients from their intraoperative environment, thereby potentially reducing sedative and narcotic medication usage. This study evaluated intraoperative and acute postoperative results of patients undergoing primary total hip (THA) and total knee arthroplasty (TKA) with and without IVR. Methods: Utilizing IVR as an adjunct to spinal anesthesia, 18 primary THAs (n = 8) and TKAs (n = 10) were performed. These cases were 1:2 matched based on procedure type, age, sex, and body mass index to those performed without IVR. Intraoperative and postanesthesia care unit sedative/narcotic usage, vital signs, and pain scores were compared. Acute perioperative outcomes, including 24hour oral morphine equivalent (OME), first ambulation distance, length of stay, and 30-day complications, were also analyzed. Pearson Chi-square and Wilcoxon-Mann-Whitney tests evaluated categorical and continuous variables, respectively. Results: When compared to non-IVR primary THAs and TKAs, those performed with IVR utilized significantly less intraoperative sedation (48 mg vs 708 mg of propofol; *P* < .001) and trended toward less narcotic usage (13 mcg vs 39 mcg of fentanyl; P = .07). In the postanesthesia care unit, IVR and non-IVR patients showed no significant differences (P > .3) in vital signs, pain scores, or OME received. Additionally, similar (P > .3) postoperative outcomes were noted in both cohorts' 24-hour OME use, distance at first ambulation, length of stay, and 30-day complications. Conclusions: The use of spinal anesthesia with the IVR adjunct to perform primary THAs and TKAs appears to be well-tolerated and associated with less intraoperative sedative medication usage than spinal anesthesia alone.





Besharat A, Imsdahl SI, Yamagami M, et al. Virtual reality doorway and hallway environments alter gait kinematics in people with Parkinson disease and freezing. *Gait Posture*. 2022;92:442-448. doi:10.1016/j.gaitpost.2021. 12.013 Background: Many people with Parkinson disease (PD) experience freezing of gait (FoG), a transient gait disturbance associated with increased fall risk and reduced quality of life. Head-mounted virtual reality (VR) systems allow overground walking and can create immersive simulations of physical environments that induce FoG. Research question: For people with PD who experience FoG (PD+FoG), are kinematic gait changes observed in VR simulations of FoG-provoking environments? Methods: In a cross-sectional experiment, people with PD+FoG walked at their self-selected speed in a physical laboratory and virtual laboratory, doorway, and hallway environments. Motion analysis assessed whole-body kinematics, including lower extremity joint excursions, swing phase toe clearance, trunk flexion, arm swing, sagittal plane inclination angle, and spatiotemporal characteristics. One-way repeated measures analysis of variance was conducted to examine the effects of environment on gait variables, with planned contrasts between laboratory environments and the virtual doorway and hallway. Results: Twelve participants with PD+FoG (mean age [standard deviation]=72.8 [6.5] years, disease duration=8.8 [8.9] years, 3 females) completed the protocol. The environment had significant and widespread effects on kinematic and spatiotemporal variables. Compared to the physical laboratory, reduced joint excursions were observed in the ankle, knee, and hip when walking in the virtual doorway and in the knee and hip when walking in the virtual hallway. In both the virtual doorway and hallway compared to the physical laboratory, peak swing phase toe clearance, arm swing, and inclination angle were reduced, and walking was slower, with shorter, wider steps. **Significance:** Virtual doorway and hallway environments induced kinematic changes commonly associated with FoG episodes, and these kinematic changes are consistent with forward falls that are common during FoG episodes. Combined with the flexibility of emerging VR technology, this research supports the potential of VR applications designed to improve the understanding, assessment, and treatment of FoG.





Borisova N, Moore N, Sira Mahalingappa S, et al. Virtual Reality-Based Interventions for Treating Depression in the Context of COVID-19 Pandemic: Inducing the Proficit in Positive Emotions as a Key Concept of Recovery and a Path Back to Normality. *Psychiatr Danub*. 2022;34(Suppl 8):276-284. **Background:** During the COVID-19 pandemic as much as 40% of the global population reported deterioration in depressive mood, whereas 26% experienced increased need for emotional support. At the same time, the availability of on-site psychiatric care declined drastically because of the COVID-19 preventive social restriction measures. To address this shortfall, telepsychiatry assumes a greater role in mental health care services. Among various on-line treatment modalities, immersive virtual reality (VR) environments provide an important resource for adjusting the emotional state in people living with depression. Therefore, we reviewed the literature on VR-based interventions for depression treatment during the COVID-19 pandemic. **Subjects and methods:** We searched the PubMed and Scopus databases, as well as the Internet, for full-length articles published during the period of 2020-2022 citing a set of following key words: "virtual reality", "depression", "COVID-19", as well as their terminological synonyms and word combinations. The inclusion criteria were: 1) the primary or secondary study objectives included the treatment of depressive states or symptoms; 2) the immersive VR intervention used a head-mounted display (HMD); 3) the article presented clinical study results and/or case reports 4) the study was urged by or took place during the COVID-19-associated lockdown period. Results: Overall, 904 records were retrieved using the search strategy. Remarkably, only three studies and one case report satisfied all the inclusion criteria elaborated for the review. These studies included 155 participants: representatives of healthy population (n=40), a case report of a patient with major depressive disorder (n=1), patients with cognitive impairments (n=25), and COVID-19 patients who had survived from ICU treatment (n=89). The described interventions used immersive VR scenarios, in combination with other treatment techniques, and targeted depression. The most robust effect, which the VR-based approach had demonstrated, was an immediate post-intervention improvement in mood and the reduction of depressive symptoms in healthy population. However, studies showed no significant findings in relation to both short-term effectiveness in treatment of depression and primary prevention of depressive symptoms. Also, safety issues were identified, such as: three participants developed mild adverse events (e.g., headache, "giddiness", and VR misuse behavior), and three cases of discomfort related to wearing a VR device were registered. **Conclusions:** There has been a lack of appropriately designed clinical trials of the VR-based interventions for depression since the onset of the COVID-19 pandemic. Moreover, all these studies had substantial limitations due to the imprecise study design, small sample size, and minor safety issues, that did not allow us making meaningful judgments and conclude regarding the efficacy of VR in the treatment of depression, taking into account those investigations we have retrieved upon the inclusion criteria of our particularistic review design. This may call for randomized, prospective studies of the short-term and long-lasting effect of VR modalities in managing negative affectivity (sadness, anxiety, anhedonia, selfguilt, ignorance) and inducing positive affectivity (feeling of happiness, joy, motivation, self-confidence, viability) in patients suffering from clinical depression.





Botha BS, De Wet L, Botma Y. Background: Within the ever-expanding world of virtual reality for education, numerous strides have been made towards providing students with quality Undergraduate Nursing Student Experiences in teaching and learning opportunities. One such application area that has not Using Immersive Virtual been exhaustively investigated is within nursing education. **Methods:** To help the research community to understand nursing students' perceptions towards the Reality to Manage a Patient With a Foreign Object in the use of virtual reality as a possible alternative to high-fidelity simulation and to determine whether students would enjoy virtual clinical simulation, Right Lung. Clinical Simulation in Nursing. undergraduate nursing students for a South African higher education institution 2021;56:76-83. were asked to partake in a virtual clinical simulation where they could manage a doi:10.1016/j.ecns.2020.10. patient with a foreign object in the airway. The virtual environment (VE) already 800 existed and was previously tested for the purpose of training third and fourth year undergraduate nurses during previous research endeavours. For the project discussed in this article, the participants consisted of third year undergraduate nursing students, as they had the theoretical knowledge to partake in the simulation. During the testing sessions, observational data were recorded along with subjective opinions captured through questionnaires to determine how the students experienced the VE and the simulation. **Results:** Although the results indicated that future improvements were needed to maintain a relevant and evolving VE and scenario, the students' experiences were overwhelmingly positive. **Conclusion:** The created VE and scenario were found to be useable to the extent where the nursing students indicated that they would benefit from this teaching and learning method.



Rotha RS, Do Wat I	Cybergickpage is a global issue offecting users of immergive virtual reality
CVDVICS: A framowork to	However, there is no agreement on the event source of substraislyness. Taking inte
by vice. A namework to	appointered is no agreement on the exact cause of cypersickness. Taking into
	consideration now it can differ greatly from one person to another, it makes it
cybersickness in immersive	even more difficult to determine the exact cause or find a solution. Because
virtual clinical simulation.	cybersickness excludes so many prospective users, including healthcare
Heliyon. 2024;10(8):e29595.	professionals, from using immersive virtual reality as a learning tool, this
doi:10.1016/j.heliyon.2024.e	research sought to find solutions in existing literature and construct a framework
29595	that can be used to prevent or minimise cybersickness during immersive virtual
	clinical simulation (CyPVICS). The Bestfit Framework by Carrol and authors were
	used to construct the CyPVICS framework. The process started by conducting
	two separate literature searchers using the BeHEMoTh (for models, theories,
	and frameworks) and SPIDER (for primary research articles) search techniques.
	Once the literature searches were completed the models, theories and
	framework were used to construct a priori framework. The models' theories and
	frameworks were analysed to determine aspects relevant to causes, reducing,
	eliminating, and detecting cybersickness. The priori framework was expanded
	by first coding the findings of the primary research study into the existing
	aspects of the priori framework. Once coded the aspects that could not be
	coded were added in the relevant category for example causes. After reviewing
	1567 abstracts and titles as part of the BeHEMoTh search string 10 full text
	articles a total of 15 papers containing models, theories, and framoworks, wore
	and the construct the initial CuDV/ICS framework. Once the initial CuDV/ICS wee
	used to construct the initial CypyICS framework. Once the initial CypyICS was
	created, a total 904 primary research studies (SPIDER) were evaluated, based on
	their titles and abstracts, of which 100 were reviewed in full text. In total, 67
	articles were accepted and coded to expand the initial CyPVICS framework. This
	paper presents the CyPVICS framework for use, not only in health professions'
	education, but also in other disciplines, since the incorporated models,
	theories, frameworks, and primary research studies were not specific to virtual
	clinical simulation.
Bowyer MW, Streete KA,	Advances in simulation technology are fueling a paradigmatic shift in how
Muniz GM, Liu AV. Immersive	medicine will be taught and practiced in the future. Current simulators range
Virtual Environments for	from simplified part task trainers to fully immersive virtual environments. We are
Medical Training. Seminars	on the verge of training platforms that provide realistic representations of
in Colon and Rectal Surgery.	medical and surgical scenarios that engage learners in a manner that
2008;19(2):90-97.	approximates reality. This article reviews the rationale for developing advanced
doi:10.1053/j.scrs.2008.02.0	virtual environments and details the technologies that are currently available.
05	Immersive environments using virtual reality, herein reviewed, include Cave
	Automated Virtual Environments, Distributive Virtual Environments for
	collaborative learning over the internet (Project TOUCH), Serious Games for
	medical education (PULSE and 3DiTeams), and a Wide Area Virtual Environment.
	The ultimate role of these technologies in surgical education remains to be
	determined but will undoubtedly play an important part in the future.





Bridge P, Mehta J, Keane P, et al. A virtual reality environment for supporting mental wellbeing of students on remote clinical placement: A multi-methods evaluation. *Nurse Education Today*. 2024;138:106184. doi:10.1016/j.nedt.2024.106 184

Background: Nursing and Allied Health Profession (NAHP) students undertake clinical placements as part of their pre-registration training. The remote nature of some placement sites, shiftwork and the emotionally challenging nature of the workload has led to mental wellbeing issues in many students. Aim: This project aimed to evaluate a novel 3D immersive virtual reality environment that supports mental wellbeing for NAHP students on clinical placement. It comprises a calming 3D tropical beach environment where students and tutors can meet for reflection and mutual support. Design: A multi-methods design gathered quantitative impact data with validated measurement tools and qualitative output related to the lived experience of students. Settings and participants: All 600 pre-registration NAHP students within the institution undertaking clinical placements were invited to participate, irrespective of mental wellbeing status. Students were randomly assigned to either a VR or Conventional cohort; all participants received the control support mechanism in a subsequent placement. Methods: All participants completed an initial demographic and Readiness for Therapy survey followed by weekly Beck Anxiety and Depression Inventories during placement. All participants were invited to a semi-structured interview. Results: Overall, 32 participants engaged with the application; although the VR cohort demonstrated improved scores on both Beck inventories, these were not statistically significant. This is probably due to the low response rate for the control cohort. A total of 15 interviews were conducted and several themes emerged from the data in relation to both experiential outcomes (escapism, anonymity and sense of community) and instrumental outcomes (calming, mindfulness and combatting loneliness). Conclusions: User feedback indicates that a VR environment can provide a calming escape from the pressures and anxiety arising from clinical placement for healthcare students. The relaxing beach environment facilitated mindfulness meditation and the additional opportunities for pseudo-anonymous interactions with peers and tutors were well received by students.





Brimelow RE, Thangavelu K,	Objectives: To assess the feasibility of using group-based fully immersive virtual
Beattie R, Dissanayaka NN.	reality (VR) across multiple sessions to reduce behavioral and psychological
Feasibility of Group-Based	symptoms (BPSs), including depression, anxiety, and agitated behaviors, in
Multiple Virtual Reality	cognitively diverse aged care residents. <b>Design:</b> A 6-session feasibility trial was
Sessions to Reduce	conducted within a residential aged care facility using convenience sampling to
Behavioral and	recruit N = 25 residents of varying cognitive capacity. Groups of 5 residents
Psychological Symptoms in	viewed 360-degree videos on a wireless head-mounted display to provide fully
Persons Living in Residential	immersive VR experiences. Setting and participants: Half of the participants
Aged Care. Journal of the	recruited from the 160-bed facility had a diagnosis of dementia (48%), whereas
American Medical Directors	assessment with the Psychogeriatric Assessment Scale for cognitive impairment
Association. 2022;23(5):831-	revealed that 64% experienced cognitive impairment (mild 20%, moderate 16%,
837.e2.	and severe 28%). Additionally, 32% of participants had an existing anxiety or
doi:10.1016/j.jamda.2021.07	depression diagnosis. Measures: The Cornell Scale for Depression in Dementia,
.026	Generalized Anxiety Disorder 7-item, and Cohen Mansfield Agitation Inventory–
	Short were used to assess changes in persisting BPS pre- to postintervention
	period. The Person-Environment Apathy Rating apathy subscale, Observed
	Emotions Rating Scale, and a visual analog scale (Smileometer) were used to
	assess immediate mood responses from residents at every VR session. VR
	tolerability and resident feedback was also recorded. <b>Results:</b> Pleasure
	(z = $-5.892$ , P < .001) and general alertness (z = $-2.455$ , P = .014) of participants
	improved at VR sessions, whereas apathy diminished (z = $-5.275$ , P < .001).
	Compared to baseline, post-intervention depression was significantly lowered
	(z = -2.60, P = .009), whereas agitation increased $(z = -2.98, P = .003)$ . No
	significant changes in anxiety were observed. The quality of 360-degree videos
	and the device used did not induce any major VR-related negative side effects.
	Conclusions and implications: Overall group-based VR reduced depressive
	symptoms and apathy, and induced a positive emotional response in most
	residents, with few observed side effects. Results indicate feasibility of group-
	based VR technological innovation within RAC.





Cant R, Ryan C, Kardong-	<b>Objectives:</b> Bibliometrics is an emerging science in nursing. Quantitative
Edgren S. Virtual simulation	methods were used to conduct a bibliometric analysis of highly cited virtual
studies in nursing education:	simulation nursing education articles to describe rank order, breadth of topics
A bibliometric analysis of the	and authorship patterns. Design and data sources: A desktop analysis of
top 100 cited studies, 2021.	publication performance was conducted using the Scopus database as the
Nurse Education Today.	source of article citation data. <b>Results and Discussion:</b> The top 100 cited
2022;114:105385.	articles clustered over 14-years, 2008 to 2021. Citations per paper ranged from
doi:10.1016/i.nedt.2022.105	88 to a low of 3 (median 18, mean 22.1) and in the top 10 studies, from 88 to 41.
385	The citation trajectory was moderately correlated with article maturity (r = $384$ .
	$p \leq 0.001$ ). Article citations in subsequent publications commenced the first year
	after publication and three-year-old papers reached the mean citation rate of 22
	Nurse Education Today was the most cited journal. There was no significant
	impact of article type (72% primary research, 17% literature reviews, 11%
	(n = 0.755) (n = 0.755) International representation was strong as first
	$(\mu = 0.753)$ . International representation was strong, as inst authors in 21 countries were cited many (42%) from LISA. One highly cited
	authors (M. Vorkuvl) from Conodo lod aix papero, with aix other outhors cooh
	loading two studies. Virtual simulation modelities included virtual simulation
	teaung two studies. Virtual simulation modalities included virtual simulation,
	virtual reality simulation, 3D virtual reality simulation, virtual games and virtual
	worlds. The top 10 articles offer a diverse resource for faculty and educators
	who wish to consider using virtual simulation. <b>Conclusion:</b> Virtual simulation
	studies in nursing education cover an emerging field of research that has
	relatively low citation rates. Nursing researchers and faculty need to understand
	the usefulness and limitations of bibliometric analysis as this methodology can
	make a unique contribution to research, policy, and funding decisions, and
	enable productivity assessments of faculty staff and departments.
Chae D, Kim J, Kim K, Ryu J,	Educational approaches proven to produce cultural competence among nurses,
Asami K, Doorenbos AZ. An	consistently and cost-effectively, are not yet widely available. This study
Immersive Virtual Reality	describes the development and feasibility of an immersive virtual reality
Simulation for Cross-	simulation to improve cross-cultural communication skills. We used a multi-
Cultural Communication	methods approach, recruiting 15 nursing students from a nursing college in
Skills: Development and	South Korea to assess the simulation's feasibility according to sense of
Feasibility. Clinical	presence, usability, simulation design, task difficulty, and satisfaction. This
Simulation in Nursing.	theory-based immersive virtual reality simulation was developed through
2023;77:13-22.	content and face validity testing by expert panels. We identified high levels of
doi:10.1016/j.ecns.2023.01.	usability, simulation design, and satisfaction, a low level of task difficulty, and a
005	good level of sense of presence. Participants were satisfied with the simulation
	"feeling real and immersive," "improved cultural competence," "useful for
	repetitive learning," "appropriate difficulty for learning," and "easy to control."
	Reports of "insufficient prior information." "insufficient cognitive fidelity."
	"limited to dialogue selection." and "discomfort for wearers of glasses" indicate
	needed improvements. Virtual reality simulation could contribute to filling a
	critical gap in cultural competence in nursing education





Chang YM, Lai CL. Exploring the experiences of nursing students in using immersive virtual reality to learn nursing skills. *Nurse Education Today*. 2021;97:104670. doi:10.1016/j.nedt.2020.104 670 Background: In recent years, virtual reality teaching applications exhibited exponential development in numerous fields. An increasing number of virtual reality application cases and modules have been developed in the nursing education field to verify their effectiveness. Objective: The research objective is to understand the experience of nursing students in using virtual reality skill learning process. **Design:** This study is a qualitative research that adopts focus group research methods. The participants were able to freely describe their subjective feelings toward the virtual reality skill learning process. **Participants/settings:** This research was conducted in a nursing school in Taiwan. Purposive sampling was adopted to select 60 nursing students who participated in the Adult Nursing and Practice course. The participants were divided into six focus groups containing 10 participants each. Method: Aside from learning with traditional practice equipment, the students also experienced the virtual reality nasogastric tube care skill learning system. Focus group interviews were held from March 25 to 27, 2019. During the interview, we inquired about the students' subjective feelings toward the virtual reality skill learning system and reflected on its influence on the students' learning process. **Results:** An analysis of the focus group interview content of 60 students, revealed that the students' experience toward the virtual reality skill learning process could be classified into five themes, namely "convenient to practice, but requires adaptation," "fast skill learning process," "stress-free learning environment," "environmentally friendly," and "lacks a sense of reality." **Conclusions:** Instead of replacing conventional skill teaching methods, future applications of the virtual reality nursing skill education support system shall serve as a student self-learning supporting tool. Additionally, the research and development of the virtual reality nursing skill education support system should focus on its stereognosis aspect and include an interactive function to upgrade the system into a practical teaching and learning support material.





Chang YY, Chao LF, Chang W, et al. Impact of an immersive virtual reality simulator education program on nursing students' intravenous injection administration: A mixed methods study. *Nurse Educ Today*. 2024;132:106002. doi:10.1016/j.nedt.2023.106 002 **Background:** Undergraduate nursing students often face limited opportunities to gain hands-on experience in performing invasive procedures and techniques. Immersive media tools may be helpful in training and enhancing skill development among nursing students. **Objectives:** The specific aims of this study were threefold: (1) to describe the development process of an intravenous injection virtual reality simulator (IIVRS) program, (2) to determine the effect of the IIVRS program on intravenous injection knowledge, and (3) to examine the acceptability, learning motivation, and experience of the IIVRS program among nursing students. Methods: This study is a mixed method design, encompassing a one-group pre- and post-test approach and the utilization of reflection logs among 128 second-year nursing students enrolled at a university in northern Taiwan. An innovative gamification IIVRS program was developed by our research team. Knowledge of intravenous injection was assessed using a point visual analog scale at pre-and post-testing. Acceptability and motivation were assessed using items on a 5-point Likert scale. The IIVRS program experience was evaluated using open-ended questions of reflection. A paired t-test was used for comparing knowledge at pre-and post-tests, independent t-tests were conducted to compare levels of acceptance and learning motivation among different students' characteristics, and content analysis was used for qualitative data. Results: Students' knowledge of intravenous injection was significantly improved (Pre-test Mean = 3.08 vs. Post-test Mean = 4.96, p < 0.001). Students reported high levels of acceptance (Mean = 4.65) and learning motivation (Mean = 4.69). Students reported three themes of their experience: (1) attracts my attention and stimulates my motivation to learn, (2) enhanced memorization of the skill and process, and (3) a sense of presence and realism/unrealism. **Conclusion:** The virtual reality program for intravenous injection administration can be an effective education tool, fostering students' motivation to learn and a heightened sense of accomplishment.





Chen T, Chen J, Or CK, Lo FP. Path analysis of the roles of age, self-efficacy, and TAM constructs in the acceptance of performing upper limb exercises through immersive virtual reality games. <i>International Journal</i> <i>of Industrial Ergonomics</i> . 2022;91:103360. doi:10.1016/j.ergon.2022.10 3360	<b>Objective:</b> We aimed to assess whether individuals accept performing upper limb exercises using immersive VR games, indicated by behavioral intention, and the roles of age, self-efficacy, and technology acceptance model (TAM) constructs in the acceptance. <b>Methods:</b> Sixty healthy participants aged 20–79 years were examined for their perceptions and acceptance of VR game-based exercises using a questionnaire. Participants were instructed to perform upper limb exercises by playing five immersive VR games in a laboratory. A theoretical model delineated the roles of the focal constructs in the acceptance was formulated and tested using path analysis. <b>Results:</b> At least 76.6% of participants (n = 46) expressed their intention to perform upper limb exercises through immersive VR games in the future. Overall, the model explained 83% variance in behavioral intention. Significant associations were observed, as follows. Age was positively associated with perceived usefulness ( $\beta$ = 0.27, p = 0.01), which positively influenced attitude ( $\beta$ = 0.64, p < 0.001). Moreover, self-efficacy positively affected behavioral intention ( $\beta$ = 0.84, p < 0.001). <b>Conclusions:</b> Factors such as age, perceived usefulness, attitude, and self- efficacy were found to play significant roles in the acceptance of immersive VR games for upper limb exercises. In the future, strategies should be devised to meet the requirements of end users of different ages and promote usefulness, attitude, and self-efficacy in performing upper limb exercises through immersive VR games.
Clay F, Hunt R, Obiefuna N, et al. The Use of Immersive Virtual Reality in Sensory Sessions on a Specialist Dementia Unit: Service Evaluation of Feasibility and Acceptability. <i>Occup Ther</i> <i>Health Care</i> . 2024;38(2):317-330. doi:10.1080/07380577.2023. 2270052	This service evaluation reviewed inclusion of Immersive Virtual Reality (iVR) relaxation activities as part of routine occupational therapy sensory sessions on a specialist dementia unit. Twenty-five sessions were completed over 13 wk with 14 participants. Nine participants chose to engage in multiple sessions. Feasibility was assessed through participant engagement and tolerability. Modal first session length was in the range 30 s to 2 min. This increased to over 2 min on second sessions. There was a lack of significant adverse effects measured by direct questioning, neuropsychiatric assessment before vs. after sessions and adverse incident reporting. Acceptability was assessed via structured review of user and staff feedback which noted positive experiences such as relaxation, openness to discussion, reminiscence, wider engagement and interest in future use. Further work is required to explore efficacy and use in other settings.
Cypress BS, Caboral- Stevens M. "Sense of Presence" in Immersive Virtual Reality Environment: An Evolutionary Concept Analysis. <i>Dimens Crit Care</i> <i>Nurs</i> . 2022;41(5):235-245. doi:10.1097/DCC.0000000 00000538	There is no concept analysis in the literature about "sense of presence" in immersive virtual reality environment in the context of nursing clinical education. The purpose of this article is to explore the meaning and derive an operational definition of the concept of sense of presence within the context of immersive virtual reality environment in nursing clinical education. Using Rodgers' approach, this evolutionary concept analysis will clarify the concept's surrogate and related terms, attributes, antecedents, and consequences. A clearer conceptualization is paramount to help provide knowledge for nurses and other health care professionals, thus guiding their practice, theory, and research.





Demeter N, Josman N, Eisenberg E, Pud D. Who can benefit from virtual reality to reduce experimental pain? A crossover study in healthy subjects. <i>Eur J Pain</i> . 2015;19(10):1467-1475. doi:10.1002/ejp.678	<b>Background:</b> The present study aimed to identify predicting factors affecting experimental pain stimuli reduction by using 'EyeToy', which is an Immersive Virtual Reality System (IVRS). <b>Methods:</b> Sixty-two healthy subjects (31 M, 31 F) underwent a battery of pain tests to determine each participant's baseline sensitivity to nociceptive. The battery included thermal pain tests (hot and cold) as well as a paradigm to induce conditioned pain modulation (CPM). Later on, each subject participated in two study conditions in random order: (1) An exposure to tonic heat stimulation (46.5 °C/135 s) to the ankle while participating in VR environment which included an activity requiring limb movements; (2) Same heat stimulation with no exposure to VR. Six pain measures were taken during each study condition (baseline, test 1-5). <b>Results:</b> An interaction of time × treatment was found (RM ANOVA, F(5, 305) = 24.33, p < 0.001, $\eta^2 = 0.28$ ). Specifically, the reduction in pain score between baseline and test 1 was significantly greater in VR condition than in control (p < 0.001). The maximal pain reduction in both conditions was between baseline and test 1. Hierarchical regression revealed gender and the extent of CPM as predictive factors for pain reduction in the VR condition (6.1% and 7.5%, respectively). <b>Conclusions:</b> It can be concluded that VR can serve as an effective manipulation for pain reduction in individuals with efficient CPM and in women. These findings constitute a promising platform for future research and
	hold potential for the improvement and facilitation of clinical treatment.
Ding J, He Y, Chen L, et al.	<b>Objective:</b> To investigate whether immersive virtual reality (VR) distraction could
Virtual reality distraction	decrease pain during postoperative dressing changes. <b>Methods:</b> This was a
decreases pain during daily	prospective, open-label randomized clinical trial that enrolled patients that had
dressing changes following	undergone nemorrholdectomy. Patients were randomly assigned to one of two
naemorrhold surgery. J Int	groups: a control group that received the standard pharmacological analgesic
Med Res. 2019;47(9):4380-	Intervention during dressing change and a VR group that received VR distraction
4388.	during dressing change plus standard pharmacological analgesic intervention.
doi:10.11///030006051985/	Pain scores and physiological measurements were collected before, during and
862	after the first postoperative dressing change. <b>Results:</b> A total of 182 patients
	were randomly assigned to the control and VR groups. The baseline
	characteristics of the VR and control groups were comparable. There was no
	significant difference in mean pain scores prior to and after the dressing change
	procedure between the two groups. The mean pain scores at the 5-, 10-, 15- and
	20-min time-points during the first dressing change were significantly lower in
	the VR group compared with the control group. Heart rates and oxygen
	saturation were not significantly different between the two groups.
	<b>Conclusion:</b> Immersive VR was effective as a pain distraction tool in
	combination with standard pharmacological analgesia during dressing change in
	patients that had undergone hemorrhoidectomy.





du Sert OP, Potvin S, Lipp O, et al. Virtual reality therapy for refractory auditory verbal hallucinations in schizophrenia: A pilot clinical trial. *Schizophr Res.* 2018;197:176-181. doi:10.1016/j.schres.2018.0 2.031 Schizophrenia is a chronic and severe mental illness that poses significant challenges. While many pharmacological and psychosocial interventions are available, many treatment-resistant schizophrenia patients continue to suffer from persistent psychotic symptoms, notably auditory verbal hallucinations (AVH), which are highly disabling. This unmet clinical need requires new innovative treatment options. Recently, a psychological therapy using computerized technology has shown large therapeutic effects on AVH severity by enabling patients to engage in a dialogue with a computerized representation of their voices. These very promising results have been extended by our team using immersive virtual reality (VR). Our study was a 7-week phase-II, randomized, partial cross-over trial. Nineteen schizophrenia patients with refractory AVH were recruited and randomly allocated to either VR-assisted therapy (VRT) or treatment-as-usual (TAU). The group allocated to TAU consisted of antipsychotic treatment and usual meetings with clinicians. The TAU group then received a delayed 7weeks of VRT. A follow-up was ensured 3months after the last VRT therapy session. Changes in psychiatric symptoms, before and after TAU or VRT, were assessed using a linear mixed-effects model. Our findings showed that VRT produced significant improvements in AVH severity, depressive symptoms and quality of life that lasted at the 3-month follow-up period. Consistent with previous research, our results suggest that VRT might be efficacious in reducing AVH related distress. The therapeutic effects of VRT on the distress associated with the voices were particularly prominent (d=1.2). VRT is a highly novel and promising intervention for refractory AVH in schizophrenia.





Feenstra IM, Van Der Storm	Background: Digital tools like digital box trainers and VR seem promising in
SL, Barsom EZ, Bonjer JH,	delivering safe and tailored practice opportunities outside of the surgical clinic,
Nieveen Van Dijkum EJM,	yet understanding their efficacy and limitations is essential. This study
Schijven MP. Which, how,	investigated Which digital tools are available to train surgical skills, How these
and what? Using digital tools	tools are used, How effective they are, and What skills they are intended to
to train surgical skills; a	teach. <b>Methods:</b> Medline, Embase, and Cochrane libraries were systematically
systematic review and meta-	reviewed for randomized trials, evaluating digital skill-training tools based on
analysis. Surgery Open	objective outcomes (skills scores and completion time) in surgical residents.
Science. 2023:16:100-110.	Digital tools effectiveness were compared against controls, wet/drv lab training,
doi:10.1016/i.sopen.2023.10	and other digital tools. Tool and training factors subgroups were analysed, and
.002	studies were assessed on their primary outcomes: technical and/or non-
	technical <b>Besults:</b> The 33 included studies involved 927 residents and six digital
	tools: digital how trainers (immersive) virtual reality (VB) trainers, robot surgery
	trainers, coaching and foodback, and sorious games. Digital tools outperformed
	$\alpha$ and $\beta$ a
	$\begin{array}{c} \text{Controls in Skill Scoles (SMD 1.06 [1.06, 2.25], F < 0.00001, 12 - 33\% \text{/} and \\ \text{completion time (SMD 1.05 [ 1.72 - 0.20], } P = 0.0001, 12 - 71\% \text{/} \\ \end{array}$
	completion time (SMD - 1.05 $\begin{bmatrix} -1.72 \\ -0.38 \end{bmatrix}$ , P = 0.0001, 12 = 71%). There were no
	significant differences between digital tools and lab training, between tools, or in
	other subgroups. Only two studies focused on non-technical skills. <b>Conclusion:</b>
	While the efficacy of digital tools in enhancing technical surgical skills is evident
	- especially for VR-trainers -, there is a lack of evidence regarding non-technical
	skills, and need to improve methodological robustness of research on new
	(digital) tools before they are implemented in curricula. Key message: This study
	provides critical insight into the increasing presence of digital tools in surgical
	training, demonstrating their usefulness while identifying current challenges,
	especially regarding methodological robustness and inattention to non-
	technical skills.
Ferrandini Price M,	<b>Objectives:</b> The main objective of the study is to determine the efficiency in the
Escribano Tortosa D, Nieto	execution of the START (Simple Triage and Rapid Treatment) triage, comparing
Fernandez-Pacheco A, et al.	Virtual Reality (VR) to Clinical Simulation (CS) in a Mass Casualty Incident (MCI).
Comparative study of a	The secondary objective is to determine the stress produced in the health
simulated incident with	professionals in the two situations described. <b>Materials:</b> A comparative study
multiple victims and	on the efficiency and the stress during triage in a MSI was conducted. The basal
immersive virtual reality.	and post levels of salivary $\alpha$ -amylase (sAA) activity were measured in all the
Nurse Education Today.	participants before and after the simulation. <b>Results:</b> The percentage of victims
2018:71:48-53.	that were triaged correctly was $87.65\%$ (SD = $8.3$ ); $88.3\%$ (SD = $9.65$ ) for the
doi:10.1016/i.nedt 2018.09	Clinical Simulation with Actors (CSA) group and 87.2% (SD = 7.2) for the Virtual
006	Reality Simulation (VRG) group, without any significant differences ( $n = 0.612$ )
	between both groups. The basal sAA was 103.26 (SD = 79.13) $II/I$ with a
	significant increase $(n < 0.001)$ with respect to the past simulation levels
	significant increase ( $p < 0.001$ ) with respect to the post-simulation levels (182.22, SD = 148.65 $\mu$ /m).
	(182.22, 5D = 148.65  U/L). The increase of SAA was 80.70 (5D = 109.67) U/mL,
	being greater for the USA group than the VRG group. <b>Conclusion:</b> The results
	snow that virtual reality method is as efficient as clinical simulation for training
	on the execution of basic triage (START model). Also, based on the sAA results,
	we can attest that clinical simulation creates a more stressful training
	experience for the student, so that is should not be substituted by the use of
	virtual reality, although the latter could be used as a complementary activity.





Flood LS. Use of Virtual Reality Simulations to Embody a Patient: Exploring the Impact on Nursing Students' Confidence, Feelings, and Perceptions. <i>Nurse Educ</i> . 2024;49(1):36-40. doi:10.1097/NNE.0000000 00001442	<b>Background:</b> Using immersive virtual reality (VR), students are able to physically and emotionally embody patients while interacting in simulated environments with family and health care providers. <b>Purpose:</b> This pilot study explored how embodying patients with Alzheimer disease and terminal cancer at end of life using highly immersive VR impacted nursing students' confidence, feelings, and perceptions. <b>Methods:</b> A quasi-experimental design was used with a convenience sample of bachelor of science in nursing students who completed pre/posttest scaled and open-ended questions. <b>Results:</b> Participants (N = 32) reported significant confidence increases; feelings about dying and hospice were also significantly changed. The majority described how the simulations would impact their future nursing care. <b>Conclusion:</b> Using VR, students experienced disease, dying, and health care from the patient's perspective reporting differences in confidence, feelings, and perceptions. Immersive VR simulations warrant further study and have the potential to transform nursing education and impact health care
Flores A, Hoffman HG, Navarro-Haro MV, et al. Using Immersive Virtual Reality Distraction to Reduce Fear and Anxiety before Surgery. <i>Healthcare (Basel)</i> . 2023;11(19):2697. Published 2023 Oct 9. doi:10.3390/healthcare1119 2697	Presurgical anxiety is very common and is often treated with sedatives. Minimizing or avoiding sedation reduces the risk of sedation-related adverse events. Reducing sedation can increase early cognitive recovery and reduce time to discharge after surgery. The current case study is the first to explore the use of interactive eye-tracked VR as a nonpharmacologic anxiolytic customized for physically immobilized presurgery patients. <b>Method:</b> A 44-year-old female patient presenting for gallbladder surgery participated. Using a within-subject repeated measures design (treatment order randomized), the participant received no VR during one portion of her preoperative wait and interactive eye- tracked virtual reality during an equivalent portion of time in the presurgery room. After each condition (no VR vs. VR), the participant provided subjective 0- 10 ratings and state-trait short form Y anxiety measures of the amount of anxiety and fear she experienced during that condition. <b>Results:</b> As predicted, compared to treatment as usual (no VR), the patient reported having 67% lower presurgical anxiety during VR. She also experienced "strong fear" (8 out of 10) during no VR vs. "no fear" (0 out of 10) during VR. She reported a strong sense of presence during VR and zero nausea. She liked VR, she had fun during VR, and she recommended VR to future patients during pre-op. Interactive VR distraction with eye tracking was an effective nonpharmacologic technique for reducing anticipatory fear and anxiety prior to surgery. The results add to existing evidence that supports the use of VR in perioperative settings. VR technology has recently become affordable and more user friendly, increasing the potential for widespread dissemination into medical practice. Although case studies are scientifically inconclusive by nature, they help identify new directions for future
	larger, carefully controlled studies. VR sedation is a promising non-drug fear and anxiety management technique meriting further investigation.





Francis ER, Bernard S, Nowak ML, Daniel S, Bernard JA. Operating Room Virtual Reality Immersion Improves Self-Efficacy Amongst Preclinical Physician Assistant Students. <i>Journal</i> <i>of Surgical Education</i> . 2020;77(4):947-952. doi:10.1016/j.jsurg.2020.02. 013	<b>Objective:</b> To assess the impact on self-efficacy for preclinical physician assistant (PA) students through immersive virtual reality (VR) operating room simulation. <b>Design:</b> Randomized double-blinded controlled experiment measuring self-efficacy using Schwarzer and Jerusalem's general self-efficacy scale. An entirely novel operating room was created, casted, and filmed using VR software. Fifty-two preclinical PA students were randomly assigned to VR (n = 26) or traditional lecture (n = 26) and self-efficacy was measured in both conditions using a general self-efficacy scale given before and after the virtual experience. A mixed ANOVA, independent sample t tests, and paired samples t tests were performed. <b>Setting:</b> Shenandoah University Physician Assistant program, Winchester, Virginia. <b>Results:</b> Exposure to VR training after the
	Exposure to VR improved self-efficacy compared to traditional methods ( $p < 0.05$ ).
	0.05). There was no difference in self-efficacy amongst PA students with the
	traditional model (p < 0.05). <b>Conclusions:</b> The introduction of VR simulation
	improved preclinical PA student self-efficacy in the operating room setting.
Garrett B, Taverner T,	Objectives: Immersive virtual reality (IVR) therapy has been explored as an
Masinde W, Gromala D,	adjunct therapy for the management of acute pain among children and adults for
Shaw C, Negraett M. A rapid	several conditions. Therapeutic approaches have traditionally involved
evidence assessment of	medication and physiotherapy but such approaches are limited over time by
an adjunct therapy in acute	for and against IVP as an adjunctive therapy for acute clinical pain applications
pain management in clinical	Methods: A rapid evidence assessment (RFA) strategy was used CINAHI
practice. <i>Clin J Pain</i> .	Medline. Web of Science. IEEE Xplore Digital Library, and the Cochrane Library
2014;30(12):1089-1098.	databases were screened in from December 2012 to March 2013 to identify
doi:10.1097/AJP.0000000000	studies exploring IVR therapies as an intervention to assist in the management of
000064	pain. Main outcome measures were for acute pain and functional impairment.
	Results: Seventeen research studies were included in total including 5 RCTs, 6
	randomized crossover studies, 2 case series studies, and 4 single-patient case
	studies. This included a total of 337 patients. Of these studies only 4 had a low
	risk of bias. There was strong overall evidence for immediate and short-term
	pain reduction, whereas moderate evidence was found for short-term effects on
	physical function. Little evidence exists for longer-term benefits. IVR was not
	associated with any serious adverse events. <b>Discussion:</b> This review found
	moderate evidence for the reduction of pain and functional impairment after IVR
	conclusive judgment of its effectiveness in acute pain, to establish potential
	benefits for chronic pain, and for safety





Geraets CNW, Van Der Stouwe ECD, Pot-Kolder R, Veling W. Advances in immersive virtual reality interventions for mental disorders: A new reality? *Current Opinion in Psychology*. 2021;41:40-45. doi:10.1016/j.copsyc.2021.0 2.004

Hamilton T, Burback L, Smith-MacDonald L, et al. Moving Toward and Through Trauma: Participant Experiences of Multi-Modal Motion-Assisted Memory Desensitization and Reconsolidation (3MDR). *Front Psychiatry*. 2021;12:779829. Published 2021 Dec 22. doi:10.3389/fpsyt.2021.7798 29 Immersive virtual reality (VR) has been identified as a potentially revolutionary tool for psychological interventions. This study reviews current advances in immersive VR-based therapies for mental disorders. VR has the potential to make psychiatric treatments better and more cost-effective and to make them available to a larger group of patients. However, this may require a new generation of VR therapeutic techniques that use the full potential of VR, such as embodiment, and self-led interventions. VR-based interventions are promising, but further well-designed studies are needed that use novel techniques and investigate efficacy, efficiency, and cost-effectiveness of VR interventions and dissemination of VR in regular clinical practice.

Introduction: Military members and Veterans are at risk of developing combatrelated, treatment-resistant posttraumatic stress disorder (TR-PTSD) and moral injury (MI). Conventional trauma-focused therapies (TFTs) have shown limited success. Novel interventions including Multi-modal Motion-assisted Memory Desensitization and Reconsolidation therapy (3MDR) may prove successful in treating TR-PTSD. **Objective:** To qualitatively study the experiences of Canadian military members and Veterans with TR-PTSD who received the 3MDR intervention. Methods: This study explored qualitative data from a larger mixedmethod waitlist control trial testing the efficacy of 3MDR in military members and veterans. Qualitative data were recorded and collected from 3MDR sessions, session debriefings and follow-up interviews up to 6 months postintervention; the data were then thematically analyzed. **Results:** Three themes emerged from the data: (1) the participants' experiences with 3MDR; (2) perceived outcomes of 3MDR; and (3) keys to successful 3MDR treatment. Participants expressed that 3MDR provided an immersive environment, active engagement and empowerment. The role of the therapist as a coach and "fireteam partner" supports the participants' control over their therapy. The multi-modal nature of 3MDR, combining treadmill-walking toward self-selected trauma imagery with components of multiple conventional TFTs, was key to helping participants engage with and attribute new meaning to the memory of the traumatic experience. Discussion: Preliminary thematic analysis of participant experiences of 3MDR indicate that 3MDR has potential as an effective intervention for combat-related TR-PTSD, with significant functional, well-being and relational improvements reported postintervention. Conclusion: Military members and Veterans are at risk of developing TR-PTSD, with worse outcomes than in civilians. Further research is needed into 3MDR and its use with other trauma-affected populations. Teaching nursing students to understand LGBTQI+ health care perspectives is

Hannans J. Integrating<br/>LGBTQI+ Content in Nursing<br/>Education Using Immersive<br/>Virtual Reality: Embodying<br/>Eden. Nurs Educ Perspect.<br/>2023;44(5):321-322.Teaching nursing students to understand LGBTQI+ health care perspectives is<br/>critical in providing safe and effective care. Nursing curricula often have limited<br/>LGBTQI+ content to prepare students, with clinical experiences too varied to<br/>ensure exposure to specific gender diversity learning opportunities. Immersive<br/>virtual reality is a promising strategy to offer rich learning experiences from the<br/>perspective of the LGBTQI+ community.

doi:10.1097/01.NEP.000000 0000001181





Hanson J, Andersen P, Dunn PK. The effects of a virtual learning environment compared with an individual handheld device on pharmacology knowledge acquisition, satisfaction and comfort ratings. *Nurse Education Today*. 2020;92:104518. doi:10.1016/j.nedt.2020.104 518 **Background:** Virtual reality is reported to improve post-intervention knowledge and skills outcomes of health professionals compared to traditional teaching methods or digital online media. However, providing equitable access to high quality virtual reality resources for large, diverse nursing and midwifery student cohorts within multi-campus settings remains challenging. Objectives: This study compared the effect on student learning, satisfaction and comfort following exposure to a three-dimensional pharmacology artefact in a virtual facility (CAVE2™)11CAVE2™ Cave Automatic Virtual Environment is an immersive virtual reality environment with viewing of the same artefact using a mobile handheld device with stereoscopic lenses attached. **Design:** The study used a pretest-posttest design. Setting: School of Nursing and Midwifery in a regional university in Southeast Queensland, Australia. Participants: Two hundred and forty-nine second year undergraduate nursing and midwifery students. Methods: Online multiple choice tests were deployed to measure knowledge acquisition. Self-reported satisfaction scores and comfort ratings were collected using questionnaires. Results: Participants were not disadvantaged in terms of knowledge acquisition by using either CAVE2<sup>™</sup> or the mobile handheld visualisation mode (P = 0.977). Significant differences in favour of the CAVE2™ environment were found in between students' satisfaction scores for clinical reasoning (P = 0.013) and clinical learning (P < 0.001) compared to the handheld mode, and there were no significant differences in their satisfaction with debriefing and reflective practice processes (P = 0.377) related to undertaking visualisation activities. A small number of students using handheld devices with stereoscopic lenses reported greater discomfort in relation to the visualisation that negatively impacted their learning (P = 0.001). Conclusion: Threedimensional artefacts using mobile devices is promising in terms of costeffectiveness and accessibility for students with restricted access to on-campus teaching modes.





Hargett JL, McElwain SD, McNair ME, Palokas MJ, Martin BS, Adcock DL. Virtual Reality Based Guided Meditation for Patients with Opioid Tolerance and Opioid Use Disorders. *Pain Management Nursing*. 2022;23(3):259-264. doi:10.1016/j.pmn.2022.02. 005 Background: The management of acute pain in patients with pre-existing opioid tolerance or opioid use disorders presents unique challenges. In light of the concerns regarding opioid use, safe and effective alternatives to opioid medications are of increasing interest. **Aims:** This study was conducted to determine if the use of guided meditation delivered through immersive virtual reality can reduce pain in patients with opioid tolerance or opioid use disorders, including opioid abuse or opioid dependence. Design: A quasi-experimental pre-test and post-test study design was used. Settings: A 31-bed inpatient orthopedic/trauma unit in the southeastern United States. Participants/Subjects: Subjects of the pilot study were hospitalized adults over the age of 18 with pre-existing opioid tolerance or opioid use disorder who were experiencing acute pain. Methods: This pilot study examined the effect of a 10minute guided meditation activity through immersive virtual reality on the reported acute pain of hospitalized adults (n = 11) with pre-existing opioid tolerance or opioid use disorders. The Calm® application on an Oculus Go® virtual reality head-mounted display was used for the meditation activity. **Results:** Before the intervention, the mean patient-reported pain rating was 6.68, and the mean pain score after the virtual reality experience was 3.36. Using the Wilcoxon signed rank test, this was a statistically significant difference (p = .003). Patients were also observed and queried regarding any significant side effects or other incidental findings, none of which were reported. **Conclusions:** This study demonstrates that the use of guided meditation through virtual reality can result in statistically significant reductions in patient-reported pain scores.





Hendricks TM, Gutierrez CN, Stulak JM, Dearani JA, Miller JD. The Use of Virtual Reality to Reduce Preoperative Anxiety in First-Time Sternotomy Patients: A Randomized Controlled Pilot Trial. *Mayo Clinic Proceedings*. 2020;95(6):1148-1157. doi:10.1016/j.mayocp.2020. 02.032 Objective: To report the first randomized controlled trial to investigate if immersive virtual reality (VR) treatment can reduce patient perceptions of anxiety compared with a tablet-based control treatment in adults undergoing a first-time sternotomy. Method: Twenty first-time sternotomy patients were prospectively randomized (blinded to investigator) to a control or VR intervention. The VR intervention was a game module "Bear Blast" (AppliedVR) displayed using a Samsung Gear Oculus VR headset. The control intervention was a tablet-based game with comparable audio, visual, and tactile components. The State-Trait Anxiety Inventory was administered before and after the assigned intervention. Self-reported anxiety measures between the control and VR groups were evaluated using an unpaired t test. Changes in selfreported anxiety measures pre- and post-intervention were evaluated with a paired t test for both the control and VR groups. The study took place from May 1, 2017, through January 1, 2019 (Institutional Review Board 16-009784). **Results:** Both control and VR groups were 90.0% male, with a mean ± SD age of 63.4 ± 9.11 and 69.5 ± 6.9 years, respectively. VR users experienced significant reductions in feeling tense and strained, and significant improvements in feeling calm when compared with tablet controls (P<0.05). They also experienced significant reductions in feeling strained, upset, and tense when compared with their own self-reported anxiety measure pre- and post-intervention (P<0.05). Critically, control patients had no change in these categories. **Conclusion:** Immersive VR is an effective, nonpharmacologic approach to reducing preoperative anxiety in adults undergoing cardiac surgery and shows the validity and utility of this technology in adult patients.





Hess SP, Levin M, Akram F, et al. The impact and feasibility of a brief, virtual, educational intervention for home healthcare professionals on Parkinson's Disease and Related Disorders: pilot study of I SEE PD Home. *BMC Med Educ*. 2022;22(1):506. Published 2022 Jun 28. doi:10.1186/s12909-022-03430-7 Background: Individuals with advanced Parkinson's Disease (PD) and Parkinson-related disorders (PRD) are frequently referred for home allied therapies and nursing care, yet home healthcare professionals have limited training in PD/PRD. While recognizing the need for such care, patients and families report home healthcare professionals are unfamiliar with these conditions, which may be driven by neurophobia and may contribute to suboptimal care and early termination of services. We sought to determine the feasibility and effects of a virtual, multimodal educational intervention on PD knowledge, confidence, and empathy among home health professionals. **Methods:** Home health nurses, occupational therapists, physical therapists and physical therapy assistants, and speech-language pathologists participated in a daylong, virtual symposium on advanced PD/PRD, combining focused lectures, discipline-specific breakout sessions, immersive virtual reality vignettes, and interactive panels with both patients and families, and movement disorders and home healthcare experts. Participants completed online pre- and postsymposium surveys including: demographics; PD/PRD knowledge (0-10 points possible); empathy (Interpersonal Reactivity Index); and 10-point scales of confidence with and attitudes towards individuals with PD/PRD, respectively. Pre-post intervention changes and effect sizes were evaluated with paired ttests and Cohen's d. We performed qualitative analyses of post-symposium free-text feedback using a grounded theory approach to identify participants' intentions to change their practice. **Results:** Participants had a mean improvement of 3.1 points on the PD/PRD knowledge test (p < 0.001, d = 1.97), and improvement in confidence managing individuals with PD/PRD (p = 0.0003, d = .36), and no change in empathy. The interactive, virtual format was rated as effective by 95%. Common themes regarding symposium-motivated practice change included: interdisciplinary collaboration; greater involvement and weighting of the patient and caregiver voice in care plans; attention to visit scheduling in relation to patient function; recognition and practical management of the causes of sudden change in PD/PRD, including infections and orthostatic hypotension. **Conclusions:** A virtual, multimodal, brief educational pilot intervention improved PD/PRD-specific knowledge and confidence among home healthcare nurses and allied health professionals. Future studies are necessary to test the short- and long-term effects of this intervention more broadly and to investigate the impact of this education on patient and caregiver outcomes.





Hitching R, Hoffman HG, Garcia-Palacios A. et al. The	Over the past 20 years, there has been a significant reduction in the incidence of adverse events associated with sedation outside of the operating room. Non-
Emerging Role of Virtual	pharmacologic techniques are increasingly being used as peri-operative
Reality as an Adjunct to	adjuncts to facilitate and promote anxiolysis, analgesia and sedation, and to
Procedural Sedation and	reduce adverse events. This narrative review will briefly explore the emerging
Anesthesia: A Narrative	role of immersive reality in the peri-procedural care of surgical patients.
Review. J Clin Med.	Immersive virtual reality (VR) is intended to distract patients with the illusion of
2023;12(3):843. Published	"being present" inside the computer-generated world, drawing attention away
2023 Jan 20.	from their anxiety, pain, and discomfort. VR has been described for a variety of
doi:10.3390/jcm12030843	procedures that include colonoscopies, venipuncture, dental procedures, and
	burn wound care. As VR technology develops and the production costs
	decrease, the role and application of VR in clinical practice will expand. It is
	important for medical professionals to understand that VR is now available for
	prime-time use and to be aware of the growing body in the literature that
	supports VR.
Hoffman HG, Boe DA,	Introduction: Affordable virtual reality (VR) technology is now widely available.
Rombokas E, et al. Virtual	Billions of dollars are currently being invested into improving and mass
reality hand therapy: A new	producing VR and augmented reality products. <b>Purpose of the Study:</b> The
tool for nonopioid analgesia	purpose of the present study is to explore the potential of immersive VR to make
for acute procedural pain,	physical therapy/occupational therapy less painful, more fun, and to help
hand rehabilitation, and VR	motivate patients to cooperate with their hand therapist. <b>Discussion:</b> The
embodiment therapy for	following topics are covered: a) psychological influences on pain perception, b)
phantom limb pain. <i>Journal</i>	the logic of how VR analgesia works, c) evidence for reduction of acute
of Hand Therapy.	procedural pain during hand therapy, d) recent major advances in VR
2020;33(2):254-262.	technology, and e) future directions—immersive VR embodiment therapy for
doi:10.1016/j.jht.2020.04.00	phantom limb (chronic) pain. <b>Conclusion:</b> VR hand therapy has potential for a
1	wide range of patient populations needing hand therapy, including acute pain
	and potentially chronic pain patients. Being in VR helps reduce the patients'
	pain, making it less painful for patients to move their hand/fingers during hand
	therapy, and gamified VR can help motivate the patient to perform therapeutic
	hand exercises, and make hand therapy more fun. In addition, VR camera-based
	nand tracking technology may be used to help therapists monitor now well
	patients are doing their hand therapy exercises, and to quantify whether
	adherence to treatment increases long-term functionality. Additional research
	and development into using VK as a tool for hand therapist is recommended for
	both acute pain and persistent pain patient populations.





Hofmann SM, Klotzsche F, Mariola A, Nikulin V, Villringer A, Gaebler M. Decoding subjective emotional arousal from EEG during an immersive virtual reality experience. *Elife*. 2021;10:e64812. Published 2021 Oct 28. doi:10.7554/eLife.64812 Immersive virtual reality (VR) enables naturalistic neuroscientific studies while maintaining experimental control, but dynamic and interactive stimuli pose methodological challenges. We here probed the link between emotional arousal, a fundamental property of affective experience, and parieto-occipital alpha power under naturalistic stimulation: 37 young healthy adults completed an immersive VR experience, which included rollercoaster rides, while their EEG was recorded. They then continuously rated their subjective emotional arousal while viewing a replay of their experience. The association between emotional arousal and parieto-occipital alpha power was tested and confirmed by (1) decomposing the continuous EEG signal while maximizing the comodulation between alpha power and arousal ratings and by (2) decoding periods of high and low arousal with discriminative common spatial patterns and a long short-term memory recurrent neural network. We successfully combine EEG and a naturalistic immersive VR experience to extend previous findings on the neurophysiology of emotional arousal towards real-world neuroscience.





Huai P, Li Y, Wang X, Zhang L, Liu N, Yang H. The effectiveness of virtual reality technology in student nurse education: A systematic review and metaanalysis. *Nurse Education Today*. 2024;138:106189. doi:10.1016/j.nedt.2024.106 189 Aim: The purpose of this study was to analyze the effectiveness of virtual reality technology in nursing education. Background: Virtual reality technology is regarded as one of the advanced and significant instructional tools in contemporary education. However, its effectiveness in nursing education remains a subject of debate, and there is currently limited comprehensive research discussing the impact of varying degrees of virtual technology on the educational effectiveness of nursing students. Design: Systematic review and meta-analysis. Methods: The present systematic review and meta-analysis were applied according to the Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) statement. The PubMed, Embase, CINAHL, ProQuest, Cochrane Library, Web of Science, and Scopus were searched for relevant articles in the English language. The methodologies of the studies evaluated were assessed using Cochrane Risk of Bias2 (ROB 2) tool and Joanna Briggs Institute (JBI) assessment tool. We took the learning satisfaction, knowledge, and skill performance of nursing students as the primary outcomes, and nursing students' self-efficacy, learning motivation, cognitive load, clinical reasoning, and communication ability were assessment as secondary outcomes. The metaanalysis was performed using R 4.3.2 software according to PRISMA guidelines. Heterogeneity was assessed by I2 and P statistics. Standardized mean difference (SMD) and 95 % confidence intervals (CIs) were used as effective indicators. Results: Twenty-six studies were reviewed, which involved 1815 nursing students. The results showed that virtual reality teaching, especially immersive virtual reality, was effective in improving nursing students' learning satisfaction (SMD: 0.82, 95%CI: 0.53-1.11, P < 0.001), knowledge (SMD: 0.56, 95%CI: 0.34–0.77, P < 0.001), skill performance (SMD: 1.13, 95 % CI: 0.68–1.57, P < 0.001), and self-efficacy (SMD: 0.64, 95%CI: 0.21,1.07, P < 0.001) compared to traditional teaching methods. However, the effects of virtual reality technology on nursing students' motivation, cognitive load, clinical reasoning, and communication ability were not significant and require further research. Conclusions: The results of this study show that virtual reality technology has a positive impact on nursing students. Nonetheless, it is crucial not to underestimate the effectiveness of traditional education methods, and future research could analyze the impact of different populations on nursing education while improving virtual reality technology, to more comprehensively explore how to improve the quality of nursing education. Moreover, it is imperative to emphasize the integration of virtual education interventions with real-world experiences promptly. This integration is essential for bridging the gap between the virtual learning environment and real-life scenarios effectively.





Jahn FS, Skovbye M,	Cognitive impairment occurs across several neuropsychiatric diseases and
Obenhausen K, Jespersen	impede everyday functioning and quality of life. Fully immersive Virtual Reality
AE, Miskowiak KW. Cognitive	(VR) aid motivation and engagement and therefore has a potential to help
training with fully immersive	overcome the obstacles in the field of cognitive rehabilitation. The aim of this
virtual reality in patients with	systematic review is to investigate whether VR can be a useful intervention in
neurological and psychiatric	cognitive rehabilitation transdiagnostically. We identified nine studies with
disorders: A systematic	randomized controlled trials following the PRISMA guidelines in databases
review of randomized	Pubmed, Embase and PsychInfo. The trials were all evaluated through Cochrane
controlled trials. Psychiatry	Collaboration's Risk of Bias. The studies were conducted in patients with mild
Research. 2021;300:113928.	cognitive impairment (k=4), schizophrenia (k=3), ADHD (k=1), or stroke (k=1) and
doi:10.1016/j.psychres.2021	involved 6-12 weeks of training. Overall, results showed improvement in some
.113928	domains of cognition, primarily executive function and attention. The studies
	were pilot studies with 6-34 participants per treatment group. Risk of bias was
	either high (k=3) or moderate (some concerns) (k=6). Key reasons were
	suboptimal statistical analyses and lack of clarification on randomization and
	blinding of participants and assessors. In conclusion, this review found
	promising evidence for VR cognitive rehabilitation for neuropsychiatric illnesses.
	However, larger and methodologically stronger studies are warranted to
	establish the full potential of VR.
Javvaji CK, Reddy H, Vagha	Virtual reality (VR) has experienced a remarkable evolution over recent decades,
JD, Taksande A,	evolving from its initial applications in specific military domains to becoming a
Kommareddy A, Reddy NS.	ubiquitous and easily accessible technology. This thorough review delves into
Immersive Innovations:	the intricate domain of VR within healthcare, seeking to offer a comprehensive
Exploring the Diverse	understanding of its historical evolution, theoretical foundations, and current
Applications of Virtual	adoption status. The examination explores the advantages of VR in enhancing
Reality (VR) in	the educational experience for medical students, with a particular focus on skill
Healthcare. Cureus.	acquisition and retention. Within this exploration, the review dissects the
2024;16(3):e56137.	applications of VR across diverse medical disciplines, highlighting its role in
Published 2024 Mar 14.	surgical training and anatomy/physiology education. While navigating the
doi:10.7759/cureus.56137	expansive landscape of VR, the review addresses challenges related to
	technology and pedagogy, providing insights into overcoming technical hurdles
	and seamlessly integrating VR into healthcare practices. Additionally, the review
	looks ahead to future directions and emerging trends, examining the potential
	impact of technological advancements and innovative applications in
	healthcare. This review illuminates the transformative potential of VR as a tool
	poised to revolutionize healthcare practices.





Jawed YT, Golovyan D, Lopez Background: Delirium prevention requires optimal management of pain and anxiety. Given the limitations of current pharmacologic interventions, evaluation D, et al. Feasibility of a virtual reality intervention in of novel non-pharmacological interventions is required. Virtual reality (VR) the intensive care unit. Heart stimulation may be a promising intervention because of its capability to reduce & Lung. 2021;50(6):748-753. psychophysiological stress, pain, and anxiety and to restore cognitive and doi:10.1016/j.hrtlng.2021.05 attentional capacities. Objective: To ascertain patients' and providers' .007 perceptions of acceptability and safety of VR intervention in the intensive care unit (ICU). Methods: We enrolled a cohort of 15 ICU patients and 21 health care providers to administer a 15-minute session showing a relaxing beach scene with VR headsets and nature sound effects. Participants were then asked to rate their experiences on a Likert scale survey. **Results:** The majority of patients (86%, 12 of 14) rated the headsets as moderately to very comfortable. All had moderate or greater sense of presence in the virtual environment, and 79% (11 of 14) rated their overall experience at 3 or greater (5 indicating that they enjoyed it very much). Seventy-one percent (10 of 14) of the patients felt that their anxiety was better with VR, and 57% (8 of 14) did not notice a change in their pain or discomfort. All health care providers found the headset to be at least moderately comfortable and felt a moderate or greater sense of presence. All providers concluded that VR therapy should be available for their patients. Both groups experienced minimal side effects. Conclusion: In this prospective study of perceptions of VR therapy for ICU patients and health care providers, there was a high level of acceptance, with minimal side effects, for both groups despite their low levels of prior experience with virtual reality and video gaming. Objective: Focused assessment with sonography for trauma (FAST) is a valuable Junge K, Larsen JD, Stougaard SW, et al. ultrasound procedure in emergency settings, and there is a need for evidence-Education in Focused based education in FAST to ensure competencies. Immersive virtual reality (IVR) is a progressive training modality gaining traction in the field of ultrasound Assessment With Sonography for Trauma training. IVR holds several economic and practical advantages to the common Using Immersive Virtual instructor-led FAST courses using screen-based simulation (SBS). Methods: This prospective, interventional cohort study investigated whether training FAST Reality: A Prospective, Interventional Cohort Study using IVR unsupervised and out-of-hospital was non-inferior to a historical and Non-inferiority Analysis control group training at a 90 min SBS course in terms of developing FAST With a Historical Control. competencies in novices. Competencies were assessed in both groups using the same post-training simulation-based FAST test with validity evidence, and a Ultrasound in Medicine & Biology. 2024;50(2):277-284. non-inferiority margin of 2 points was chosen. **Results:** A total of 27 medical doi:10.1016/j.ultrasmedbio. students attended the IVR course, and 27 junior doctors attended the SBS 2023.10.013 course. The IVR group trained for a median time of 117 min and scored a mean 14.2 ± 2.0 points, compared with a mean 13.7 ± 2.5 points in the SBS group. As the lower bound of the 95% confidence interval at 13.6 was within the range of the non-inferiority margin (11.7–13.7 points), training FAST in IVR for a median of 117 min was found non-inferior to training at a 90 min SBS course. No significant correlation was found between time spent in IVR and test scores. **Conclusion:** Within the limitations of the use of a historical control group, the results suggest that IVR could be an alternative to SBS FAST training and suitable for unsupervised, out-of-hospital courses in basic FAST competencies.





Kamaraj DC, Dicianno BE, Mahajan HP, Buhari AM, Cooper RA. Interrater Reliability of the Power Mobility Road Test in the Virtual Reality-Based Simulator-2. <i>Arch Phys Med</i> <i>Rehabil</i> . 2016;97(7):1078- 1084. doi:10.1016/j.apmr.2016.02. 005	<b>Objective:</b> To assess interrater reliability of the Power Mobility Road Test (PMRT) when administered through the Virtual Reality-based SIMulator-version 2 (VRSIM-2). <b>Design:</b> Within-subjects repeated-measures design. <b>Setting:</b> Participants interacted with VRSIM-2 through 2 display options (desktop monitor vs immersive virtual reality screens) using 2 control interfaces (roller system vs conventional movement-sensing joystick), providing 4 different driving scenarios (driving conditions 1-4). Participants performed 3 virtual driving sessions for each of the 2 display screens and 1 session through a real-world driving course (driving condition 5). The virtual PMRT was conducted in a simulated indoor office space, and an equivalent course was charted in an open space for the real-world assessment. After every change in driving condition, participants completed a self-reported workload assessment questionnaire, the Task Load Index, developed by the National Aeronautics and Space Administration. <b>Participants:</b> A convenience sample of electric-powered wheelchair (EPW) athletes (N=21) recruited at the 31st National Veterans Wheelchair Games. <b>Interventions:</b> Not applicable. <b>Main outcome measures:</b> Total composite PMRT score. <b>Results:</b> The PMRT had high interrater reliability (intraclass correlation coefficient [ICC]>.75) between the 2 raters in all 5 driving conditions. Post hoc analyses revealed that the reliability analyses had >80% power to detect high ICCs in driving conditions 1 and 4. <b>Conclusions:</b> The PMRT has high interrater reliability in conditions 1 and 4 and could be used to assess EPW driving performance virtually in VRSIM-2. However, further psychometric assessment is necessary to assess the feasibility of administering the PMRT using the different interfaces of VRSIM. 2
Kamm CP. Kueng R. Blättler	<b>Background:</b> Impaired manual dexterity is frequent and disabling in patients
R. Development of a new	with multiple sclerosis (MS), affecting activities of daily living and quality of life.
immersive virtual reality (VR)	<b>Objective:</b> To develop a new immersive virtual-reality (VR) headset-based
headset-based dexterity	dexterity training to improve impaired manual dexterity in persons with MS
training for patients with	(pwMS) while being feasible and usable in a home-based setting. <b>Methods:</b> The
multiple sclerosis: Clinical	training intervention was tailored to the specific group of pwMS by implementing
and technical	a simple and intuitive application with regard to hardware and software. To be
aspects. Technol Health	efficacious, the training intervention covers the main functions of the hands and
Care. 2024;32(2):1067-1078.	arm relevant for use in everyday life. <b>Results:</b> Taking clinical, feasibility, usability
doi:10.3233/THC-230541	as well as technical aspects with regard to hardware and software into account,
	six different training exercises using hand tracking technology were developed
	on the Meta quest 2 using Unity. Conclusion: We report the developmental
	process of a new immersive virtual VR headset-based dexterity training for pwMS
	implementing clinical and technical aspects. Good feasibility, usability, and
	patient satisfaction was already shown in a feasibility study qualifying this
	training intervention for further efficacy trials.





Khalifa YM, Bogorad D,	Current training models are limited by an unstructured curriculum, financial
Gibson V, Peifer J, Nussbaum	costs, human costs, and time constraints. With the newly mandated resident
J. Virtual Reality in	surgical competency, training programs are struggling to find viable methods of
Ophthalmology Training.	assessing and documenting the surgical skills of trainees. Virtual-reality
Survey of Ophthalmology.	technologies have been used for decades in flight simulation to train and assess
2006;51(3):259-273.	competency, and there has been a recent push in surgical specialties to
doi:10.1016/j.survophthal.20	incorporate virtual-reality simulation into residency programs. These efforts
06.02.005	have culminated in an FDA-approved carotid stenting simulator. What role
	virtual reality will play in the evolution of ophthalmology surgical curriculum is
	uncertain. The current apprentice system has served the art of surgery for over
	100 years, and we foresee virtual reality working synergistically with our current
	curriculum modalities to streamline and enhance the resident's learning
	experience.
Khirallah Abd El Fatah N,	Background: Virtual reality (VR) reminiscence is an innovative strategy that
Abdelwahab Khedr M,	integrates technology into the care of older adults. Limited research was
Alshammari M, Mabrouk	conducted to compare the role of VR reminiscence and traditional RT in
Abdelaziz Elgarhy S. Effect of	improving older adults' cognitive and psychological well-being. Aim: Investigate
Immersive Virtual Reality	the effect of virtual reality reminiscence versus traditional reminiscence therapy
Reminiscence versus	on cognitive function and psychological well-being among older adults in
Traditional Reminiscence	assisted living facilities. <b>Methods:</b> A randomized controlled trial research design
Therapy on Cognitive	was followed. Sixty older adults were recruited and randomly assigned to three
Function and Psychological	equal groups (20 older adults for each group). <b>Results:</b> Post interventions, a
Well-being among Older	significant increase in the mean scores of cognitive function and psychological
Adults in Assisted Living	well-being was evident among the VR and RT groups with statistically significant
Facilities: A randomized	differences (P < 0.05) compared with pre-intervention and the control group.
controlled trial. Geriatric	<b>Conclusion:</b> Application of VR reminiscence or traditional RT is efficacious in
Nursing. 2024;55:191-203.	improving cognitive function and psychological well-being among
doi:10.1016/j.gerinurse.2023	institutionalized older adults.
.11.010	




Kragting M, Pool-	Background: When instructing exercises to improve Range of Motion (ROM),
Goudzwaard AL, Pezzica C,	clinicians often create an internal focus of attention, while motor performance
Voogt L, Coppieters MW.	may improve more when using an external focus. Objectives: Using Virtual
Does having an external	Reality (VR), we investigated the effect of tasks with an internal and external
focus in immersive virtual	focus on maximal ROM in people with neck pain and explored whether this
reality increase range of	effect was associated with fear of movement. Method: In this cross-over
motion in people with neck	experimental design study, the cervical ROM of 54 participants was measured
pain?. Musculoskelet Sci	while performing a target-seeking exercise in a VR-environment (external focus
Pract. Published online	task) and during three maximal rotation and flexion-extension movements with
March 13, 2024.	the VR-headset on, without signal (internal focus task). The main statistical
doi:10.1016/j.msksp.2024.1	analysis included two dependent T-tests. Pearson correlation coefficients were
02940	calculated to investigate whether the differences in ROM in both conditions were
	correlated to fear of movement. <b>Results:</b> Maximal neck rotation was larger in the
	external focus condition than in the internal focus condition (mean difference:
	26.4°, 95% CI [20.6, 32.3]; p < 0.001, d = 1.24). However, there was a difference
	favouring the internal focus condition for flexion-extension (mean difference:
	8.2°, 95% CI [-14.9, -1.5]; p = 0.018, d = 0.33). The variability in ROM was not
	explained by variability in fear of movement (for all correlations $p \ge 0.197$ ).
	Conclusion: An external focus resulted in a larger range of rotation, but our
	flexion-extension findings suggest that the task has to be specific to elicit such
	an effect. Further research, using a task that sufficiently elicits movement in all
	directions, is needed to determine the value of an external focus during exercise.





Landowska A, Roberts D, Eachus P, Barrett A. Withinand Between-Session Prefrontal Cortex Response to Virtual Reality Exposure Therapy for Acrophobia. *Front Hum Neurosci*. 2018;12:362. Published 2018 Nov 1. doi:10.3389/fnhum.2018.00 362 Exposure Therapy (ET) has demonstrated its efficacy in the treatment of phobias, anxiety and Post-traumatic Stress Disorder (PTSD), however, it suffers a high drop-out rate because of too low or too high patient engagement in treatment. Virtual Reality Exposure Therapy (VRET) is comparably effective regarding symptom reduction and offers an alternative tool to facilitate engagement for avoidant participants. Neuroimaging studies have demonstrated that both ET and VRET normalize brain activity within a fear circuit. However, previous studies have employed brain imaging technology which restricts people's movement and hides their body, surroundings and therapist from view. This is at odds with the way engagement is typically controlled. We used a novel combination of neural imaging and VR technology-Functional Near-Infrared Spectroscopy (fNIRS) and Immersive Projection Technology (IPT), to avoid these limitations. Although there are a few studies that have investigated the effect of VRET on a brain function after the treatment, the present study utilized technologies which promote ecological validity to measure brain changes after VRET treatment. Furthermore, there are no studies that have measured brain activity within VRET session. In this study brain activity within the prefrontal cortex (PFC) was measured during three consecutive exposure sessions. N = 13 acrophobic volunteers were asked to walk on a virtual plank with a 6 m drop below. Changes in oxygenated (HbO) hemoglobin concentrations in the PFC were measured in three blocks using fNIRS. Consistent with previous functional magnetic resonance imaging (fMRI) studies, the analysis showed decreased activity in the DLPFC and MPFC during first exposure. The activity increased toward normal across three sessions. The study demonstrates potential efficacy of a method for measuring within-session neural response to virtual stimuli that could be replicated within clinics and research institutes, with equipment better suited to an ET session and at fraction of the cost, when compared to fMRI. This has application in widening access to, and increasing ecological validity of, immersive neuroimaging across understanding, diagnosis, assessment and treatment of, a range of mental disorders such as phobia, anxiety and PTSD or addictions.





Larsen JD, Jensen RO,	Focused lung ultrasound (FLUS) has high diagnostic accuracy in many common
Pietersen PI, et al. Education	conditions seen in a variety of emergency settings. Competencies are essential
in Focused Lung Ultrasound	for diagnostic success and patient safety but can be challenging to acquire in
Using Gamified Immersive	clinical environments. Immersive virtual reality (IVR) offers an interactive risk-
Virtual Reality: A	free learning environment and is progressing as an educational tool. First, this
Randomized Controlled	study explored the educational impact of novice FLUS users participating in a
Study. Ultrasound in	gamified or non-gamified IVR training module in FLUS by comparing test scores
Medicine & Biology.	using a test with proven validity evidence. Second, the learning effect was
2023;49(3):841-852.	assessed by comparing scores of each group with known test scores of novices,
doi:10.1016/j.ultrasmedbio.	intermediates and experienced users in FLUS. A total of 48 participants were
2022.11.011	included: 24 received gamified and 24 received non-gamified IVR training. No
	significant difference was found between gamified (mean = 15.5 points) and
	non-gamified (mean = 15.2 points), indicating that chosen gamification elements
	for our setup did not affect learning outcome (p = 0.66). The mean scores of both
	groups did not significantly differ from those of known intermediate users in
	FLUS (gamified p = 0.63, non-gamified p = 0.24), indicating that both IVR
	modules could be used as unsupervised out-of-hospital training for novice
	trainees in FLUS.





Lau ST, Siah RCJ, Dzakirin Bin Rusli K, et al. Design and Evaluation of Using Head-Mounted Virtual Reality for Learning Clinical Procedures: Mixed Methods Study. *JMIR Serious Games*. 2023;11:e46398. Published 2023 Aug 30. doi:10.2196/46398 Background: The capacity of health care professionals to perform clinical procedures safely and competently is crucial as it will directly impact patients' outcomes. Given the ability of head-mounted virtual reality to simulate the authentic clinical environment, this platform should be suitable for nurses to refine their clinical skills for knowledge and skills acquisition. However, research on head-mounted virtual reality in learning clinical procedures is limited. Objective: The objectives of this study were (1) to describe the design of a headmounted virtual reality system and evaluate it for education on clinical procedures for nursing students and (2) to explore the experience of nursing students using head-mounted virtual reality for learning clinical procedures and the usability of the system. **Methods:** This usability study used a mixed method approach. The stages included developing 3D models of the necessary instruments and materials used in intravenous therapy and subcutaneous injection procedures performed by nurses, followed by developing the procedures using the Unreal Engine (Epic Games). Questionnaires on the perception of continuance intention and the System Usability Scale were used along with open-ended questions. **Results:** Twenty-nine nursing students took part in this questionnaire study after experiencing the immersive virtual reality (IVR) intervention. Participants reported largely favorable game perception and learning experience. Mean perception scores ranged from 3.21 to 4.38 of a maximum score of 5, while the mean system usability score was 53.53 of 100. The majority found that the IVR experience was engaging, and they were immersed in the game. The challenges encountered included unfamiliarity with the new learning format; technological constraints, such as using hand controllers; and physical discomfort. Conclusions: The conception of IVR for learning clinical procedures through deliberate practice to enhance nurses' knowledge and skills is promising. However, refinement of the prototypes is required to improve user experience and learning. Future research can explore other ways to use IVR for better education and health care purposes.





Li S. Immersive technologies in health professions education: A bibliometric analysis. Computers & Education: X Reality. 2024;4:100051. doi:10.1016/j.cexr.2024.100 051 Immersive technologies are playing an increasingly crucial role in revolutionizing health professions education, as they provide students with realistic and interactive learning experiences. These experiences better prepare them for the complexities and challenges they will encounter in real-world healthcare practice. To comprehensively explore the growth, trends, and patterns at the intersection of immersive technologies and health professions education, a bibliometric analysis was conducted in May 2023 using the Clarivate Analytics -Web of Science Core Collection database. Specifically, we conducted a thorough descriptive examination of various facets within the dataset of 956 bibliographic records, obtained through a systematic literature search. We presented descriptive insights from this scientific literature at multiple levels, including the article (e.g., most frequent words, important themes, trends of keywords), journal (most productive, and most cited journals), affiliation (most productive affiliations), and country (most productive, and most cited countries) levels. Furthermore, we explored the conceptual, intellectual, and social structures of this field of study, represented by the co-occurrence network, coword network, and collaboration network, respectively. These analyses collectively painted a comprehensive picture of the research landscape within the realm of immersive technologies in health professions education. This study not only contributes to the identification of trends and gaps in the literature but also provides actionable insights for educators, researchers, and policymakers regarding influential players, resource allocation, and global collaboration.





Liu JYW, Mak PY, Chan K, et al. The Effects of Immersive Virtual Reality-Assisted Experiential Learning on Enhancing Empathy in Undergraduate Health Care Students Toward Older Adults With Cognitive Impairment: Multiple-Methods Study. *JMIR Med Educ*. 2024;10:e48566. Published 2024 Feb 15. doi:10.2196/48566 Background: Immersive virtual reality (IVR)-assisted experiential learning has the potential to foster empathy among undergraduate health care students toward older adults with cognitive impairment by facilitating a sense of embodiment. However, the extent of its effectiveness, including enhancing students' learning experiences and achieving intended learning outcomes, remains underexplored. **Objective:** This study aims to evaluate the impacts of IVR-assisted experiential learning on the empathy of undergraduate health care students toward older people with cognitive impairment as the primary outcome (objective 1) and on their learning experience (objective 2) and their attainment of learning outcomes as the secondary outcomes (objective 3). Methods: A multiple-methods design was used, which included surveys, focus groups, and a review of the students' group assignments. Survey data were summarized using descriptive statistics, whereas paired 2-tailed t tests were used to evaluate differences in empathy scores before and after the 2-hour IVR tutorial (objective 1). Focus groups were conducted to evaluate the impacts of IVR-assisted experiential learning on the empathy of undergraduate health care students toward older people with cognitive impairment (objective 1). Descriptive statistics obtained from surveys and thematic analyses of focus groups were used to explore the students' learning experiences (objective 2). Thematic analysis of group assignments was conducted to identify learning outcomes (objective 3). Results: A total of 367 undergraduate nursing and occupational therapy students were recruited via convenience sampling. There was a significant increase in the students' empathy scores, measured using the Kiersma-Chen Empathy Scale, from 78.06 (SD 7.72) before to 81.17 (SD 8.93) after (P<.001). Students expressed high satisfaction with the IVR learning innovation, with a high satisfaction mean score of 20.68 (SD 2.55) and a high self-confidence mean score of 32.04 (SD 3.52) on the Student Satisfaction and Self-Confidence scale. Students exhibited a good sense of presence in the IVR learning environment, as reflected in the scores for adaptation (41.30, SD 6.03), interface quality (11.36, SD 3.70), involvement (62.00, SD 9.47), and sensory fidelity (31.47, SD 5.23) on the Presence Questionnaire version 2.0. In total, 3 major themes were identified from the focus groups, which involved 23 nursing students: enhanced sympathy toward older adults with cognitive impairment, improved engagement in IVR learning, and confidence in understanding the key concepts through the learning process. These themes supplement and align with the survey results. The analysis of the written assignments revealed that students attained the learning outcomes of understanding the challenges faced by older adults with cognitive impairment, the importance of providing personcentered care, and the need for an age-friendly society. Conclusions: IVRassisted experiential learning enhances students' knowledge and empathy in caring for older adults with cognitive impairment. These findings suggest that IVR can be a valuable tool in professional health care education.





Liu JYW, Yin YH, Kor PPK, et al. The Effects of Immersive Virtual Reality Applications on Enhancing the Learning Outcomes of Undergraduate Health Care Students: Systematic Review With Meta-synthesis. *J Med Internet Res*. 2023;25:e39989. Published 2023 Mar 6. doi:10.2196/39989 Background: Immersive virtual reality (IVR) applications are gaining popularity in health care education. They provide an uninterrupted, scaled environment capable of simulating the full magnitude of sensory stimuli present in busy health care settings and increase students' competence and confidence by providing them with accessible and repeatable learning opportunities in a failsafe environment. Objective: This systematic review aimed to evaluate the effects of IVR teaching on the learning outcomes and experiences of undergraduate health care students compared with other teaching methods. Methods: MEDLINE, Embase, PubMed, and Scopus were searched (last search on May 2022) for randomized controlled trials (RCTs) or quasi-experimental studies published in English between January 2000 and March 2022. The inclusion criteria were studies involving undergraduate students majoring in health care, IVR teaching, and evaluations of students' learning outcomes and experiences. The methodological validity of the studies was examined using the Joanna Briggs Institute standard critical appraisal instruments for RCTs or quasiexperimental studies. The findings were synthesized without a meta-analysis using vote counting as the synthesis metric. A binomial test with P<.05 was used to test for statistical significance using SPSS (version 28; IBM Corp). The overall quality of evidence was evaluated using the Grading of Recommendations Assessment, Development, and Evaluation tool. Results: A total of 17 articles from 16 studies totaling 1787 participants conducted between 2007 and 2021 were included. The undergraduate students in the studies majored in medicine, nursing, rehabilitation, pharmacy, biomedicine, radiography, audiology, or stomatology. The IVR teaching domains included procedural training (13/16, 81%), anatomical knowledge (2/16, 12%), and orientation to the operating room setting (1/16, 6%). The quality of the 75% (12/16) of RCT studies was poor, with unclear descriptions of randomization, allocation concealment, and outcome assessor blinding procedures. The overall risk of bias was relatively low in the 25% (4/16) of quasi-experimental studies. A vote count showed that 60% (9/15; 95% CI 16.3%-67.7%; P=.61) of the studies identified similar learning outcomes between IVR teaching and other teaching approaches regardless of teaching domains. The vote count showed that 62% (8/13) of the studies favored using IVR as a teaching medium. The results of the binomial test (95% CI 34.9%-90%; P=.59) did not show a statistically significant difference. Low-level evidence was identified based on the Grading of Recommendations Assessment, Development, and Evaluation tool. Conclusions: This review found that undergraduate students had positive learning outcomes and experiences after engaging with IVR teaching, although the effects may be similar to those of other forms of virtual reality or conventional teaching methods. Given the identification of risk of bias and low level of the overall evidence, more studies with a larger sample size and robust study design are required to evaluate the effects of IVR teaching.





Lo YT, Yang CC, Yeh TF, Tu HY, Chang YC. Effectiveness of immersive virtual reality training in nasogastric tube feeding education: A randomized controlled trial. *Nurse Education Today*. 2022;119:105601. doi:10.1016/j.nedt.2022.105 601 Background: Given rapidly aging societies worldwide, improving the quality of long-term care through the cultivation of immense nursing assistants is critical. Accordingly, developing a satisfactory learning model to improve the learning outcomes of nursing assistant students is imperative. **Objective:** This study tested the hypothesis that students in long-term care departments who underwent immersive virtual reality (IVR) training would have significantly (1) higher levels of knowledge about the skills of nasogastric tube feeding, (2) higher learning motivations (i.e., intrinsic and extrinsic motivations, task values, and self-efficacy), (3) lower cognitive load, and (4) higher satisfaction than a control group. **Design:** A randomized controlled trial with pretest and posttest design. Settings and participants: We randomly assigned 107 students from the longterm care departments of two universities in central Taiwan to the IVR group (n = 54) or the control group (n = 53). Methods: The IVR group learned the procedure of nasogastric tube feeding through IVR, whereas the control group watched a 15-min 2D video. The participants filled pretest and posttest questionnaires on nasogastric tube feeding knowledge. After the experiment was completed, the participants answered another questionnaire on their learning motivations, cognitive load, and learning satisfaction. **Results:** The nasogastric tube feeding knowledge improved significantly in the IVR and control groups after the intervention, with no significant between-group differences. The IVR group scored significantly higher than the control group on extrinsic goals, task value, and satisfaction; nevertheless, they also experienced a significantly higher cognitive load. **Conclusions:** Both the IVR training and the traditional 2D video improved the learning outcomes of the nursing assistant students. The students were more satisfied with IVR than with the conventional learning model and indicated that IVR inspired their extrinsic learning motivations and perceived task value. However, IVR incurred a high cognitive load, which must be addressed in future course designs.





López Chávez O, Rodríguez LF, Gutierrez-Garcia JO. A comparative case study of 2D, 3D and immersive- virtual-reality applications for healthcare education. <i>Int J Med Inform</i> . 2020;141:104226. doi:10.1016/j.ijmedinf.2020. 104226	<b>Background and objective:</b> The workings of medical educational tools are implemented using a myriad of approaches ranging from presenting static content to immersing students in gamified virtual-reality environments. The objective of this paper is to explore whether and how different approaches for designing medical educational tools affect students' learning performance. <b>Materials and methods:</b> Four versions of an educational tool for the study of clinical cases were implemented: a 2D version, a gamified 2D version, a gamified 3D version, and a gamified immersive-virtual-reality version. All complying with the same functional requirements. Each version was used and evaluated by an independent group of students. The participants (n = 78) evaluated the applications regarding usefulness, usability, and gamification. Afterward, the students took an exam to assess the retention of information on the clinical cases presented. <b>Results:</b> One-sample Wilcoxon signed-rank tests confirmed that the participants perceived that it was at least quite likely that gamification helped improved their learning. In addition, based on the participants' perception, the gamification of the immersive-virtual-reality version helped the most to improve their learning performance in comparison with the gamified 2D and 3D versions. <b>Conclusions:</b> Regardless of whether different versions of a medical educational tool (complying with the same functional requirements) are perceived as equally useful and usable, the design approach (either 2D, 3D, or immersive-virtual-reality with or without gamification) affects are objective as a discipants of an education at cool (complying with the same functional requirements) are perceived as equally useful and usable, the design approach (either 2D, 3D, or immersive-virtual-reality with or without gamification) affects are discipants' perceivenes and tool (complying with the same functional requirements) are perceived as equally useful and usable, the design approach (either 2D, 3D, or immersive-virt
Manuli A Maggio MG Tripoli	Introduction: Multiple sclerosis (MS) is an inflammatory neurodegenerative
D, et al. Patients' perspective and usability of innovation technology in a new rehabilitation pathway: An exploratory study in patients with multiple sclerosis. <i>Multiple Sclerosis and Related Disorders</i> . 2020;44:102312. doi:10.1016/j.msard.2020.1 02312	disease of the central nervous system, which causes sensori-motor and cognitive disabilities, as well as neuropsychiatric abnormalities. Technological innovations could offer a valuable way to improve neurorehabilitation outcomes. Aim of the study is to assess the feasibility and usability of new rehabilitation technologies as perceived by patients suffering from MS. <b>Materials and Methods:</b> MS inpatients attending the Robotic and Behavioral Neurorehabilitation Service of the IRCCS Centro Neurolesi Bonino Pulejo (Messina, Italy) from February 2017 to April 2019, were enrolled in this exploratory study. The patients were submitted to a personalized rehabilitation treatment using robotics (such as Lokomat, Geosystem, Ekso, Armeo) and virtual reality (i.e. BTS-Nirvana, CAREN, VRRS), following a dedicated innovative pathway. <b>Results:</b> All patients completed the study. Significant pre-post- treatment differences were found in the perception of patients' quality of life, regarding both physical and mental items (p<0,001), as well as in the achievement of the therapeutic goal. Finally, we observed that patients declared a high usability of the robotic devices, and that rehabilitation with the new devices was well tolerated. <b>Conclusions:</b> our results support the idea that neurorehabilitation using innovation technologies can be useful for the commitment and motivation during the rehabilitation process, with possible positive effects on the functional and psychological outcomes of patients with





Martino Cinnera A, Bisirri A, Chioccia I, et al. Exploring the Potential of Immersive Virtual Reality in the Treatment of Unilateral Spatial Neglect Due to Stroke: A Comprehensive Systematic Review. <i>Brain</i> <i>Sci.</i> 2022;12(11):1589. Published 2022 Nov 20. doi:10.3390/brainsci121115 89	The present review aims to explore the use of Immersive Virtual Reality (IVR) in the treatment of visual perception in Unilateral Spatial Neglect (USN) after a stroke. PubMed, Scopus, Embase and Pedro databases were searched, from inception to 1 February 2022. All studies that investigated the effect of IVR on USN, such as outcome in the stroke population, have been included. The current comprehensive systematic review was performed following Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) recommendations and was registered in the PROSPERO database [CRD42022311284]. Methodological quality was assessed through JBI critical appraisal tool. A total of 436 articles were identified through the database searches. A total of 10 articles, with a heterogeneous study design, which involved 77 patients with USN with low-to-moderate methodological quality, have been selected. Five out the included studies tested usability of IVR for assessed or treated visual perception deficits in USN, comparing the results with 134 healthy subjects. In the rest of studies that tested IVR such as treatment, three showed statistical positive results ( $p < 0.05$ ) in visual perception outcome. To date, the literature has suggested the potential benefits in the use of IVR for the treatment of visual perception disorders in USN. Interestingly, IVR motivates patients during the rehabilitation process improving compliance and interest. The heterogeneity in the studies' design and in IVR treatments indicate the need of future investigations in the consideration of potentiality and low-cost of this
McCullough M, Osborne TF,	<b>Purpose:</b> Virtual reality (VR) is an emerging technology with the potential to
Rawlins C, Reitz RJ 3rd, Fox	enhance patient care by reducing pain and anxiety for a variety of medical
PM, Curtin C. The Impact of	procedures. The aim of this study was to evaluate an immersive VR program as a
Virtual Reality on the	nonpharmacologic intervention to reduce anxiety and increase satisfaction in
Patients and Providers	patients undergoing wide-awake, local-only hand surgery. The secondary aim
Experience in Wide-Awake,	was to assess providers' experience with the program. <b>Methods:</b> An
Local-Only Hand Surgery. J	Implementation evaluation was employed to assess the experience of 22
7023-5(3)-200-203	affairs bospital. We assessed the patients' anxiety scores and vital signs before
Published 2023 Mar 26	and after the procedure as well as postprocedural satisfaction measures. The
doi:10.1016/i.ihsg.2023.01.0	providers' experience was also assessed. <b>Besults:</b> Patients who used VB
14	exhibited lower anxiety scores after the procedure compared with what they
	exhibited before the procedure and had high satisfaction levels with their VR
	experience. Surgeons who used the system reported that VR improved their
	ability to teach learners and better focus on the procedure. <b>Conclusions:</b> Virtual
	reality, as a nonpharmacologic intervention, reduced anxiety and contributed to
	the patients' perioperative satisfaction with wide-awake, local-only hand
	surgery. As a secondary finding, VR positively impacted the providers'
	experience by increasing their ability to concentrate on tasks during the surgery.
	Clinical relevance: Virtual reality represents a novel technology that can reduce
	anxiety and contribute to a positive experience for both patients and providers
	during wide-awake, local-only hand procedures.





McLean E, Cornwell MA,	Over the last century, collaboration between clinical neuropsychologists and
Bender HA, et al. Innovations	neurosurgeons has advanced the state of the science in both disciplines. These
in Neuropsychology: Future	advances have provided the field of neuropsychology with many opportunities
Applications in	for innovation in the care of patients prior to, during, and following neurosurgical
Neurosurgical Patient	intervention. Beyond giving a general overview of how present-day advances in
Care. World Neurosurg.	technology are being applied in the practice of neuropsychology within a
2023;170:286-295.	neurological surgery department, this article outlines new developments that
doi:10.1016/j.wneu.2022.09.	are currently unfolding. Improvements in remote platform, computer interface,
103	"real-time" analytics, mobile devices, and immersive virtual reality have the
	capacity to increase the customization, precision, and accessibility of
	neuropsychological services. In doing so, such innovations have the potential to
	improve outcomes and ameliorate health care disparities.
Mehrotra D, Markus AF.	The last few decades have seen an exponential growth in the development and
Emerging simulation	adoption of novel technologies in medical and surgical training of residents
technologies in global	globally. Simulation is an active and innovative teaching method, and can be
craniofacial surgical training.	achieved via physical or digital models. Simulation allows the learners to
Journal of Oral Biology and	repeatedly practice without the risk of causing any error in an actual patient and
Craniofacial Research.	enhance their surgical skills and efficiency. Simulation may also allow the
2021;11(4):486-499.	clinical instructor to objectively test the ability of the trainee to carry out the
doi:10.1016/j.jobcr.2021.06.	clinical procedure competently and independently prior to trainee's completion
002	of the program. This review aims to explore the role of emerging simulation
	technologies globally in craniofacial training of students and residents in
	improving their surgical knowledge and skills. These technologies include 3D
	printed biomodels, virtual and augmented reality, use of google glass, hololens
	and haptic feedback, surgical boot camps, serious games and escape games
	and how they can be implemented in low and middle income countries.
	Craniofacial surgical training methods will probably go through a sea change in
	the coming years, with the integration of these new technologies in the surgical
	curriculum, allowing learning in a safe environment with a virtual patient,
	through repeated exercise. In future, it may also be used as an assessment tool
	to perform any specific procedure, without putting the actual patient at risk.
	Although these new technologies are being enthusiastically welcomed by the
	young surgeons, they should only be used as an addition to the actual
	curriculum and not as a replacement to the conventional tools, as the mentor-
	mentee relationship can never be replaced by any technology.





Miyahira SD, Folen RA, Stetz	Poorly managed anger responses can be detrimental to one's physical and
M, Rizzo A, Kawasaki MM.	psychosocial well-being. Cognitive behavior therapies (CBT) have been found to
Use of immersive virtual	be effective in treating anger disorders. A key component of CBT treatment is
reality for treating	exposure to the anger arousing stimuli. Virtual reality (VR) environments can
anger. Stud Health Technol	elicit potent reactions and may facilitate the treatment of anger. An anger VR
Inform. 2010;154:82-86.	environment with six video vignettes was developed by this study to examine the
	anger arousal potential of VR. Outcome measures included assessment of
	emotional reactivity, state anger, and presence. The results showed that
	significant anger arousal occurred during exposure to the VR environment, and
	arousal was greater when viewed in an immersive HMD than a non-immersive
	flat screen. In addition, presence was found to moderate the effects of VR. Low
	presence resulted in low reactivity regardless of the display modality.
Mottelson A, Vandeweerdt C,	Effective interventions for increasing people's intention to get vaccinated are
Atchapero M, et al. A self-	crucial for global health, especially considering COVID-19. We devised a novel
administered virtual reality	intervention using virtual reality (VR) consisting of a consultation with a general
intervention increases	practitioner for communicating the benefits of COVID-19 vaccination and, in
COVID-19 vaccination	turn, increasing the intention to get vaccinated against COVID-19. We
intention. Vaccine.	conducted a preregistered online experiment with a 2×2 between-participant
2021;39(46):6746-6753.	design. People with eligible VR headsets were invited to install our experimental
doi:10.1016/j.vaccine.2021.1	application and complete the ten minute virtual consultation study at their own
0.004	discretion. Participants were randomly assigned across two age conditions
	(young or old self-body) and two communication conditions (with provision of
	personal benefit of vaccination only, or collective and personal benefit). The
	primary outcome was vaccination intention (score range 1–100) measured three
	times: immediately before and after the study, as well as one week later. Five-
	hundred-and-seven adults not vaccinated against COVID-19 were recruited.
	Among the 282 participants with imperfect vaccination intentions (<100), the VR
	intervention increased pre-to-post vaccination intentions across intervention
	conditions (mean difference 8.6, 95% Cl 6.1 to 11.1, p<0.0001). The pre-to-post
	difference significantly correlated with the vaccination intention one week later,
	$\rho$ =0.20, p<0.0001. The VR intervention was effective in increasing COVID-19
	vaccination intentions both when only personal benefits and personal and
	collective benefits of vaccination were communicated, with significant retention
	one week after the intervention. Utilizing recent evidence from health psychology
	and embodiment research to develop immersive environments with customized
	and salient communication efforts could therefore be an effective tool to
	complement public health campaigns.





Mugisha S, Job M, Zoppi M, Testa M, Molfino R. Computer-Mediated Therapies for Stroke Rehabilitation: A Systematic Review and Meta-Analysis. *Journal of Stroke and Cerebrovascular Diseases*. 2022;31(6):106454. doi:10.1016/j.jstrokecerebro vasdis.2022.106454 **Objective:** To evaluate the efficacy of different forms of virtual reality (VR) treatments as either immersive virtual reality (IVR) or non-immersive virtual reality (NIVR) in comparison to conventional therapy (CT) in improving physical and psychological status among stroke patients. **Methods:** The literature search was conducted on seven databases: ACM Digital Library, Medline (via PubMed), Cochrane, IEEE Xplore, Web of Science, Scopus, and science direct. The effect sizes of the main outcomes were calculated using Cohen's d. Pooled results were used to present an overall estimate of the treatment effect using a randomeffects model. Results: A total of 22 randomized controlled trials were evaluated. 3 trials demonstrated that immersive virtual reality improved upper limb activity, function and activity of daily life in a way comparable to CT. 18 trials showed that NIVR had similar benefits to CT for upper limb activity and function, balance and mobility, activities of daily living and participation. A comparison between the different forms of VR showed that IVR may be more beneficial than NIVR for upper limb training and activities of daily life. **Conclusions:** This study found out that IVR therapies may be more effective than NIVR but not CT to improve upper limb activity, function, and daily life activities. However, there is no evidence of the durability of IVR treatment. More research involving studies with larger samples is needed to assess the long-term effects and promising benefits of immersive virtual reality technology.





Muñoz J, Mehrabi S, Li Y, et al. Immersive Virtual Reality Exergames for Persons Living With Dementia: User-Centered Design Study as a Multistakeholder Team During the COVID-19 Pandemic. *JMIR Serious Games*. 2022;10(1):e29987. Published 2022 Jan 19. doi:10.2196/29987 Background: Advancements in supporting personalized health care and wellbeing using virtual reality (VR) have created opportunities to use immersive games to support a healthy lifestyle for persons living with dementia and mild cognitive impairment (MCI). Collaboratively designing exercise video games (exergames) as a multistakeholder team is fundamental to creating games that are attractive, effective, and accessible. **Objective:** This research extensively explores the use of human-centered design methods that involve persons living with dementia in long-term care facilitates, exercise professionals, content developers, game designers, and researchers in the creation of VR exergames targeting physical activity promotion for persons living with dementia/MCI. Methods: Conceptualization, collaborative design, and playtesting activities were carried out to design VR exergames to engage persons living with dementia in exercises to promote upper limb flexibility, strength, and aerobic endurance. We involved a total of 7 persons living with dementia/MCI, 5 exercise professionals, 5 community-dwelling older adults, a VR company for content creation, and a multidisciplinary research team with game designers, engineers, and kinesiology experts. **Results:** An immersive VR exergame called Seas the Day was jointly designed and developed and it is freely available to be played in state-of-the-art VR headsets (Oculus Quest 1, 2). A model for the triadic interaction (health care institution, industry partner, academia) is also presented to illustrate how different stakeholders contribute to the design of VR exergames that consider/complement complex needs, preferences, and motivators of an underrepresented group of end users. Conclusions: This study provides evidence that a collaborative multistakeholder design results in more tailored and context-aware VR games for persons living with dementia. The insights and lessons learned from this research can be used by others to codesign games, including remote engagement techniques that were used during the COVID-19 pandemic.





Patterson DR, Drever S, Soltani M, et al. A comparison of interactive immersive virtual reality and still nature pictures as distraction-based analgesia in burn wound care. *Burns*. 2023;49(1):182-192. doi:10.1016/j.burns.2022.02 .002 Purpose: Non-pharmacologic adjuncts to opioid analgesics for burn wound debridement enhance safety and cost effectiveness in care. The current study explored the feasibility of using a custom portable water-friendly immersive VR hardware during burn debridement in adults, and tested whether interactive VR would reduce pain more effectively than nature stimuli viewed in the same VR goggles. Methods: Forty-eight patients with severe burn injuries (44 adults and 4 children) had their burn injuries debrided and dressed in a wet wound care environment on Study Day 1, and 13 also participated in Study Day 2. **Intervention:** The study used a within-subject design to test two hypotheses (one hypothesis per study day) with the condition order randomized. On Study Day 1, each individual (n = 44 participants) spent 5 min of wound care in an interactive immersive VR environment designed for burn care, and 5 min looking at still nature photos and sounds of nature in the same VR goggles. On Study Day 2 (n = 12 adult participants and one adolescent from Day 1), each participant spent 5 min of burn wound care with no distraction and 5 min of wound care in VR, using a new water-friendly VR system. On both days, during a post-wound care assessment, participants rated and compared the pain they had experienced in each condition. Outcome measures on Study Days 1 and 2: Worst pain during burn wound care was the primary dependent variable. Secondary measures were ratings of time spent thinking about pain during wound care, pain unpleasantness, and positive affect during wound care. **Results:** On Study Day 1, no significant differences in worst pain ratings during wound care were found between the computer-generated world (Mean = 71.06, SD = 26.86) vs. Nature pictures conditions (Mean = 68.19, SD = 29.26; t < 1, NS). On secondary measures, positive affect (fun) was higher, and realism was lower during computer-generated VR. No significant differences in pain unpleasantness or "presence in VR" between the two conditions were found, however. VR vs. No VR. (Study Day 2): Participants reported significantly less worst pain when distracted with adjunctive computer generated VR than during standard wound care without distraction (Mean = 54.23, SD = 26.13 vs 63.85, SD = 31.50, t(11) = 1.91, p < .05, SD = 17.38). In addition, on Study Day 2, "time spent thinking about pain during wound care" was significantly less during the VR condition, and positive affect was significantly greater during VR, compared to the No VR condition. Conclusion: The current study is innovative in that it is the first to show the feasibility of using a custom portable water-friendly immersive VR hardware during burn debridement in adults. However, contrary to predictions, interactive VR did not reduce pain more effectively than nature stimuli viewed in the same VR goggles.





Preston AM, Brown L, Padala KP. Padala PR. Veterans Affairs Health Care Provider Perceptions of Virtual Reality: Brief Exploratory Survey. Interact J Med Res. 2022;11(2):e38490. Published 2022 Sep 2. doi:10.2196/38490

**Background:** Virtual reality (VR), a simulated experience that can be similar to or completely different from the real world, has become increasingly useful within the psychiatric and medical fields. This VR technology has been applied in medical school trainings, exposure therapy for individuals with posttraumatic stress disorder (PTSD), and reminiscence therapy associated with mood disorders for older adults. Perceptions of VR through the lens of the health care provider require further exploration. VR has grown in popularity; however, this modality continues to be underused in most Veterans Affairs (VA) hospitals. Objective: A web-based survey was used to explore health care provider perceptions of immersive VR availability and use for older adults and identify potential barriers for immersive VR use in older adults with cognitive impairment. Methods: An 8-item web-based survey was developed to obtain health care provider feedback. This survey was disseminated throughout a single Veterans Integrated Services Network (VISN). The VR survey was developed via the Survey Monkey platform and distributed through the secure VA email network. Providers were asked to voluntarily participate in the brief, anonymous survey and offer their perceptions of immersive VR use within their patient population. Survey data were reviewed and interpreted using descriptive statistics. **Results:** A total of 49 respondents completed the survey over a 15day period. Of them, 36 respondents (73%) had heard of a VR device, though the majority (n=44, 90%) had never used or prescribed a VR device. Respondents identified several potential barriers to immersive VR use in older adults with cognitive impairment (eg, hearing difficulties, perceptions of technology, cognitive concerns, access to resources, and visual impairment). Despite the barriers identified, providers (n=48, 98%) still reported that they would feel comfortable prescribing immersive VR as an intervention for their patient population. **Conclusions:** Survey findings revealed that health care providers within this VISN for VAs have heard of VR, although they may not have actively engaged in its use. Most of the providers reported that they would prescribe the use of an immersive VR intervention for their older adult patients. This key point highlights the desire to implement VR strategies for patient use by their providers. If underlying barriers can be addressed and relatively resolved, this technological intervention has the potential to create substantial breakthroughs in clinical care. Immersive virtual reality (IVR) is a technology already developed to assist Motta A, Cattaneo A, Barbieri cognitive psychologists and therapists in their clinical work with brain-damaged E, Brancotti A. Evaluation patients. The rationale, the software and the hardware of the first application (ARCANA 1) based on affordable technology are discussed here, in order to provide a concrete example of what the authors think may be the role of IVR as a Which role for virtual reality clinical tool. Although prospects are exciting, extensive research is needed to

validate this new approach and reveal its limitations and advantages.



Pugnetti L, Mendozzi L,

and retraining of adults'

cognitive impairments:

technology? Computers in Biology and Medicine. 1995;25(2):213-227. doi:10.1016/0010-4825(94)00040-W



Qiao J, Xu J, Li L, Ouyang YQ. The integration of immersive virtual reality simulation in interprofessional education: A scoping review. <i>Nurse Educ Today</i> . 2021;98:104773. doi:10.1016/j.nedt.2021.104 773	<b>Background:</b> Contemporary healthcare systems are in dire need of teamwork and interprofessional collaboration, however, existing curricula of health education programs offer few opportunities to build these capabilities. Virtual simulations enable interaction and cooperative learning for students pursuing health majors. <b>Objective:</b> To explore the effectiveness of immersive virtual reality simulation (IVRS) in interprofessional education (IPE) and the experience of students from various disciplines in a virtual clinical environment. <b>Design,</b> <b>data sources and methods:</b> A scoping review was conducted. Literature was systematically searched from CINAHL, EMBASE, ERIC, MEDLINE/PubMed, ProQuest, PsycINFO, Scopus, Science Direct, Cochrane Library and Open Grey databases. Among 2352 records, 12 research articles were found and analyzed. <b>Results:</b> The experiences of students participating in IVRS centered on enhanced cooperation and communication across their disciplines. They obtained a more accurate picture of the patient and developed an interdisciplinary care plan. After the IPE session, they had greater appreciation of the importance of a team approach and shared learning. Students acknowledged the usability of virtual worlds (VWs) and appreciated the immersive learning experience that was offered. They gained valuable insight into mutual roles and believed that this experience would benefit their role as a health care team member. <b>Conclusions:</b> This study supports the usability of VWs for IPE. As a new teaching modality, the IVRS experience effectively promotes interprofessional collaboration and communication. Future advances in the use of these technologies are expected to revolutionize health science oducation.
Rashidian N. Giglio MC. Van	<b>Background:</b> Virtual reality (VR) is increasingly used in surgical education, but
Herzeele I, et al.	evidence of its benefits in complex cognitive training compared to conventional
Effectiveness of an	3-dimensional (3D) visualization methods is lacking. The objective of this study
immersive virtual reality	is to assess the impact of 3D liver models rendered visible by VR or desktop
environment on curricular	Interfaces (DIS) on residents' performance in clinical decision-making. <b>Method:</b>
cognitive skills in liver	educational intervention trial was conducted at two university hospitals in
surgery: a multicentric	Belgium and Italy. A proficiency-based stepwise curriculum for preoperative liver
crossover randomized trial.	surgery planning was developed for general surgery residents. After completing
HPB. 2022;24(12):2086-	the training, residents were randomized in one of two assessment sequences to
2095.	evaluate ten real clinical scenarios. <b>Results:</b> Among the 50 participants, 46 (23
doi:10.1016/j.hpb.2022.07.0	juniors/23 seniors) completed the training and were randomized. Forty residents
09	(86.96%) achieved proficiency in decision-making. The accuracy of virtual
	surgical planning using VR was higher than that using DI in both groups A
	$(8.43 \pm 1.03 \text{ vs} 6.86 \pm 1.79, \text{ p} < 0.001)$ and B $(8.08 \pm 0.9 \text{ vs} 6.52 \pm 1.37, \text{ p} < 0.001)$ .
	conclusion: Proficiency-based curricular training for liver surgery planning
	superior to DI visualization of 3D models in decision-making
	superior to Dr Houddization of oD mouoto in decision making.





Robison RA, Liu CY, Apuzzo	<b>Objective:</b> To review virtual reality in neurosurgery, including the history of
MLJ. Man, Mind, and	simulation and virtual reality and some of the current implementations; to
Machine: The Past and	examine some of the technical challenges involved; and to propose a potential
Future of Virtual Reality	paradigm for the development of virtual reality in neurosurgery going forward.
Simulation in Neurologic	Methods: A search was made on PubMed using key words surgical simulation,
Surgery. World	virtual reality, haptics, collision detection, and volumetric modeling to assess
Neurosurgery.	the current status of virtual reality in neurosurgery. Based on previous results,
2011;76(5):419-430.	investigators extrapolated the possible integration of existing efforts and
doi:10.1016/j.wneu.2011.07.	potential future directions. <b>Results:</b> Simulation has a rich history in surgical
008	training, and there are numerous currently existing applications and systems
	that involve virtual reality. All existing applications are limited to specific task-
	oriented functions and typically sacrifice visual realism for real-time interactivity
	or vice versa, owing to numerous technical challenges in rendering a virtual
	space in real time, including graphic and tissue modeling, collision detection,
	and direction of the haptic interface. <b>Conclusions:</b> With ongoing technical
	advancements in computer hardware and graphic and physical rendering,
	incremental or modular development of a fully immersive, multipurpose virtual
	reality neurosurgical simulator is feasible. The use of virtual reality in
	neurosurgery is predicted to change the nature of neurosurgical education, and
	to play an increased role in surgical rehearsal and the continuing education and
	credentialing of surgical practitioners.
Rogers MP, DeSantis AJ,	Surgical training has undergone substantial change in the last few decades. As
Janjua H, Barry TM, Kuo PC.	technology and patient complexity continues to increase, demands for novel
The future surgical training	approaches to ensure competency have arisen. Virtual reality systems
paradigm: Virtual reality and	augmented with machine learning represents one such approach. The ability to
machine learning in surgical	offer on-demand training, integrate checklists, and provide personalized,
education. Surgery.	surgeon-specific feedback is paving the way to a new era of surgical training.
2021;169(5):1250-1252.	Machine learning algorithms that improve over time as they acquire more data
doi:10.1016/j.surg.2020.09.0	will continue to refine the education they provide. Further, fully immersive
40	simulated environments coupled with machine learning analytics provide real-
	world training opportunities in a safe atmosphere away from the potential to
	harm patients. Careful implementation of these technologies has the potential
	to increase access and improve quality of surgical training and patient care and
	are poised to change the landscape of current surgical training. Herein, we
	describe the current state of virtual reality coupled with machine learning for
	surgical training, future directions, and existing limitations of this technology.





Rudschies C, Schneider I.	Virtual agents (VAs) and immersive virtual reality (VR) applications broaden the
Ethical, legal, and social	opportunities for accessing healthcare by transposing certain processes from
implications (ELSI) of virtual	the analogue world into a virtual realm. While these innovations offer a number
agents and virtual reality in	of advantages including improved access for individuals in diverse geographic
healthcare. Social Science &	locations and novel therapeutic options, their implementation raises significant
Medicine, 2024:340:116483.	ethical, social, and legal implications. Key considerations pertain to the doctor-
doi:10.1016/i socscimed 20	natient relationship, privacy and data protection, justice, fairness, and equal
23 116483	access as well as to issues of accountability liability and safety. This paper
20.110400	conducts a comprehensive review of the existing literature to analyse the
	ethical social and legal ramifications of employing VAs and VB applications in
	healthcare. It examines the recommended strategies to mitigate notential
	adverse effects and addresses current research gaps in this domain
Salating A. Zavattara C	Introduction: In recent decades, now virtual reality (VP) based protocols have
Commori P. ot al. Virtual	hoon proposed for the rehabilitation of Unilatoral Spatial Neglect (USN), a
reality rehabilitation for	debilitating disorder of apatial awareness. However, it remains upclear which
	type of VP protocol and lovel of VP immersion can maximize the clinical banefite
avetematic review of	To answer these questions, we conducted a systematic review of the use of VP
	for the rehabilitation of USN. <b>Mathed:</b> Studies between 2000 and 2022 that mat
and non-immersive	for the renabilitation of USN. <b>Method:</b> Studies between 2000 and 2022 that met
and non-immersive	the inclusion criteria were classified according to their research design and
Richard Angel Parison	degree of immersion (non-immersive, NIVR; semi-immersive, SIVR; immersive,
Biobenavioral Reviews.	IVR). <b>Results:</b> A total of 375 studies were identified, of which 26 met the
2023;152:105248.	Inclusion criteria. Improvements were found in 84.6% of the reviewed studies:
doi:10.1016/j.neubiorev.202	85.7% used NIVR, 100% used SIVR and 55.6% used IVR. However, only 42.3% of
3.105248	them included a control group and only 19.2% were randomized control trials
	(RCI). <b>Conclusion:</b> VR protocols may offer new opportunities for USN
	rehabilitation, although further RCTs are needed to validate their clinical
	efficacy.
Samant S, Bakhos JJ, Wu W,	Artificial intelligence, computational simulations, and extended reality, among
et al. Artificial Intelligence,	other 21st century computational technologies, are changing the health care
Computational Simulations,	system. To collectively highlight the most recent advances and benefits of
and Extended Reality in	artificial intelligence, computational simulations, and extended reality in
Cardiovascular	cardiovascular therapies, we coined the abbreviation AISER. The review
Interventions. JACC:	particularly focuses on the following applications of AISER: 1) preprocedural
Cardiovascular	planning and clinical decision making; 2) virtual clinical trials, and
Interventions.	cardiovascular device research, development, and regulatory approval; and 3)
2023;16(20):2479-2497.	education and training of interventional health care professionals and medical
doi:10.1016/j.jcin.2023.07.0	technology innovators. We also discuss the obstacles and constraints
22	associated with the application of AISER technologies, as well as the proposed
	solutions. Interventional health care professionals, computer scientists,
	biomedical engineers, experts in bioinformatics and visualization, the device
	industry, ethics committees, and regulatory agencies are expected to streamline
	the use of AISER technologies in cardiovascular interventions and medicine in
	general.





Sayma M, Tuijt R, Cooper C,	Background and objectives: Cognitive training therapies may delay cognitive
Walters K. Are We There Yet?	deterioration in dementia. There is potential to enhance delivery through
Immersive Virtual Reality to	immersive virtual reality (IVR), as removing potential distractors for cognitively
Improve Cognitive Function	impaired individuals can enhance their experience, resulting in increased
in Dementia and Mild	engagement. Evidence in this field is emerging and not yet synthesized. We
Cognitive	aimed to summarize research investigating the use of IVR in dementia to
Impairment. Gerontologist.	evaluate the current extent of use, acceptability, feasibility, and potential
2020;60(7):e502-e512.	effectiveness. We also aimed to identify gaps in current research and to create a
doi:10.1093/geront/gnz132	set of recommendations in utilizing this therapy. <b>Research design and</b>
	methods: A systematic literature review was conducted. Our review was
	registered with PROSPERO, registration number: CRD42019122295. We
	undertook searches of five databases, article references, and citations. Key
	authors in the field of health care VR were also contacted to identify additional
	papers. Articles were assessed for inclusion by two researchers independently.
	Data were extracted using standardized forms. <b>Results:</b> Our search identified a
	total of 2,824 citations, following screening for duplicates and application of
	inclusion and exclusion criteria, five studies were included for analysis. Included
	studies were heterogeneous, with small sample sizes and mixed outcomes.
	<b>Discussion and implications:</b> We were unable to reach definitive conclusions
	over the use, acceptability, and effectiveness of IVR for dementia and mild
	cognitive impairment. Future studies should focus on ensuring their
	interventions are truly immersive, developing more robust controls and account
	for the rapid rate of obsolescence in digital technologies.
Shi Y, Peng Q. A VR-based	Existing uses of rehabilitation devices are not user-friendly in convenience,
user interface for the upper	comfort and efficiency. There is a lack of accuracy and adaptability in the
limb rehabilitation. Procedia	rehabilitation process. Virtual reality (VR) technologies support effective
CIRP. 2018;78:115-120.	interactions between patients and rehabilitation devices. This paper introduces
doi:10.1016/j.procir.2018.08	an interface to improve patients' experience in the upper limb rehabilitation
.311	processes. Quality function deployment and ergonomic analysis are applied to
	identify needs to improve patients' interest and rehabilitation. A VR-based user
	interface is developed to meet the needs using the Unity3D software and Kinect
	motion sensor. Patient rehabilitations are improved through game playing using
	the developed interface.





Spiegel BMR, Rizzo A, Persky S, et al. What Is Medical Extended Reality? A Taxonomy Defining the Current Breadth and Depth of an Evolving Field. *J Med Ext Real*. 2024;1(1):4-12. doi:10.1089/jmxr.2023.0012 Medical extended reality (MXR) has emerged as a dynamic field at the intersection of health care and immersive technology, encompassing virtual, augmented, and mixed reality applications across a wide range of medical disciplines. Despite its rapid growth and recognition by regulatory bodies, the field lacks a standardized taxonomy to categorize its diverse research and applications. This American Medical Extended Reality Association guideline, authored by the editorial board of the Journal of Medical Extended Reality, introduces a comprehensive taxonomy for MXR, developed through a multidisciplinary and international collaboration of experts. The guideline seeks to standardize terminology, categorize existing work, and provide a structured framework for future research and development in MXR. An international and multidisciplinary panel of experts was convened, selected based on publication track record, contributions to MXR, and other objective measures. Through an iterative process, the panel identified primary and secondary topics in MXR. These topics were refined over several rounds of review, leading to the final taxonomy. The taxonomy comprises 13 primary topics that jointly expand into 180 secondary topics, demonstrating the field's breadth and depth. At the core of the taxonomy are five overarching domains: (1) technological integration and innovation; (2) design, development, and deployment; (3) clinical and therapeutic applications; (4) education, training, and communication; and (5) ethical, regulatory, and socioeconomic considerations. The developed taxonomy offers a framework for categorizing the diverse research and applications within MXR. It may serve as a foundational tool for researchers, clinicians, funders, academic publishers, and regulators, facilitating clearer communication and categorization in this rapidly evolving field. As MXR continues to grow, this taxonomy will be instrumental in guiding its development and ensuring a cohesive understanding of its multifaceted nature.





Sridhar A. Shiliang Z.	Objectives: Most women experience moderate to severe pain during first-
Woodson R. Kwan L. Non-	trimester surgical termination of pregnancy despite the application of various
pharmacological anxiety	analgesic techniques. Studies have shown that virtual reality (VR) is effective in
reduction with immersive	reducing anxiety among a range of women in differing circumstances. Our study
virtual reality for first-	objectives were to assess the feasibility of using VR during first-trimester dilation
trimester dilation and	and curettage under local anaesthesia and understand the effect of VR on
curettage: a pilot study. <i>Eur J</i>	procedure-related anxiety during first-trimester dilation and curettage.
Contracept Reprod Health	Methods: A pilot feasibility study was conducted in a convenience sample of 30
<i>Care</i> . 2020;25(6):480-483.	women (15 in the intervention group and 15 in the control group). Anxiety scores
doi:10.1080/13625187.2020.	were recorded before, during and after the procedure. In-depth interviews were
1836146	conducted after the procedure. <b>Results:</b> Participants reported that VR was
	either very effective (53%) or somewhat effective (40%) in relieving anxiety during
	and after the procedure. Eleven participants used the VR device for the entire
	procedure and four participants removed it during the procedure. The anxiety
	scores before the procedure were not significantly different between the groups.
	The intervention group had a median five point post-procedure decrease in
	anxiety score rated on a visual analogue scale, which was significantly different
	from that of the control group. Overall, participants had a positive experience
	but there were some technological frustrations. Conclusion: Women
	undergoing dilation and curettage in the first trimester were able to use a VR
	device during the procedure. VR-induced distraction and relaxation helped to
	reduce anxiety in some participants both during and after the procedure.
Tsai TY, Onuma Y, Złahoda-	Technological advancement and the COVID-19 pandemic have brought virtual
Huzior A, et al. Merging	learning and working into our daily lives. Extended realities (XR), an umbrella
virtual and physical	term for all the immersive technologies that merge virtual and physical
experiences: extended	experiences, will undoubtedly be an indispensable part of future clinical
realities in cardiovascular	practice. The intuitive and three-dimensional nature of XR has great potential to
medicine. Eur Heart J.	benefit healthcare providers and empower patients and physicians. In the past
2023;44(35):3311-3322.	decade, the implementation of XR into cardiovascular medicine has flourished
doi:10.1093/eurheartj/ehad3	such that it is now integrated into medical training, patient education, pre-
52	procedural planning, intra-procedural visualization, and post-procedural care.
	This review article discussed how XR could provide innovative care and
	complement traditional practice, as well as addressing its limitations and
	considering its future perspectives.





Van Doren N, Ng H, Rawat E, McKenna KR, Blonigen DM. Virtual reality mindfulness training for veterans in residential substance use treatment: Pilot study of feasibility and acceptability. *J Subst Use Addict Treat*. Published online February 18, 2024. doi:10.1016/j.josat.2024.209 315 Background: Mindfulness training is effective in recovery from substance use disorders; however, adoption can be difficult due to environmental and personal distractions. Virtual reality (VR) may help overcome these challenges by providing an immersive environment for practicing mindfulness, but there is currently limited knowledge regarding patient and provider perceptions of VRbased tools. Objective: The present study investigated the feasibility and acceptability of VR mindfulness training for veterans in residential substance use treatment as well as potential benefits of VR mindfulness interventions in this population. We conducted a pilot feasibility/acceptability study as a first step toward conducting a larger randomized controlled trial (RCT). Methods: The study recruited participants (N = 32) from a 30-day residential substance use program and collected both qualitative and quantitative feedback on the VR mindfulness intervention using a mixed-methods approach. Patients (n = 20) and providers (n = 12) rated the acceptability, usability, and satisfaction of the intervention. Using a within-subjects design, patients provided pre-post emotion ratings and reported on state mindfulness and VR presence after completing a single-session self-guided VR mindfulness intervention. Patients provided qualitative interview data on their overall impressions, while providers gave the same information via survey. **Results:** Both patients and providers reported high satisfaction and confidence in the intervention. Moreover, within subjects t-tests showed that patients experienced significant reductions in negative affect and significant increases in positive affect from pre-post, along with high levels of state mindfulness and presence. Results of thematic analysis revealed that the intervention facilitated focused attention on the present moment, induced a state of calm and relaxation, and reduced negative thoughts and emotions. Participants requested improvements such as better integration of audiovisual elements, a more personalized and longer intervention, and more comfortable fitting headset. Finally, the intervention presented with several advantages compared to other mindfulness experiences including reduced distractions and a sense of safety and privacy. Conclusions: Self-guided VR mindfulness intervention is feasible and acceptable to patients and providers. VR mindfulness training provides an immersive experience that uplifts mood and reduces distractions. VR may provide a scaffolding tool to set the stage for deepening mindfulness skills. Results of the present study could inform further development and tailoring for future interventions.





van Gelderen MJ, Nijdam MJ, Haagen JFG, Vermetten E. Interactive Motion-Assisted Exposure Therapy for Veterans with Treatment- Resistant Posttraumatic Stress Disorder: A Randomized Controlled Trial. <i>Psychother</i> <i>Psychosom</i> . 2020;89(4):215- 227. doi:10.1159/000505977	<b>Background:</b> Veterans with posttraumatic stress disorder (PTSD) tend to benefit less from evidence-based treatments than other PTSD populations. A novel virtual reality and motion-assisted exposure therapy, called 3MDR, provides treatment in an immersive, personalized and activating context. <b>Objective:</b> To study the efficacy of 3MDR for veterans with treatment-resistant PTSD. <b>Method:</b> In a randomized controlled trial (n = 43) 3MDR was compared to a non- specific treatment component control group. Primary outcome was clinician- rated PTSD symptoms at baseline, after 3MDR, and at the 12-week and 16-week follow-up (primary end point). Intention-to-treat analyses of covariance and mixed models were applied to study differences between groups at the end point and over the course of intervention, controlling for baseline scores. <b>Results:</b> The decrease in PTSD symptom severity from baseline to end point was significantly greater for 3MDR as compared to the control group, with a large effect size (F[1, 37] = 6.43, p = 0.016, d = 0.83). No significant between-group difference was detected in the course of PTSD symptoms during treatment when including all time points. The dropout rate was low (7%), and 45% of the patients in the 3MDR group improved clinically. The number needed to treat was 2.86. <b>Conclusions:</b> In this trial, 3MDR significantly decreased PTSD symptoms in veterans with, on average, a history of 4 unsuccessful treatments. The low dropout rate may be indicative of high engagement. However, a lack of significant differences on secondary outcomes limits conclusions that can be drawn on its efficacy and underlines the need for larger phase III trials. These data show emerging evidence for 3MDR and its potential to progress PTSD
Wrzesien M, Burkhardt JM, Botella C, Alcañiz M. Evaluation of the quality of collaboration between the client and the therapist in phobia treatments. <i>Interacting with Computers</i> . 2012;24(6):461-471. doi:10.1016/j.intcom.2012.0 9.001	A growing number of empirical studies evaluate the influence of Mental Health (MH) technology on the clinical effectiveness, the therapeutic relationship (i.e., therapeutic alliance), and usability issues. However, to the authors' knowledge, no studies have yet been performed regarding the influence of technology on the therapeutic process in terms of collaboration. This study evaluates the quality of collaboration between the client and therapist in Augmented Reality Exposure Therapy (ARET) context and the traditional, In Vivo Exposure Therapy (IVET) context with the Therapeutic Collaborative Scale (TCS). Twenty participants received an intensive session of cognitive behavioral therapy in either a technology-mediated therapeutic context or in a traditional therapeutic context. The results indicate that both therapeutic conditions show high collaboration scores. However, the asymmetry of roles between the therapist and the client under both conditions were detected. Also, a greater level of distraction was observed for therapists in ARET, which affected the quality of the therapists' involvement in the therapeutic session. The implications of these results are discussed.





Zackoff MW, Davis D, Rios M, et al. Tolerability and Acceptability of Autonomous Immersive Virtual Reality Incorporating Digital Twin Technology for Mass Training in Healthcare. *Simul Healthc*. Published online November 13, 2023. doi:10.1097/SIH.00000000 0000755 **Introduction:** As part of onboarding and systems testing for a clinical expansion, immersive virtual reality (VR) incorporating digital twin technology was used. While digital twin technology has been leveraged by industry, its use in health care has been limited with no prior application for onboarding or training. The tolerability and acceptability of immersive VR for use by a large population of healthcare staff were unknown. Methods: A prospective, observational study of an autonomous immersive VR onboarding experience to a new clinical space was conducted from May to September 2021. Participants were healthcare staff from several critical care and acute care units. Primary outcomes were tolerance and acceptability measured by reported adverse effects and degree of immersion. Secondary outcomes were attitudes toward the efficacy of VR compared with standard onboarding experiences. **Results:** A total of 1522 healthcare staff participated. Rates of adverse effects were low and those with prior VR experience were more likely to report no adverse effects. Odds of reporting immersion were high across all demographic groups, though decreased with increasing age. The preference for VR over low-fidelity methods was high across all demographics; however, preferences were mixed when compared with traditional simulation and real-time clinical care. **Conclusions:** Large-scale VR onboarding is feasible, tolerable, and acceptable to a diverse population of healthcare staff when using digital twin technology. This study also represents the largest VR onboarding experience to date and may address preconceived notions that VR-based training in health care is not ready for widespread adoption.





## Table 2: Physical Rehabilitation

Citation	Abstract
Adlakha S, Chhabra D,	The present review aims to analyze distinctive features of gamification in
Shukla P. Effectiveness of	rehabilitation from neurodegenerative disorders. This work is an effort to
gamification for the	decipher various gamified elements which are commonly used for the
rehabilitation of	rehabilitation of patients suffering from neurodegenerative diseases including
neurodegenerative	the scope of these gamified techniques towards their role with traditional
disorders. Chaos, Solitons &	methods for recovery of such disorders. Further, gamified tools and techniques
Fractals. 2020;140:110192.	used in the treatment process are studied in depth. Moreover, an overview of the
doi:10.1016/j.chaos.2020.11	inclusion of gamified techniques used in healthcare for neurodegenerative
0192	diseases towards enhancing patient engagement is reviewed and modeling of
	gamification effectiveness using statistical tools have also been discussed.
	Subsequently, it is found out that the virtual reality games, active video games
	and serious games are most commonly used in rehabilitation of
	neurodegenerative diseases. The most used gamified techniques are found to
	be virtual reality and mobile video games followed by serious games. Moreover,
	despite some limitations, it is concluded that the gamified methods prove to be
	a valuable addition to traditional treatments as they enhance patient
	engagement, socialization, feedback, adherence to the treatment process and
	provides better health outcomes. Finally, it adds motivation, literacy and helps
	in diverting patients from painful treatments with effective therapeutics.





Ahmadi Marzaleh M, Peyravi M, Azhdari N, et al. Virtual reality applications for rehabilitation of COVID-19 patients: A systematic review. *Health Sci Rep*. 2022;5(6):e853. Published 2022 Oct 3. doi:10.1002/hsr2.853 Background and aims: The COVID-19 pandemic has changed people's lifestyles as well as the way healthcare services are delivered. Undoubtedly, the difficulties associated with COVID-19 infection and rehabilitation and those associated with guarantine and viral preventive efforts may exacerbate the need for virtual reality to be used as a part of a complete rehabilitation strategy for these individuals. Thus, the present research aimed to evaluate the potential uses of virtual reality for the rehabilitation of individuals suffering from COVID-19. Methods: From 2019 to March 1, 2022, a systematic search was conducted in PubMed, Cochran Library, Scopus, Science Direct, ProQuest, and Web of Science databases. The papers were selected based on search terms and those that discussed the use of virtual reality in the rehabilitation of COVID-19 patients were reviewed. Each step of the study was reviewed by two authors. Results: A total of 699 papers were found during the first search. Three papers were chosen for further investigation after a thorough evaluation of the publications' titles, abstracts, and full texts. Cross-sectional studies, randomized controlled clinical trials, and case reports comprised 33%, 33%, and 33% of the publications, respectively. Based on the results, people suffering from COVID-19 were the focus of two papers (66%) that employed immersion virtual reality for cognitive rehabilitation, whereas one study (33%) used non-immersive virtual reality for physical rehabilitation. In two papers (66%), virtual reality was also offered to patients in the form of a game. Conclusion: According to the results of the present research, virtual reality games may enhance functional and cognitive consequences, contentment levels among patients, and their ability to take charge of their own health care. In light of the obstacles faced by COVID-19 patients, alterations in the delivery of healthcare, and the significance of rehabilitation in this group during guarantine, new techniques have been considered for these patients to maintain treatment, return to regular life, and enhance their standard of life.





Aida J, Chau B, Dunn J.	Background: Traumatic brain injury (TBI) is a common cause of morbidity and
Immersive virtual reality in	mortality in the United States with its sequelae often affecting individuals long
traumatic brain injury	after the initial injury. Innovations in virtual reality (VR) technology may offer
rehabilitation: A literature	potential therapy options in the recovery from such injuries. However, there is
review. NeuroRehabilitation.	currently no consensus regarding the efficacy of VR in the setting of TBI
2018;42(4):441-448.	rehabilitation. <b>Objective:</b> The aim of this review is to evaluate and summarize
doi:10.3233/NRE-172361	the current literature regarding immersive VR in the rehabilitation of those with
	TBI. Methods: A comprehensive literature search was conducted utilizing
	PubMed, Google Scholar, and the Cochrane Review using the search terms
	"virtual reality," "traumatic brain injury," "brain injury," and "immersive."
	<b>Results:</b> A total of 11 studies were evaluated. These were primarily of low-level
	evidence, with the exception of two randomized, controlled trials. 10 of 11
	studies demonstrated improvement with VR therapy. VR was most frequently
	used to address gait or cognitive deficits. <b>Conclusions:</b> While the current
	literature generally offers support for the use of VR in TBI recovery, there is a
	paucity of strong evidence to support its widespread use. The increasing
	availability of immersive VR technology offers the potential for engaging therapy
	in TBI rehabilitation, but its utility remains uncertain given the limited studies
	available at this time.
Álvarez de la Campa Crespo	<b>Background:</b> Recent evidence supports the use of immersive virtual reality (VR)
M, Donegan T, Amestoy-	as a means of delivering bodily illusions that may have therapeutic potential for
Alonso B, Just A, Combalía	the treatment of musculoskeletal conditions. We wanted to investigate whether
A, Sanchez-Vives MV. Virtual	a single session of an embodiment-based immersive VR training program
embodiment for improving	influences pain-free range of motion in patients with shoulder pain.
range of motion in patients	Methods: We designed a rehabilitation program based on developing ownership
with movement-related	over a virtual body and then "exercising" the upper limb in immersive VR, while
shoulder pain: an	the real arm remains static. We then carried out a single-arm pre-post
experimental study. J Orthop	experiment in which 21 patients with movement-related musculoskeletal
Surg Res. 2023;18(1):729.	shoulder pain were exposed to the 15-min VR program and measured their
Published 2023 Sep 26.	active pain-free range of motion immediately before and afterwards.
doi:10.1186/s13018-023-	<b>Results:</b> We found that shoulder abduction and hand-behind-back movements,
04158-w	but not shoulder flexion, were significantly and clinically improved post-
	intervention and that the level of improvement correlated with the level of
	embodiment. Following this one session, at 1-week follow-up the improvements
	were not maintained. Conclusions: Virtual embodiment may be a useful
	therapeutic tool to help improve range of motion in patients with movement-
	related shoulder pain in the short term, which in turn could expedite
	rehabilitation and recovery in these conditions





Appel L, Appel E, Bogler O, et al. Older Adults With Cognitive and/or Physical Impairments Can Benefit From Immersive Virtual Reality Experiences: A Feasibility Study. *Front Med (Lausanne)*. 2020;6:329. Published 2020 Jan 15. doi:10.3389/fmed.2019.003 29 Background: Older adults living in long term care, rehabilitation hospitals, and seniors' residences often experience reduced mobility, sometimes resulting in confinement indoors and isolation, which can introduce or aggravate symptoms of depression, anxiety, loneliness, and apathy. As Virtual Reality (VR) technologies become increasingly accessible and affordable, there is a unique opportunity to enable older adults to escape their restricted physical realities and be transported to both stimulating and calming places which may improve their general well-being. To date no robust evaluations of the use of immersive VR therapy [experienced through a head-mounted-display (HMD)] for older adults within these settings have been reported. VR-therapy may prove to be a safe, inexpensive, non-pharmacological means of managing depressive symptoms and providing engagement and enjoyment to this rapidly growing demographic. Objectives: Establish whether it is feasible to use immersive VR technology as therapy for older adults who have reduced sensory, mobility and/or impaired cognition. This includes evaluation of tolerability, comfort, and ease of use of the HMD, and of the potential for immersive VR to provide enjoyment/relaxation and reduce anxiety and depressive symptoms. **Methods:** Sixty-six older adults (mean age 80.5, SD = 10.5) with varying cognitive abilities (normal = 28, mild impairment = 17, moderate impairment = 12, severe impairment = 3, unknown cognitive score = 6), and/or physical impairments, entered a multi-site non-randomized interventional study in Toronto, Canada. Participants experienced 3 to 20 min of 360°-video footage of nature scenes displayed on Samsung GearVR HMD. Data was collected through pre/post-intervention surveys, standardized observations during intervention, and post-intervention semi-structured interviews addressing the VR experience. **Results:** All participants completed the study with no negative side-effects reported (e.g., No dizziness, disorientation, interference with hearing aids); the average time spent in VR was 8 min and 76% of participants viewed the entire experience at least once. Participants tolerated the HMD very well; most had positive feedback, feeling more relaxed and adventurous; 76% wanted to try VR again. Better image quality and increased narrative video content were suggested to improve the experience. Conclusion: It is feasible and safe to expose older adults with various levels of cognitive and physical impairments to immersive VR within these settings. Further research should evaluate the potential benefits of VR in different settings (e.g., home/community based) and explore better customization/optimization of the VR content and equipment for the targeted populations.





Asadzadeh A, Salahzadeh Z, Samad-Soltani T, Rezaei- Hachesu P. An affordable and immersive virtual reality- based exercise therapy in forward head posture. <i>PLoS</i> <i>One</i> . 2024;19(3):e0297863. Published 2024 Mar 6. doi:10.1371/journal.pone.02 97863	Forward Head Posture (FHP) is one of the most commonly occurring musculoskeletal abnormalities. Despite exercise therapy being an effective approach for FHP treatment, it can be long, monotonous, and tedious. Virtual reality (VR) can be used as an innovative solution to address these challenges. We designed an affordable and immersive VR-based exercise therapy (VRET) system for FHP correction. The VRET contents (i.e., exercises and VR scenarios) were determined by physiotherapists and game designers at the focus group meetings. Hardware requirements include a VR box, smartphone, and sensors (i.e., a smartphone accelerometer and an affordable Inertial Measurement Unit (IMU)) to measure head motions and transfer them via Wi-Fi to the VRET system. The IMU was designed using the MPU6050, Arduino Nano, and ESP8266-01S. Gwet's AC1, Game Experience Questionnaires (GEQ), and System Usability Scale (SUS) were used to measure intra-rater reliability, user experience, and system usability, respectively. The determined exercises, including Capital Flexion-Extension and Chin Tuck, were designed IMU (i.e., pitch and roll < 0.1° and yaw < 1.3°). Gwet's AC1 and SUS results showed very good intra-rater reliability (coefficient = 0.892) and excellent usability (score = 87.14), respectively. According to the mean scores of the GEQ, participants were confident about competence, immersion, flow, and positive affect components. The development of low-cost VRET systems for FHP correction is a step towards facilitating rehabilitation challenges by providing positive experiences for users as well as helping them parform therapeutic exercises correctly.
Bacha JMR, Pereira GAF, Silva IBAN, et al. Immersive Virtual Tasks with Motor and Cognitive Components: A Feasibility Study of Adults and Older Adult Fallers and Nonfallers. <i>Cyberpsychol Behav Soc Netw</i> . 2023;26(3):169-176. doi:10.1089/cyber.2022.002 5	The objective of the present study was to compare the feasibility, safety, and satisfaction of an immersive virtual reality system developed specifically for cognitive-sensory-motor training among older adult fallers and nonfallers and adult individuals. This was a cross-sectional observational study, and 20 adults, 20 nonfaller older adults, and 20 faller older adults were assessed. The primary outcome was feasibility assessed with safety and satisfaction measures. Safety outcomes were associated with adverse events occurred during the experience with the immersive virtual reality system (IVRS), assessed through the Simulator Sickness Questionnaire and by registering the falls, pain, or any discomfort reported by the participants. Satisfaction was assessed with a structured questionnaire, answered after 10 minutes of experiencing the IVRS. The dates were assessed with one-way analysis of variance or the Kruskal-Wallis test and Bonferroni post hoc test. The results showed that the IVRS was safe and the participants related good satisfaction with the system. Most of participants related no symptoms (93.6 percent) or light cybersickness symptoms (6.0 percent). There were no occurrences of falls or pain associated with the IVRS. The IVRS was feasible for adults and nonfaller and faller older adults.





Baldominos A, Saez Y, Pozo CGD. An Approach to Physical Rehabilitation Using State-of-the-art Virtual Reality and Motion Tracking Technologies. <i>Procedia</i> <i>Computer Science</i> . 2015;64:10-16. doi:10.1016/j.procs.2015.08. 457	This paper explores an approach to physical rehabilitation using state-of-the-art technologies in virtual reality and motion tracking; in particular, Oculus Rift DK2 (released in July, 2014) and Intel RealSense (released in November, 2014) are used. A game is developed which requires from the patient to perform an established set of abduction and adduction arm movements to achieve rotator cuff rehabilitation after injury. While conduct of clinical trials is outside the scope of this work, experts in physical rehabilitation working in the medical field have carried out a preliminary evaluation, showing encouraging results.
Baragash RS, Aldowah H, Ghazal S. Virtual and augmented reality applications to improve older adults' quality of life: A systematic mapping review and future directions. <i>Digit</i> <i>Health</i> . 2022;8:20552076221132099 . Published 2022 Oct 31. doi:10.1177/2055207622113 2099	<b>Objective:</b> The use of virtual reality and augmented reality to improve older adults' quality of life has rapidly increased in recent years. This systematic mapping review aimed to provide a comprehensive overview of existing research that identifies and classifies current virtual reality and augmented reality applications that enhance the quality of life of older adults to increase the understanding of the impact of these technologies. <b>Methods:</b> To reach this objective, a systematic mapping review was conducted of the studies published between 2009 and 2020 in major scientific databases, such as IEEE Xplore, Web of Science, Scopus, and PubMed. A total of 57 studies were analyzed and classified into four main quality of life domains: physical, cognitive, psychological, and social well-being. <b>Results:</b> The findings showed that virtual reality and augmented reality have found their places in many quality of life studies of older adults. Although virtual reality and augmented reality applications are notably growing in the physical and cognitive well-being domains in training and rehabilitation settings, they are still in the early stages of development in psychological and social well-being research as well as healthcare settings. Our findings also revealed that virtual reality systems are the most common virtual reality and augmented reality types among the reviewed studies. Moreover, balance and attention were the most prevalent physical and cognitive functions when using motion-based and immersive virtual reality exergames and augmented reality systems and games, respectively, while confidence and interaction were the most dominant psychological and social functions. <b>Conclusion:</b> This mapping review provides a comprehensive overview of potential areas for further research in this field, thereby assisting researches, technologists, and health practitioners in exnanding this field of research





Benham S, Kang M, Grampurohit N. Immersive Virtual Reality for the Management of Pain in Community-Dwelling Older Adults. *OTJR (Thorofare N J)*. 2019;39(2):90-96. doi:10.1177/1539449218817 291

Immersive virtual reality (VR) can provide a high level of engagement and distraction analgesia to address pain. However, community-based applications of this technology for older adults have not been studied. The objective of this study was to examine the applicability and effectiveness of an immersive VR intervention for pain, depression, and quality of life (QOL) in older adults. This pretest-posttest, mixed-methods design included senior center members (n = 12) with pain that interfered with daily functioning. The outcomes included the Numeric Pain Rating Scale, Patient-Reported Outcomes Measurement Information System (PROMIS<sup>®</sup>) depression scale, World Health Organization Quality of Life Scale Brief Version (WHO QOL-BREF), and open-ended questions. The VR intervention (15- to 45-min sessions, 12 sessions over 6 weeks) was well accepted with no dropouts. There was a significant decrease in pain (p = .002, d = -1.54) with no effect on depression and QOL. There were no adverse effects, and positive perceptions of VR were reported. The 6-week immersive VR intervention was applicable and effective in reducing pain intensity for community-dwelling older adults.





Bertoni R, Mestanza Mattos FG, Porta M, et al. Effects of immersive virtual reality on upper limb function in subjects with multiple sclerosis: A cross-over study. *Mult Scler Relat Disord*. 2022;65:104004. doi:10.1016/j.msard.2022.1 04004 **Background:** Upper limb dysfunctions are common in people with multiple sclerosis (PwMS) and lead to limitations in activities of daily living. In this study, we investigated the feasibility and effects of an immersive commercial virtual reality system for upper limb bilateral rehabilitation. Methods: A total of 20 participants were included in a cross over study with two arm sequences: Treatment-Waiting List (T-WL; N = 9) and Waiting List-Treatment (WT-T; N = 11). T-WL sequence performed 12 sessions of bilateral UL rehabilitation over a 4week period, based on the use of a commercially VR immersive platform (Oculus Rift), followed by a 4-week wash-out period and a 4-week waiting list period. WL-T sequence followed the protocol in the reverse order. Participants were tested at baseline (T0), after the end of the first 4-week period (T1), at the end of the wash-out period and finally at the end of the third 4-week period (T2). The primary outcome was the Box and Blocks test (BBT). Secondary outcome measures were: Nine Hole Peg Test (NHPT), Maximal isometric handgrip strength, Manual Ability Measure-36 (MAM-36), Modified Fatigue Impact Scale (MFIS), and the System Usability Scale (SUS). In absence of carryover effects, we analyzed primary and secondary outcome measures with mixed linear effect models. Treatment efficacy was assessed on the within-subject differences. Specifically, we used the intra-individual differences at the end of treatment and waiting-list periods (T1 and T2) as dependent variables and sequences (T-WL or WL-T) as independent variable. In presence of carryover effects (p-value < 0.05), we assessed between sequence differences by an unpaired t-test considering T0 and T1 as time points, and sequence as group factor. Results: We observed clinical and statistical improvements for BBT, with an overall between-sequence difference of 8.6 ± 2.6 blocks (p < 0.01) favoring treatment period in the less affected side, and a not significant change of  $3.0 \pm 2.6$  blocks (p = 0.28) in the most affected side. Small and not significant between-sequence differences were found for 9HPT, and handgrip strength in both sides. Similarly, no differences were found for patient reported outcomes, MFIS and MAM-36. Finally, mean SUS score was 45.9 ± 11.1 points, representing a moderate usability of the system. **Conclusion:** An immersive VR-based approach resulted useful to improve gross manual dexterity in the less affected limb in PwMS. However, such improvement did not translate into modifications in terms of selfreported ability to carry out activities of daily living nor went along with improvement in fine hand dexterity, strength or fatigue. Finally, usability of this technology was overall judged moderate, with lower scores assigned to items representing user-friendliness.





Besharat A, Imsdahl SI, Yamagami M, et al. Virtual reality doorway and hallway environments alter gait kinematics in people with Parkinson disease and freezing. *Gait & Posture*. 2022;92:442-448. doi:10.1016/j.gaitpost.2021. 12.013 Background: Many people with Parkinson disease (PD) experience freezing of gait (FoG), a transient gait disturbance associated with increased fall risk and reduced quality of life. Head-mounted virtual reality (VR) systems allow overground walking and can create immersive simulations of physical environments that induce FoG. Research question: For people with PD who experience FoG (PD+FoG), are kinematic gait changes observed in VR simulations of FoG-provoking environments? Methods: In a cross-sectional experiment, people with PD+FoG walked at their self-selected speed in a physical laboratory and virtual laboratory, doorway, and hallway environments. Motion analysis assessed whole-body kinematics, including lower extremity joint excursions, swing phase toe clearance, trunk flexion, arm swing, sagittal plane inclination angle, and spatiotemporal characteristics. One-way repeated measures analysis of variance was conducted to examine the effects of environment on gait variables, with planned contrasts between laboratory environments and the virtual doorway and hallway. Results: Twelve participants with PD+FoG (mean age [standard deviation]=72.8 [6.5] years, disease duration=8.8 [8.9] years, 3 females) completed the protocol. The environment had significant and widespread effects on kinematic and spatiotemporal variables. Compared to the physical laboratory, reduced joint excursions were observed in the ankle, knee, and hip when walking in the virtual doorway and in the knee and hip when walking in the virtual hallway. In both the virtual doorway and hallway compared to the physical laboratory, peak swing phase toe clearance, arm swing, and inclination angle were reduced, and walking was slower, with shorter, wider steps. **Significance:** Virtual doorway and hallway environments induced kinematic changes commonly associated with FoG episodes, and these kinematic changes are consistent with forward falls that are common during FoG episodes. Combined with the flexibility of emerging VR technology, this research supports the potential of VR applications designed to improve the understanding, assessment, and treatment of FoG.





Brouwer VHEW, Stuit S, Hoogerbrugge A, et al. Applying machine learning to dissociate between stroke patients and healthy controls using eye movement features obtained from a virtual reality task. *Heliyon*. 2022;8(4):e09207. Published 2022 Mar 31. doi:10.1016/j.heliyon.2022.e 09207

Conventional neuropsychological tests do not represent the complex and dynamic situations encountered in daily life. Immersive virtual reality simulations can be used to simulate dynamic and interactive situations in a controlled setting. Adding eye tracking to such simulations may provide highly detailed outcome measures and has great potential for neuropsychological assessment. Here, participants (83 stroke patients and 103 healthy controls) we instructed to find either 3 or 7 items from a shopping list in a virtual super market environment while eye movements were being recorded. Using Logistic Regression and Support Vector Machine models, we aimed to predict the task of the participant and whether they belonged to the stroke or the control group. With a limited number of eye movement features, our models achieved an average Area Under the Curve (AUC) of .76 in predicting whether each participant was assigned a short or long shopping list (3 or 7 items). Identifying participant as either stroke patients and controls led to an AUC of .64. In both classification tasks, the frequency with which aisles were revisited was the most dissociating feature. As such, eye movement data obtained from a virtual reality simulation contain a rich set of signatures for detecting cognitive deficits, opening the door to potential clinical applications.





Buetler KA, Penalver-Andres J, Özen Ö, et al. "Tricking the Brain" Using Immersive Virtual Reality: Modifying the Self-Perception Over Embodied Avatar Influences Motor Cortical Excitability and Action Initiation. *Front Hum Neurosci*. 2022;15:787487. Published 2022 Feb 9. doi:10.3389/fnhum.2021.78 7487 To offer engaging neurorehabilitation training to neurologic patients, motor tasks are often visualized in virtual reality (VR). Recently introduced head-mounted displays (HMDs) allow to realistically mimic the body of the user from a firstperson perspective (i.e., avatar) in a highly immersive VR environment. In this immersive environment, users may embody avatars with different body characteristics. Importantly, body characteristics impact how people perform actions. Therefore, alternating body perceptions using immersive VR may be a powerful tool to promote motor activity in neurologic patients. However, the ability of the brain to adapt motor commands based on a perceived modified reality has not yet been fully explored. To fill this gap, we "tricked the brain" using immersive VR and investigated if multisensory feedback modulating the physical properties of an embodied avatar influences motor brain networks and control. Ten healthy participants were immersed in a virtual environment using an HMD, where they saw an avatar from first-person perspective. We slowly transformed the surface of the avatar (i.e., the "skin material") from human to stone. We enforced this visual change by repetitively touching the real arm of the participant and the arm of the avatar with a (virtual) hammer, while progressively replacing the sound of the hammer against skin with stone hitting sound via loudspeaker. We applied single-pulse transcranial magnetic simulation (TMS) to evaluate changes in motor cortical excitability associated with the illusion. Further, to investigate if the "stone illusion" affected motor control, participants performed a reaching task with the human and stone avatar. Questionnaires assessed the subjectively reported strength of embodiment and illusion. Our results show that participants experienced the "stone arm illusion." Particularly, they rated their arm as heavier, colder, stiffer, and more insensitive when immersed with the stone than human avatar, without the illusion affecting their experienced feeling of body ownership. Further, the reported illusion strength was associated with enhanced motor cortical excitability and faster movement initiations, indicating that participants may have physically mirrored and compensated for the embodied body characteristics of the stone avatar. Together, immersive VR has the potential to influence motor brain networks by subtly modifying the perception of reality, opening new perspectives for the motor recovery of patients.




Campo-Prieto P. Cancela-	Physical exercise has been recognized as an important strategy in the promotion
Carral JM, Alsina-Rev B.	of healthy aging. Positive effects on older adults' motor ability are brought about
Bodríguez-Euentes G	by engaging their motor skills and promoting sensorimotor learning and cortical
Immersive Virtual Reality as	plasticity. These processes could be increased with the use of immersive virtual
a Novel Physical Therapy	reality (IVP) technology, since the multisensory stimulation is greater. The sim of
Approach for	this study was to evplore the usebility and belance offects of an IVP eversion
Approach to Approa	this study was to explore the usability and balance effects of all type exercise
Nonagenarians. Usability	programmi community-dwelling nonagenarian people. A sample of 12 women
and Effects on Balance	were allocated to an experimental group (EG $n = 6$ ; 91.67 $\pm$ 1.63 years) and a
Outcomes of a Game-Based	control group (CG $n = 6$ ; 90.83 ± 2.64 years). For 10 weeks, the EG used a
Exercise Program. J Clin	commercial IVR exergame three times a week. All the sample completed the
Med. 2022;11(13):3911.	program without adverse effects (without Simulator Sickness Questionnaire
Published 2022 Jul 5.	symptoms). Post-gaming usability was good (System Usability Scale 78.33). The
doi:10.3390/jcm11133911	EG improved some balance parameters significantly (Tinetti test: balance (10.97
	%; Sig = 0.017), gait (9.23%; Sig = 0.047) and total score (10.20%; Sig = 0.014)
	and maintained total TUG test times (-0.45%)). There were significant
	differences between groups (Tinetti test: balance (Sig = 0.004) and total score
	(Sig = 0.0032)). We successfully demonstrated that IVR training is feasible and is
	an effective and personalized method to enhance balance and to reduce the risk
	of falls in community-dwelling nonagenarian women.
Campo-Prieto P, Cancela-	One of the pillars which underpins active aging is found in the performance of
Carral JM, Rodríguez-	physical activity. While adherence to physical activity programs has traditionally
Fuentes G. Feasibility and	been low in older people, immersive virtual reality (IVR) could provide an
Effects of an Immersive	alternative and complementary training mode. A randomized clinical trial was
Virtual Reality Exergame	conducted to explore the feasibility and effects of a 10-week IVR exergame
Program on Physical	program on physical functions of 24 institutionalized older adults who were
Functions in Institutionalized	allocated to an experimental group (EG n = 13; 85.08 ± 8.48 years) and control
Older Adults: A Randomized	group (CG n = 11; 84.82 ± 8.10 years). The IVR intervention was feasible, with no
Clinical Trial. Sensors	adverse effects being reported (no Simulator Sickness Questionnaire symptoms;
(Basel). 2022:22(18):6742.	low negative experience scores on the Game Experience Ouestionnaire <
Published 2022 Sep 6.	0.34/4), no dropouts, high adherence, and good post-gaming usability (System
doi:10.3390/s22186742	Usability Scale > 73.96%). The EG showed significant improvements: Tinetti
	scores for balance (1.84 $\pm$ 1.06; p < 0.001), gait (1.00 $\pm$ 1.08; p < 0.001), total
	score (2.84 ± 1.67; $n < 0.001$ ) and handgrip (4.96 ± 4.22; $n < 0.001$ ) (pre-post
	assessment) The CG showed significantly worsened compared to the FG. Five
	times sit-to-stand test. Tinetti scores for balance gait and total score and the
	Timed I n and Go test total score (nost-assessment). The findings show that the
	IVR intervention is a feasible method to approach a personalized evercise
	program and an effective way by which to improve physical function in the target
	program and an enective way by which to improve physical fullction in the target





Campo-Prieto P, Cancela- Carral JM, Rodríguez- Fuentes G. Immersive Virtual Reality Reaction Time Test and Relationship with the Risk of Falling in Parkinson's Disease. <i>Sensors (Basel)</i> . 2023;23(9):4529. Published 2023 May 6. doi:10.3390/s23094529	Immersive virtual reality (IVR) uses customized and advanced software and hardware to create a digital 3D reality in which all of the user's senses are stimulated with computer-generated sensations and feedback. This technology is a promising tool that has already proven useful in Parkinson's disease (PD). The risk of falls is very high in people with PD, and reaction times and processing speed may be markers of postural instability and functionality, cognitive impairment and disease progression. An exploratory study was conducted to explore the feasibility of reaction time tests performed in IVR as predictors of falls. A total of 26 volunteers (79.2% male; 69.73 ± 6.32 years) diagnosed with PD (1.54 ± 0.90 H&Y stage; 26.92 ± 2.64 MMSE) took part in the study. IVR intervention was feasible, with no adverse effects (no Simulator Sickness Questionnaire symptoms). IVR reaction times were related (Spearman's rho) to functionality (timed up and go test (TUG) (rho = 0.537, <i>p</i> = 0.005); TUG-Cognitive (rho = 0.576, <i>p</i> = 0.020); cognitive impairment mini mental state exam (MMSE) (rho = -0.576, <i>p</i> = 0.002)) and the years of the patients (rho = 0.399, <i>p</i> = 0.043) but not with the first PD symptom or disease stage. IVR test is a complementary assessment tool that may contribute to preventing falls in the proposed sample.
	Additionally, based on the relationship between TUG and reaction times, a cut-
	off time is suggested that would be effective at predicting the risk of suffering a
	fall in PD patients using a simple and quick IVR test.
Campo-Prieto P. Cancela-	Parkinson's disease (PD) is a neurological disorder that usually appears in the
Carral IM Bodríguez-	6th decade of life and affects up to 2% of older people (65 years and older). Its
Fuentes C. Weershie	there and the and an ects up to 2 % of older people (05 years and older). Its
Fuences G. Wearable	there are had a set of a set of the set of t
Immersive virtual Reality	therapies but also physiotherapy. Exercise therapies have shown good results in
Device for Promoting	disease management in terms of renabilitation and/or maintenance of physical
Physical Activity in	and functional capacities, which is important in PD. Virtual reality (VR) could
Parkinson's Disease	promote physical activity in this population. We explore whether a commercial
Patients. Sensors (Basel).	wearable head-mounted display (HMD) and the selected VR exergame could be
2022;22(9):3302. Published	suitable for people with mild-moderate PD. In all, 32 patients (78.1% men; 71.50
2022 Apr 26.	± 11.80 years) were a part of the study. Outcomes were evaluated using the
doi:10.3390/s22093302	Simulator Sickness Questionnaire (SSQ), the System Usability Scale (SUS), the
	Game Experience Questionnaire (GEQ post-game module), an ad hoc
	satisfaction questionnaire, and perceived effort. A total of 60 sessions were
	completed safely (without adverse effects (no SSQ symptoms) and with low
	scores in the negative experiences of the GEQ (0.01-0.09/4)), satisfaction
	opinions were positive (88% considered the training "good" or "very good"), and
	the average usability of the wearable HMD was good (75.16/100). Our outcomes
	support the feasibility of a boxing exergame combined with a wearable
	commercial HMD as a suitable physical activity for PD and its applicability in
	different environments due to its safety, usability, low cost, and small size.
	Future research is needed focusing on postural instability, because it seems to
	be a symptom that could have an impact on the success of exergaming
	programs aimed at PD.





Campo-Prieto P. Rodríguez-	Video games have proven useful in physical rehabilitation therapy. Accessibility,
Eventes G. Cancela-Carral	however, is limited for some groups such as the elderly or patients with
IM Can Immersive Virtual	Parkinson's disease (PD). We explore the potential of fully immersive video
Beality Videogames Help	games as a rebabilitation tool in PD natients. Four patients with mild-moderate
Parkinson's Disease	DD (2 males: 1 female, 52, 71 years) participated in the study. Training consisted
Patiente2 A Case	in two immersive virtual reality video gaming appaient. Outcomes were
Study Sapara (Pagal)	avaluated using System Hashility Socia (SUS). Simulator Sickness Questionnaire
Study. Sensors (Basel).	(CCO) Come Experience Questionnaire post some (CCO) and has estisfaction
2021;21(14):4825. Published	(SSQ), Game Experience Questionnaire-post game (GEQ), an autioc satisfaction
2021 Jul 15.	questionnaire and perceived enort. All participants completed the sessions
001:10.3390/821144825	Without adverse effects (100%), without SSQ symptoms reported. Post-gaming
	SUS was >75% in both sessions (range 75-80%). Post-gaming GEQ scores were
	3.3-4.0/4 in both sessions. Immersive virtual reality video gaming is feasible in
	patients with mild-moderate PD, with positive usability and patient satisfaction,
	and no adverse effects.
Carrougher GJ, Hoffman HG,	Few studies have empirically investigated the effects of immersive virtual reality
Nakamura D, et al. The effect	(VR) on postburn physical therapy pain control and range of motion (ROM). We
of virtual reality on pain and	performed a prospective, randomized controlled study of the effects of adding
range of motion in adults	VR to standard therapy in adults receiving active-assisted ROM physical therapy,
with burn injuries. <i>J Burn</i>	by assessing pain scores and maximal joint ROM immediately before and after
Care Res. 2009;30(5):785-	therapy on two consecutive days. Thirty-nine inpatients, aged 21 to 57 years
791.	(mean 35 years), with a mean TBSA burn of 18% (range, 3-60%) were studied
doi:10.1097/BCR.0b013e318	using a within-subject, crossover design. All patients received their regular
1b485d3	pretherapy pharmacologic analgesia regimen. During physical therapy sessions
	on two consecutive days (VR one day and no VR the other day; order
	randomized), each patient participated in active-assisted ROM exercises with an
	occupational or physical therapist. At the conclusion of each session, patients
	provided 0 to 100 Graphic Rating Scale measurements of pain after each 10-
	minute treatment condition. On the day with VR, patients wore a head-position-
	tracked, medical care environment-excluding VR helmet with stereophonic
	sound and interacted in a virtual environment conducive to burn care. ROM
	measurements for each joint exercised were recorded before and after each
	therapy session. Because of nonsignificant carryover and order effects, the data
	were analyzed using simple paired t-tests. VR reduced all Graphic Rating Scale
	pain scores (worst pain, time spent thinking about the pain, and pain
	unpleasantness by 27, 37, and 31% respectively), relative to the no VR condition
	Average ROM improvement was slightly greater with the VR condition: however
	this difference failed to reach clinical or statistical significance (P = 243)
	Ninety-seven percent of patients reported zero to mild pause after the VR
	session. Immersive VR effectively reduced pain and did not impair ROM during
	postburn physical therapy. VR is easily used in the hospital setting and offers a
	safe, nonpharmacologic adjunctive analgesic treatment
	safe, nonpharmacologic adjunctive analgesic treatment.





Carus EG, Albayrak N, Bildirici HM, Ozmen SG. Immersive virtual reality on childbirth experience for women: a randomized controlled trial. <i>BMC</i> <i>Pregnancy Childbirth</i> . 2022;22(1):354. Published 2022 Apr 23. doi:10.1186/s12884-022- 04598-y	<b>Objective:</b> To evaluate the effectiveness of immersive virtual reality (VR) on patient satisfaction as a distractive tool and pain relief among laboring women. <b>Methods:</b> This was a randomized, controlled clinical trial with 42 laboring women allocated to VR intervention and control groups. Among women in the VR group, patient satisfaction with the use of VR was assessed by a Virtual Reality Satisfaction Survey, measured by a Visual Analog Scale (VAS) score and evaluated by questioning them about whether they would choose VR in future labor. As a primary outcome, patient satisfaction scores regarding the overall childbirth experience were compared between women in the two groups. A secondary outcome was pain assessed by a visual pain rating scale in the early and active phases of labor in women in both groups. Psychometric information was also collected from participants in each group using the Beck Anxiety Inventory and Beck Depression Inventory. <b>Results:</b> We observed a high level of patient satisfaction score of 87.7 $\pm$ 12.9 out of a maximum of 100. Twenty out of 21 (95%) women in the VR group stated that they would like to use VR again in future labor. VR improved pain scores in early labor and contributed positively to the overall childbirth experience. The mean pain score pre-VR was 2.6 $\pm$ 1.2 compared to 2.0 $\pm$ 1.3 post-VR (p < 0.01). Anxiety and depression scores were similar in participants in the intervention and control groups (p = 0.103 and p = 0.13, respectively). <b>Conclusion:</b> Immersive VR application during labor was associated with higher patient satisfaction based on our study findings. VR also improved participants' pain scores in early labor reducting labor was associated with higher patient satisfaction based on our study findings. VR also improve lengthy labor experiences for women. Studies with larger groups of maximum of not proves of participants of not patient set is for women.
Casale B. Damiani C. Bosati	<b>Objective:</b> Mirror box therapy and its development (immersive virtual reality) is
V. Mirror therapy in the rehabilitation of lower-limb amputation: are there any	used in pain therapy and in rehabilitation of people with amputation affected by phantom limb-related phenomena. It allows patients to view a reflection of their anatomical limb in the visual space occupied by their phantom limb. There are
contraindications?. Am J	only limited reports of its possible side effects. <b>Design:</b> we retrospectively
Phys Med Rehabil.	reviewed the existence of side effects or adverse reactions in a group of 33
2009;88(10):837-842.	nonselected patients with phantom limb-related phenomena.
doi:10.1097/PHM.0b013e31	<b>Results:</b> Nineteen reported confusion and dizziness, 6 reported a not clearly
81b74698	specified sensation of irritation, and 4 refused to continue the treatment. Only 4
	of the 33 patients did not have any complaints. <b>Conclusions:</b> Possible reasons
	Tor this large number of side effects could be the lack of selection of patients
	and the fact that the mirror box therapy was paralleled by a conventional
	renabilitation approach largeted to the use of a prostnesis. Warnings on the
	(including time from amputation and clinical acting), and passible conflicting
	mechanisms between mirror box therapy and conventional therapies are
	presented.
	protonico.





Mascaro G, et al. Effect of Immersive Virtual Reality by a Computer Assisted Rehabilitation Environment (CAREN) in Juvenile Huntington's Disease: A Case Report. <i>Medicina</i> (Kaunas). 2022;58(7):919. Published 2022 Jul 11. doi:10.3390/medicina58070 919	complementary approach to conventional neurorehabilitation therapy for improving neuromuscular and cognitive outcomes in several neurological diseases. We hereby report findings from a single-case experience of a 21-year- old woman affected by juvenile Huntington's disease (HD) who underwent a targeted rehabilitative approach using an advanced Computer Assisted Rehabilitation Environment (CAREN) with a three sessions/week schedule for six months. At the end of the program, a manifested improvement was noticed in the Falls Efficacy Scale International score, in the Tinetti Scale, in the Berg Balance score and in the lower limb strength (MRC scale). Minor although tangible improvements were also noticed in some physical performance tests (10 m walking test, time up and go test). Findings reported, although preliminary, extend for the first time the usefulness of neurorehabilitation using innovative VR technologies also to juvenile HD, a condition for which common rehabilitation strategies bring only marginal physical benefits in the majority of cases. Future, controlled studies are awaited for generalizing these observations to larger populations and for clarifying whether such benefits may persist also in the long- term.
Chau B, Phelan I, Ta P, et al. Immersive Virtual Reality for Pain Relief in Upper Limb Complex Regional Pain Syndrome: A Pilot Study. <i>Innov Clin Neurosci</i> . 2020;17(4-6):47-52.	<b>Objective:</b> This pilot study explored the effects of therapeutic immersive virtual reality (VR) on pain in upper limb complex regional pain syndrome (CRPS). While acute pain relief with VR has been studied in multiple populations, there is little data on the use of this modality in treating chronic pain, especially CRPS. <b>Participants:</b> Volunteer participants were recruited from outpatient rehabilitation services. Inclusion criteria required the diagnosis of CRPS in at least one upper limb and the ability to communicate in English to receive instructions from study personnel. A total of eight participants were recruited, with six fully completing the study. <b>Interventions:</b> An immersive virtual three-dimensional interactive kitchen environment was designed that allowed visualization of and object manipulation with virtual hands. Participants performed tasks representative of daily activities, as well as guided visualization exercises for a total of 10 sessions. <b>Main Outcome Measure:</b> Pre and postsession pain scale measurements (Short Form McGill Pain Questionnaire, Visual Analog Scale, and Wong-Baker FACES) and subjective feedback were collected with each session. <b>Results:</b> Four of the six participants that completed the study reported subjective improvement of their pain and daily function. However, objective pain scales had limited correlation to reported subjective analgesia and functional improvement in select patients with upper limb complex regional main functional improvement in select patients with upper limb complex regional main scale has a start of the study function.





Chau B, Phelan I, Ta P, Humbert S, Hata J, Tran D. Immersive Virtual Reality Therapy with Myoelectric Control for Treatment- resistant Phantom Limb Pain: Case Report. <i>Innov Clin</i> <i>Neurosci</i> . 2017;14(7-8):3-7. Published 2017 Aug 1.	<b>Objective:</b> Phantom limb pain is a condition frequently experienced after amputation. One treatment for phantom limb pain is traditional mirror therapy, yet some patients do not respond to this intervention, and immersive virtual reality mirror therapy offers some potential advantages. We report the case of a patient with severe phantom limb pain following an upper limb amputation and successful treatment with therapy in a custom virtual reality environment. <b>Methods:</b> An interactive 3-D kitchen environment was developed based on the principles of mirror therapy to allow for control of virtual hands while wearing a motion-tracked, head-mounted virtual reality display. The patient used myoelectric control of a virtual hand as well as motion-tracking control in this setting for five therapy sessions. Pain scale measurements and subjective feedback was elicited at each session. <b>Results:</b> Analysis of the measured pain scales showed statistically significant decreases per session [Visual Analog Scale, Short Form McGill Pain Questionnaire, and Wong-Baker FACES pain scores decreased by 55 percent (p=0.0143), 60 percent (p=0.023), and 90 percent (p=0.0024), respectively]. Significant subjective pain relief persisting between sessions was also reported, as well as marked immersion within the virtual environments. On followup at six weeks, the patient noted continued decrease in phantom limb pain symptoms. <b>Conclusions:</b> Currently available immersive virtual reality technology with myolectric and motion tracking control may represent a possible therapy option for treatment-resistant phantom limb pain
Chen P, Boukrina O, Krch D. Visuomotor misalignment	One evidence-based treatment for spatial neglect is prism adaptation (PA) treatment. PA after-effects, i.e., the implicit shifts in the arm reaching position
induced through immersive	toward the neglected side of space after prism removal, are considered
virtual reality to improve	fundamental to PA treatment effects. In the present study, the arm reaching
spatial neglect: a case-	position was shifted through a visuomotor misalignment procedure using
series study. Neurocase.	immersive virtual reality (VR). To examine whether this procedure might have a
2022;28(4):393-402.	beneficial impact on spatial neglect, we conducted a multi-baseline experiment
doi:10.1080/13554794.2022.	in three individuals with chronic left-sided neglect post stroke. Improved spatial
2134037	neglect was observed in all participants immediately after 5 sessions with two
	improvement two weeks later. Participants' pattern of brain lesions did not
	appear to clearly explain performance differences. The findings suggest that VR-
	induced visuomotor misalignment may improve spatial neglect immediately
	after a multi-session treatment course. The optimal number of sessions will be
	determined by future studies with a larger sample size, which may also elucidate
	the number of sessions sufficient for sustained improvement in most patients.
	Further investigations will identify the neural mechanisms underlying VR-
	induced visuomotor misalignment, which may or may not be identical to PA
	after-effects.





Choy CS, Cloherty SL,	Stroke is a serious neurological disease that may lead to long-term disabilities
Pirogova E, Fang Q. Virtual	and even death for stroke patients worldwide. The acute period, ( $\leq$ 1 mo post-
Reality Assisted Motor	stroke), is crucial for rehabilitation but the current standard clinical practice may
Imagery for Early Post-Stroke	be ineffective for patients with severe motor impairment, since most
Recovery: A Review. IEEE Rev	rehabilitation programs involve physical movement. Imagined movement - the
Biomed Eng. 2023;16:487-	so-called motor imagery (MI) - has been shown to activate motor areas of the
498.	brain without physical movement. MI therefore offers an opportunity for early
doi:10.1109/RBME.2022.316	rehabilitation of stroke patients. MI, however, is not widely employed in clinical
5062	practice due to a lack of evidence-based research. Here, we review MI-based
	approaches to rehabilitation of stroke patients and immersive virtual reality (VR)
	technologies to potentially assist MI and thus, promote recovery of motor
	function.
Clay F, Howett D, FitzGerald	Background: Immersive virtual reality (iVR) allows seamless interaction with
J, Fletcher P, Chan D, Price A.	simulated environments and is becoming an established tool in clinical
Use of Immersive Virtual	research. It is unclear whether iVR is acceptable to people with Alzheimer's
Reality in the Assessment	disease (AD) dementia or useful in their care. We explore whether iVR is a viable
and Treatment of	research tool that may aid the detection and treatment of AD. <b>Objectives:</b> This
Alzheimer's Disease: A	review examines the use of iVR in people with AD or mild cognitive impairment
Systematic Review. J	(MCI). <b>Methods:</b> Medline, PsycINFO, Embase, CINAHL, and Web of Science
Alzheimers Dis.	databases were searched from inception. PRISMA guidelines were used with
2020;75(1):23-43.	studies selected by at least two researchers. <b>Results:</b> Nine studies were eligible
doi:10.3233/JAD-191218	for inclusion. None reported any issues with iVR tolerability in participants with
	MCI and AD on assessment or treatment tasks. One study demonstrated
	capability for detecting prodromal AD and correlated with neuroanatomical
	substrates. Two studies showed iVR to have high accuracy in differentiating
	participants with AD from controls but were not hypothesis driven or with
	adequate controls measures. In a small validation study and two longitudinal
	case studies iVR cognitive training was positively rated but did not demonstrate
	reliable benefit <b>Conclusion:</b> iVR is emerging as a viable method of assessing
	older adults and people with AD. Strongest benefits were seen when closely
	integrated with theoretical models of neurodegeneration and existing screening
	methods. Further randomized controlled trials integrated with clinical
	nonulations are required. This will consolidate the nower of iVR for assessment
	of MCL and clarify treatment efficacy beyond current applications in physical
	or morand clamy dealment encacy beyond current applications in physical
	רפחמטווונמנוסח.





Connelly L, Jia Y, Toro ML, Stoykov ME, Kenyon RV, Kamper DG. A pneumatic glove and immersive virtual reality environment for hand rehabilitative training after stroke. <i>IEEE Trans Neural</i> <i>Syst Rehabil Eng</i> . 2010;18(5):551-559. doi:10.1109/TNSRE.2010.20 47588	While a number of devices have recently been developed to facilitate hand rehabilitation after stroke, most place some restrictions on movement of the digits or arm. Thus, a novel glove was developed which can provide independent extension assistance to each digit while still allowing full arm movement. This pneumatic glove, the PneuGlove, can be used for training grasp-and-release movements either with real objects or with virtual objects in a virtual reality environment. Two groups of stroke survivors, with seven subjects in each group, completed a six-week rehabilitation training protocol, consisting of three 1-h sessions held each week. One group wore the PneuGlove during training, performed both within a novel virtual reality environment and outside of it with physical objects, while the other group completed the same training without the device. Across subjects, significant improvements were observed in the Fugl- Meyer Assessment for the upper extremity ( $p < 0.001$ ), the hand/wrist portion of the Fugl-Meyer Assessment ( $p < 0.005$ ). While changes in the two groups were not statistically different, the group using the PneuGlove did show greater mean improvement on each of these measures, such as gains of 3.7 versus 2.4 points on the hand/wrist portion of the Fugl-Meyer Assessment and 14 N versus 5 N in palmar pinch
Connelly L, Stoykov ME, Jia Y, Toro ML, Kenyon RV, Kamper DG. Use of a pneumatic glove for hand rehabilitation following stroke. <i>Annu Int</i> <i>Conf IEEE Eng Med Biol Soc</i> . 2009;2009:2434-2437. doi:10.1109/IEMBS.2009.53 35400	Hand impairment is common following stroke and is often resistant to traditional therapy methods. Successful interventions have stressed the importance of repeated practice to facilitate rehabilitation. Thus, we have developed a servo-controlled glove to assist extension of individual digits to promote practice of grasp-and-release movements with the hand. This glove, the PneuGlove, permits free movement of the arm throughout its workspace. A novel immersive virtual reality environment was created for training movement in conjunction with the device. Seven stroke survivors with chronic hand impairment participated in 18 training sessions with the PneuGlove over 6 weeks. Overall, subjects displayed a significant 6-point improvement in the upper extremity score on the Fugl-Meyer assessment and this increase was maintained at the evaluation held one month after conclusion of all training ( $p < 0.01$ ). The majority of this gain came from an increase in the hand/wrist score (3.8-point increase, $p < 0.01$ ). Thus, the system shows promise for rehabilitative training of hand movements after stroke.





David R, Dumas A, Ojardias E, et al. Virtual Reality for Decreasing Procedural Pain during Botulinum Toxin Injection Related to Spasticity Treatment in Adults: A Pilot Study. <i>Medicina (Kaunas)</i> . 2023;60(1):23. Published 2023 Dec 22. doi:10.3390/medicina60010 023	<b>Background and objectives:</b> Botulinum toxin injections are commonly used for the treatment of spasticity. However, injection procedures are associated with pain and procedural anxiety. While pharmacological approaches are commonly used to reduce these, innovative technology might be considered as a potential non-pharmacological alternative. Given this context, immersive virtual reality (VR) has shown effectiveness in the management of procedural pain. Our retrospective pilot study aimed to assess the potential added value of virtual reality in the management of pain and anxiety during intramuscular injections of botulinum toxin. <b>Materials and methods:</b> Seventeen adult patients receiving botulinum toxin injections were included. A numerical rating scale was used to assess pain and anxiety during the injection procedure. The patients reported the pain experienced during previous injections without VR before injection and the pain experienced in the current procedure with VR after the end of the procedure. The level of satisfaction of VR experience, whether or not they agreed to reuse VR for the subsequent toxin botulinum injection, and whether or not they would recommend VR to other patients were assessed. <b>Results:</b> The use of virtual reality led to a decrease of 1.8 pain-related points compared to the procedure without technology. No significant improvement in the level of anxiety was reported. Patients were very satisfied with their VR experiences (7.9 out of 10), and many would agree to reuse VR in their next injection procedure (88%) and to recommend the use of VR in other patients (100%). <b>Conclusion:</b> VR was useful for managing procedural pain related to botulinum toxin injection in adults, with a high level of satisfaction reported by the patients. VR should be considered as a valuable alternative to pharmacological approaches to manage
De Cierri D. Fertini A	procedural pain during bold in the construction in addits.
De Giorgi R, Fortini A, Aghilarra E et al Virtual Art	In neurorehabilitation, some studies reported the effective use of art therapy for reducing psychological disorders and for enhancing physical functions and
Therapy: Application of	cognitive abilities. Neuroaesthetical studies showed that seeing an art
Michelangelo Effect to	masterpiece can spontaneously elicit a widespread brain arousal, also involving
Neurorehabilitation of	motor networks. To combine contemplative and performative benefits of art
Patients with Stroke. J Clin	therapy protocols, we have developed an immersive virtual reality system, giving
Med. 2023;12(7):2590.	subjects the illusion that they are able to paint a copy of famous artistic
Published 2023 Mar 29.	paintings. We previously observed that during this virtual task, subjects
doi:10.3390/jcm12072590	perceived less fatigue and performed more accurate movements than when they
	were asked to color the virtual canvas. We named this upshot the Michelangelo
	effect. The aim of this study was to test the rehabilitative efficacy of our system.
	Ten patients with stroke in the subacute phase were enrolled and trained for one
	monun with virtual art therapy (VAT) and physiotherapy. Their data were
	normaters trained only with conventional therapy for the same amount of time
	The VAT group showed a significantly higher improvements in the Barthel Index
	score a measure of independency in activities of daily living $(66 \pm 33\% \text{ yrs})^{-31}$
	28%, $p = 0.021$ ), and in pinching strength (66 ± 39% vs. 18 ± 33%, $p = 0.008$ ) with
	respect to the group treated with conventional rehabilitation.





Demeco A, Zola L, Frizziero A, et al. Immersive Virtual Reality in Post-Stroke Rehabilitation: A Systematic Review. <i>Sensors (Basel)</i> . 2023;23(3):1712. Published 2023 Feb 3. doi:10.3390/s23031712	In recent years, next to conventional rehabilitation's techniques, new technologies have been applied in stroke rehabilitation. In this context, fully immersive virtual reality (FIVR) has showed interesting results thanks to the level of immersion of the subject in the illusional world, with the feeling of being a real part of the virtual environment. This study aims to investigate the efficacy of FIVR in stroke rehabilitation. PubMed, Web of Science and Scopus were screened up to November 2022 to identify eligible randomized controlled trials (RCTs). Out of 4623, we included 12 RCTs involving post-acute and chronic stroke survivors, with a total of 350 patients (234 men and 115 women; mean age 58.36 years). High heterogeneity of the outcomes considered, the results showed that FIVR provides additional benefits, in comparison with standard rehabilitation. In particular, results showed an improvement in upper limb dexterity, gait performance and dynamic balance, influencing patient independence. Therefore, FIVR represents an adaptable, multi-faceted rehabilitation tool that can be considered in post-stroke rehabilitation, improving the compliance of the patients to the treatment and increasing the level of functioning and quality of life of stroke survivors.
Dimbwadyo-Terrer I, Trincado-Alonso F, de Los Reyes-Guzmán A, et al. Upper limb rehabilitation after spinal cord injury: a treatment based on a data glove and an immersive virtual reality environment. <i>Disabil Rehabil</i> <i>Assist Technol</i> . 2016;11(6):462-467. doi:10.3109/17483107.2015. 1027293	Purpose state: The aim of this preliminary study was to test a data glove, CyberTouch <sup>™</sup> , combined with a virtual reality (VR) environment, for using in therapeutic training of reaching movements after spinal cord injury (SCI). Method: Nine patients with thoracic SCI were selected to perform a pilot study by comparing two treatments: patients in the intervention group (IG) conducted a VR training based on the use of a data glove, CyberTouch <sup>™</sup> for 2 weeks, while patients in the control group (CG) only underwent the traditional rehabilitation. Furthermore, two functional parameters were implemented in order to assess patient's performance of the sessions: normalized trajectory lengths and repeatability. <b>Results:</b> Although no statistical significance was found, the data glove group seemed to obtain clinical changes in the muscle balance (MB) and functional parameters, and in the dexterity, coordination and fine grip tests. Moreover, every patient showed variations in at least one of the functional parameters, either along Y-axis trajectory or Z-axis trajectory. <b>Conclusions:</b> This study might be a step forward for the investigation of new uses of motion capture systems in neurorehabilitation, making it possible to train activities of daily living (ADLs) in motivational environments while measuring objectively the patient's functional evolution. Implications for Rehabilitation Key findings: A motion capture application based on a data glove is presented, for being used as a virtual reality tool for rehabilitation. This application has provided objective data about patient's functional performance. What the study has added: (1) This study allows to open new areas of research based on the use of different motion capture systems as rehabilitation tools, making it possible to train Activities of Daily Living in motivational environments. (2) Furthermore, this study could be a contribution for the development of clinical protocols to identify which types of patients will benefit most from the VR treatments, which int





Donati AR, Shokur S, Morya E, et al. Long-Term Training with a Brain-Machine Interface-Based Gait Protocol Induces Partial Neurological Recovery in Paraplegic Patients. <i>Sci Rep</i> .	Brain-machine interfaces (BMIs) provide a new assistive strategy aimed at restoring mobility in severely paralyzed patients. Yet, no study in animals or in human subjects has indicated that long-term BMI training could induce any type of clinical recovery. Eight chronic (3-13 years) spinal cord injury (SCI) paraplegics were subjected to long-term training (12 months) with a multi-stage BMI-based gait neurorehabilitation paradigm aimed at restoring locomotion. This paradigm combined intense immersive virtual reality training, enriched
2016;6:30383. Published	visual-tactile feedback, and walking with two EEG-controlled robotic actuators,
2016 Aug 11.	including a custom-designed lower limb exoskeleton capable of delivering
doi:10.1038/srep30383	tactile feedback to subjects. Following 12 months of training with this paradigm,
	all eight patients experienced neurological improvements in somatic sensation
	(pain localization, fine/crude touch, and proprioceptive sensing) in multiple
	dermatomes. Patients also regained voluntary motor control in key muscles
	below the SCI level, as measured by EMGs, resulting in marked improvement in
	their walking index. As a result, 50% of these patients were upgraded to an
	incomplete paraplegia classification. Neurological recovery was paralleled by
	the reemergence of lower limb motor imagery at cortical level. We hypothesize
	that this unprecedented neurological recovery results from both cortical and
Figenour M. Coo S. Regard	spinal cord plasticity inggered by long-term BMI usage.
Elsapour M, Cao S, Boger J.	for people living with domentics however, challenges related to domentic
Participatory design and	for people living with dementia; nowever, challenges related to dementia
games to promote	symptoms and aging can make it dimcutt for people tiving with dementia to
and a group on the physical	for exercise and rehabilitation applications, there is a lack of research regarding
activity for people living with	its use with people living with dementia. <b>Methods:</b> Through participatony design
dementia I Rehabil Assist	with evercise therapists, kinesiologists, and people living with dementia, we
Technol Eng	designed two virtual reality environments (a farm and a gym) that were
2020.7.2055668320913770	implemented on head-mounted displays to support five different upper-body
Published 2020 May 21.	exercises. Virtual reality and comparable human-guided exercises were tested
doi:10.1177/2055668320913	with six people living with dementia. Both qualitative and quantitative measures
770	were used, including reaching distance, distance traversed, and speed as well
	as feelings of enjoyment, engagement, interest, easiness, comfort, and level of
	effort. <b>Results:</b> Participants' subjective responses, motion, and fitness
	parameters all demonstrated comparable results between virtual reality and
	human-guided exercises. Therapists' feedback also supported virtual reality
	exercise as an appropriate and engaging method for people living with dementia.
	<b>Conclusions:</b> Collaborating with experts and people living with dementia
	throughout the design process resulted in an intuitive and engaging design. The
	results suggest that head-mounted virtual reality has promising potential to
	support physical activity for people living with dementia.





Ettenhofer ML, Guise B, Brandler B, et al. Neurocognitive Driving Rehabilitation in Virtual Environments (NeuroDRIVE): A pilot clinical trial for chronic traumatic brain injury. *NeuroRehabilitation*. 2019;44(4):531-544. doi:10.3233/NRE-192718 **Background:** Virtual reality (VR) technology may provide an effective means to integrate cognitive and functional approaches to TBI rehabilitation. However, little is known about the effectiveness of VR rehabilitation for TBI-related cognitive deficits. In response to these clinical and research gaps, we developed Neurocognitive Driving Rehabilitation in Virtual Environments (NeuroDRIVE), an intervention designed to improve cognitive performance, driving safety, and neurobehavioral symptoms. **Objective:** This pilot clinical trial was conducted to examine feasibility and preliminary efficacy of NeuroDRIVE for rehabilitation of chronic TBI. Methods: Eleven participants who received the intervention were compared to six wait-listed participants on driving abilities, cognitive performance, and neurobehavioral symptoms. **Results:** The NeuroDRIVE intervention was associated with significant improvements in working memory and visual search/selective attention- two cognitive skills that represented a primary focus of the intervention. By comparison, no significant changes were observed in untrained cognitive areas, neurobehavioral symptoms, or driving skills. Conclusions: Results suggest that immersive virtual environments can provide a valuable and engaging means to achieve some cognitive rehabilitation goals, particularly when these goals are closely matched to the VR training exercises. However, additional research is needed to augment our understanding of rehabilitation for driving skills, cognitive performance, and neurobehavioral symptoms in chronic TBI.





Evans E, Dass M, Muter WM, Tuthill C, Tan AQ, Trumbower RD. A Wearable Mixed Reality Platform to Augment Overground Walking: A Feasibility Study. *Front Hum Neurosci.* 2022;16:868074. Published 2022 Jun 9. doi:10.3389/fnhum.2022.86 8074 Humans routinely modify their walking speed to adapt to functional goals and physical demands. However, damage to the central nervous system (CNS) often results in abnormal modulation of walking speed and increased risk of falls. There is considerable interest in treatment modalities that can provide safe and salient training opportunities, feedback about walking performance, and that may augment less reliable sensory feedback within the CNS after injury or disease. Fully immersive virtual reality technologies show benefits in boosting training-related gains in walking performance; however, they lack views of the real world that may limit functional carryover. Augmented reality and mixed reality head-mount displays (MR-HMD) provide partially immersive environments to extend the virtual reality benefits of interacting with virtual objects but within an unobstructed view of the real world. Despite this potential advantage, the feasibility of using MR-HMD visual feedback to promote goaldirected changes in overground walking speed remains unclear. Thus, we developed and evaluated a novel mixed reality application using the Microsoft HoloLens MR-HMD that provided real-time walking speed targets and augmented visual feedback during overground walking. We tested the application in a group of adults not living with disability and examined if they could use the targets and visual feedback to walk at 85%, 100%, and 115% of each individual's self-selected speed. We examined whether individuals were able to meet each target gait speed and explored differences in accuracy across repeated trials and at the different speeds. Additionally, given the importance of task-specificity to therapeutic interventions, we examined if walking speed adjustment strategies were consistent with those observed during usual overground walking, and if walking with the MR-HMD resulted in increased variability in gait parameters. Overall, participants matched their overground walking speed to the target speed of the MR-HMD visual feedback conditions (all *p*-values > 0.05). The percent inaccuracy was approximately 5% across all speed matching conditions and remained consistent across walking trials after the first overall walking trial. Walking with the MR-HMD did not result in more variability in walking speed, however, we observed more variability in stride length and time when walking with feedback from the MR-HMD compared to walking without feedback. The findings offer support for mixed reality-based visual feedback as a method to provoke goal-specific changes in overground walking behavior. Further studies are necessary to determine the clinical safety and efficacy of this MR-HMD technology to provide extrinsic sensory feedback in combination with traditional treatments in rehabilitation.





Faber AW, Patterson DR, Bremer M. Repeated use of immersive virtual reality therapy to control pain during wound dressing changes in pediatric and adult burn patients. <i>J Burn</i> <i>Care Res</i> . 2013;34(5):563- 568. doi:10.1097/BCR.0b013e318 2777904	The current study explored whether immersive virtual reality (VR) continues to reduce pain (via distraction) during more than one wound care session per patient. Thirty-six patients aged 8 to 57 years (mean age, 27.7 years), with an average of 8.4% TBSA burned (range, 0.25-25.5 TBSA) received bandage changes, and wound cleaning. Each patient received one baseline wound cleaning/debridement session with no-VR (control condition) followed by one or more (up to seven) subsequent wound care sessions during VR. After each wound care session (one session per day), worst pain intensity was measured using a visual analog thermometer, the dependent variable. Using a within-subjects design, worst pain intensity during wound care with no-VR (baseline, day 0) was compared with pain during wound care while using immersive VR (up to 7 days of wound care during VR). Compared with pain during no-VR baseline (day 0), pain ratings during wound debridement were statistically lower when patients were in VR on days 1, 2, and 3, and although not significant beyond day 3, the pattern of results from days 4, 5, and 6 are consistent with the notion that VR continues to reduce pain when used repeatedly. Results from the present study suggest that VR continues to be effective when used for three (or possibly more) treatments during severe burn wound debridement.
Faity G. Sidahmed Y. Laffont	Unilateral spatial neglect is a common sensorimotor disorder following the
I, Froger J. Quantification and Rehabilitation of Unilateral Spatial Neglect in Immersive Virtual Reality: A Validation Study in Healthy Subjects. <i>Sensors (Basel)</i> . 2023;23(7):3481. Published 2023 Mar 27. doi:10.3390/s23073481	occurrence of a stroke, for which prismatic adaptation is a promising rehabilitation method. However, the use of prisms for rehabilitation often requires the use of specific equipment that may not be available in clinics. To address this limitation, we developed a new software package that allows for the quantification and rehabilitation of unilateral spatial neglect using immersive virtual reality. In this study, we compared the effects of virtual and real prisms in healthy subjects and evaluated the performance of our virtual reality tool (HTC Vive) against a validated motion capture tool. Ten healthy subjects were randomly exposed to virtual and real prisms, and measurements were taken before and after exposure. Our findings indicate that virtual prisms are at least as effective as real prisms in inducing aftereffects ( $4.39^\circ \pm 2.91^\circ$ with the virtual prisms compared to $4.30^\circ \pm 3.49^\circ$ with the real prisms), but that these effects were not sustained beyond 2 h regardless of exposure modality. The virtual measurements obtained with our software showed excellent metrological qualities (ICC = $0.95$ , error = $0.52^\circ \pm 1.18^\circ$ ), demonstrating its validity and reliability for quantifying deviation during pointing movements. Overall, our results suggest that our virtual reality software (Virtualis, Montpellier, France) could provide an easy and reliable means of quantifying and rehabilitating spatial neglect. Further validation of these results is required in individuals with





Fregna G, Paoluzzi C, Baroni A, Cano-de-la-Cuerda R, Casile A, Straudi S. Head-Mounted Displays for Upper Limb Stroke Rehabilitation: A Scoping Review. *J Clin Med*. 2023;12(23):7444. Published 2023 Nov 30. doi:10.3390/jcm12237444 Upper extremity (UE) paresis is one of the most frequent and disabling clinical consequences after stroke. Head-Mounted Displays (HMDs) are wearable virtual reality devices that seem effective in promoting the recovery of functional abilities by increasing adherence levels in this population. This scoping review is aimed at collecting available evidence on the use of HMD-based immersive virtual reality systems for UE rehabilitation treatment in stroke survivors. Four electronic bibliographic databases were consulted from inception until 18 January 2023. A total of 19 clinical trials in which HMDs were used as a clinical tool for increasing UE functioning, as a single intervention or in adjunct to other rehab treatments, were included; no restrictions were applied for UE paresis severity or stroke onset. The large majority of the clinical trials involved chronic stroke patients (15 out of 19), with a wide range of UE impairments. Overall, HMD use seemed to be well-tolerated and promising for increasing UE motor function in adult chronic stroke survivors, with benefits in subjects' arm use and independence. The possibility of executing highly realistic and task-oriented movements appears to be promising in enhancing gesture relevance, thus promoting new motor strategies in a "virtual ecological way". Across studies, we found a high heterogeneity in protocol design and a lack of reporting that prevents us drawing conclusions regarding potential subgroups of patients that could benefit more from HMD-based interventions or suggested treatment modalities.





Garay-Sánchez A, Suarez-Serrano C, Ferrando-Margelí M, Jimenez-Rejano JJ, Marcén-Román Y. Effects of Immersive and Non-Immersive Virtual Reality on the Static and Dynamic Balance of Stroke Patients: A Systematic Review and Meta-Analysis. *J Clin Med*. 2021;10(19):4473. Published 2021 Sep 28. doi:10.3390/jcm10194473 Background: The development of new technologies means that the use of virtual reality is increasingly being implemented in rehabilitative approaches for adult stroke patients. **Objective:** To analyze the existing scientific evidence regarding the application of immersive and non-immersive virtual reality in patients following cerebrovascular incidents and their efficacy in achieving dynamic and static balance. (2) Data sources: An electronic search of the databases Medline, Cochrane Library, PEDro, Scopus, and Scielo from January 2010 to December 2020 was carried out using the terms physiotherapy, physical therapy, virtual reality, immersive virtual reality, non-immersive virtual reality, stroke, balance, static balance, and dynamic balance. Selection of studies: Randomized controlled trials in patients older than 18 developed with an adult population (>18 years old) with balance disorders as a consequence of suffering a stroke in the previous six months before therapeutic intervention, including exercises harnessing virtual reality in their interventions and evaluations of balance and published in English or Spanish, were included. A total of two hundred twenty-seven articles were found, ten of which were included for review and of these, nine were included in the subsequent metaanalysis. (3) Data extraction: Two authors selected the studies and extracted their characteristics (participants, interventions, and validation instruments) and results. The methodological quality of the studies was evaluated using the PEDro scale, and the risk of bias was determined using the Cochrane risk-ofbias tool. Data synthesis: Of the selected studies, three did not show significant improvements and seven showed significant improvements in the intervention groups in relation to the variables. (4) Conclusions: Non-immersive virtual reality combined with conventional rehabilitation could be considered as a therapeutic option.





García-Muñoz C, Cortés-Vega MD, Hernández-Rodríguez JC, Fernández-Seguín LM, Escobio-Prieto I, Casuso-Holgado MJ. Immersive Virtual Reality and Vestibular Rehabilitation in Multiple Sclerosis: Case Report. *JMIR Serious Games*. 2022;10(1):e31020. Published 2022 Feb 16. doi:10.2196/31020 Background: Dizziness and imbalance are common and disabling symptoms in patients with multiple sclerosis (MS) and are caused by a central, peripheral, or mixed vestibulopathy. Central vestibular disorder is the most frequently reported vestibular problem in the MS population due to demyelination. Vestibular rehabilitation ameliorates these symptoms and their repercussions and improves quality of life. Immersive virtual reality (VRi) is an emerging tool in this field; however, no previous research has been performed studying its effects in MS. **Objective:** The aim of this study was to apply a VRi vestibular training protocol to a patient with MS and assess the effects induced by the experimental intervention. Methods: This case study included a 54-year-old woman with relapsing-remitting MS. We developed a standardized VRi exercise protocol for vestibular rehabilitation based on the gold-standard Cawthorne-Cooksey vestibular training protocol. The 20-session intervention was made up of 10 initial sessions and 10 advanced sessions. Each 50-minute session was performed two to three times per week for 7 weeks. Four evaluations were carried out over the study period: at baseline (T0), between initial and advances phases (T1), postintervention (T2), and 1 month after the experimental procedure (T3). The research outcomes were dizziness, balance, gait, impact of fatigue, quality of life, repercussions in muscular tone, and usability of the headmounted display device. Results: After implementing the VRi vestibular protocol, improvements were seen in the following patient parameters: Dizziness Handicap Inventory score (62 points at T0; 4 points at T2); Berg Balance Scale score (47 points at T0; 54 points at T2); instrumented Timed Up and Go time (8.35 seconds at T0; 5.57 seconds at T2); muscular tone of the erector spinae, rectus femoris, and soleus; Modified Fatigue Impact Scale score (61 points at T0; 37 points at T2); and Multiple Sclerosis Quality of Life-54 values (67.16% in the physical health area at T2; 33.56% in the mental health area at T2). The patient rated the usability of the system as 90%, based on the System Usability Scale, and gave the system a grade of A. **Conclusions:** Although further research is needed, this study provided initial evidence that the first VRi vestibular protocol for the MS population can improve dizziness, balance, gait, impact of fatigue, quality of life, and muscular tone through an exergame intervention. This study may help establish a standardized VRi protocol for vestibular rehabilitation.





Garrett B, Taverner T, Masinde W, Gromala D, Shaw C, Negraeff M. A rapid evidence assessment of immersive virtual reality as an adjunct therapy in acute pain management in clinical practice. <i>Clin J Pain</i> . 2014;30(12):1089-1098. doi:10.1097/AJP.000000000 000064	<b>Objectives:</b> Immersive virtual reality (IVR) therapy has been explored as an adjunct therapy for the management of acute pain among children and adults for several conditions. Therapeutic approaches have traditionally involved medication and physiotherapy but such approaches are limited over time by their cost and side effects. This review seeks to critically evaluate the evidence for and against IVR as an adjunctive therapy for acute clinical pain applications. <b>Methods:</b> A rapid evidence assessment (REA) strategy was used. CINAHL, Medline, Web of Science, IEEE Xplore Digital Library, and the Cochrane Library databases were screened in from December 2012 to March 2013 to identify studies exploring IVR therapies as an intervention to assist in the management of pain. Main outcome measures were for acute pain and functional impairment. <b>Results:</b> Seventeen research studies were included in total including 5 RCTs, 6 randomized crossover studies, 2 case series studies, and 4 single-patient case studies. This included a total of 337 patients. Of these studies only 4 had a low risk of bias. There was strong overall evidence was found for short-term effects on physical function. Little evidence exists for longer-term benefits. IVR was not associated with any serious adverse events. <b>Discussion:</b> This review found moderate evidence for the reduction of pain and functional impairment after IVR in patients with acute pain. Further high-quality studies are required for the conclusive judgment of its effectiveness in acute pain, to establish potential benefits for abarrie pain and for short-term and the studies are required for the conclusive judgment of its effectiveness in acute pain, to establish potential benefits for abarrie pain.
Goel T, Sharma N, Gehlot A, Srivastav AK. Effectiveness of immersive virtual reality training to improve sitting balance control among individuals with acute and sub-acute paraplegia: A randomized clinical trial. <i>J</i> <i>Spinal Cord Med</i> . 2023;46(6):964-974. doi:10.1080/10790268.2021. 2012053	<b>Objectives:</b> Spinal cord injury (SCI) is a disabling condition with physical, psychological, and financial consequences. The study's goal is to compare the effectiveness of immersive virtual reality (VR) training in balance among individuals with incomplete paraplegia to that of functional electrical stimulation (FES). <b>Design:</b> Two groups, randomized clinical trial. <b>Setting:</b> Neurological Physiotherapy Out Patient Department, Tertiary Care Hospital. <b>Participants:</b> Eighteen people aged 18-60 years with incomplete SCI. <b>Interventions:</b> VR training along with conventional physical therapy (CPT) and FES for Rectus Abdominis and Erector Spinae with CPT five times a week for 4 weeks. <b>Outcome measures:</b> The outcome measures were Modified Functional Reach Test (mFRT) and Function in Sitting Test (FIST) to assess sitting balance and Spinal Cord Independence Measure III (SCIM III) for the level of independence. Assessments were taken before initiating treatment and at the end of the 2 and 4 weeks after treatment. Within-group analyses for the mFRT values were performed using Repeated Measures ANOVA test, and betweengroup analyses were performed using the independent <i>t</i> -test test. Friedman and Mann-Whitney <i>U</i> -tests were used for analyzing FIST and SCIM III. <b>Results:</b> All variables (mFRT and FIST) improved significantly in both groups (P < 0.05), with the VR + CPT group showing a more significant result than the FES + CPT group (P value < 0.05), except for SCIM III. <b>Conclusion:</b> VR as an adjunct to CPT





This trial was designed to evaluate the effects of fully immersive virtual reality
(IVR) treatment combined with exercise training in fibromyalgia patients. Twenty patients were randomized into exercise group (EG) or IVR combined with exercise group (Exercise+IVR). The EG had combined exercise training consisted of 30 minutes of aerobic training and 30 minutes of Pilates training and Exercise+IVR group had the same protocol with EG plus 20 minutes of IVR, twice a week for 8 weeks. Visual analogue scale for pain, Modified Sensory Organization Test for balance, Tampa Scale of Kinesiophobia for kinesiophobia, Fibromyalgia Impact Questionnaire for impact of fibromyalgia, Fatigue Severity Scale for fatigue, International Physical Activity Questionnaire for level of physical activity, six-minute walk test for functional capacity, and Short-Form 36 Health Survey for quality of life were used for evaluation. Pain, balance, kinesiophobia, impact of fibromyalgia, fatigue, level of physical activity, functional exercise capacity and quality of life scores improved significantly in both groups ( $p < .05$ ). Exercise+IVR group showed significant improvement compared to the EG regarding pain, kinesiophobia, fatigue, level of physical activity, and mental component of quality of life ( $p < .05$ ). IVR treatment may be an effective method as an adjunctive therapy with other exercise trainings in fibromyalgia.
Background: Neuropathic pain following spinal cord injury (SCI) affects
approximately 60% of individuals with SCI. Effective pharmacological and non- pharmacological treatments remain elusive. We recently demonstrated that our immersive virtual reality walking intervention (VRWalk) may be effective for SCI NP. Additionally, we found that SCI NP may result from a decrease in thalamic γ- aminobutyric-acid (GABA), which disturbs central sensorimotor processing. <b>Objective:</b> While we identified GABAergic changes associated with SCI NP, a critical outstanding question is whether a decrease in SCI NP generated by our VRWalk intervention causes GABA content to rise. <b>Method:</b> A subset of participants ( <i>n</i> = 7) of our VRWalk trial underwent magnetic resonance spectroscopy pre- and post-VRWalk intervention to determine if the decrease in SCI NP is associated with an increase in thalamic GABA. <b>Results:</b> The findings revealed a significant increase in thalamic GABA content from pre- to post- VRWalk treatment. <b>Conclusion:</b> While the current findings are preliminary and should be interpreted with caution, pre- to post-VRWalk reductions in SCI NP may be mediated by pre- to post-treatment increases in thalamic GABA by targeting and normalizing maladaptive sensorimotor cortex reorganization. Understanding the underlying mechanisms of pain recovery can serve to validate the efficacy of home-based VR walking treatment as a means of managing pain following SCI. Neuromodulatory interventions aimed at increasing thalamic inhibitory function may provide more effective pain relief than currently available





Hacmun I, Regev D, Salomon R. Artistic creation in virtual reality for art therapy: A qualitative study with expert art therapists. <i>The Arts in</i> <i>Psychotherapy</i> . 2021;72:101745. doi:10.1016/j.aip.2020.1017 45	Recent advances in technology have enabled the creation of immersive digital environments commonly known as Virtual Reality (VR). The current study explored the potential of artistic creation in VR for art therapy (VRAT) from the perspective of expert art therapists. Seven expert art therapists participated in this study, all of whom experimented with creating visual art in VR and as observers. After the VR experience, a semi-structured interview was conducted to assess central aspects of their experience both as creators and as observers. The interviews were analyzed according to the principles of Thematic Analysis. Four main themes emerged from the findings: (1) The user experience of creation in VR. (2) The qualities of the VR material and medium. (3) The VR environment as a therapeutic setting. (4) The relevance of the VR medium for art therapy. The results indicated that the therapists foresee substantial potential in the novel VR medium for art therapy and highlighted further research directions needed to determine how the virtual medium can be used to treat real world prebleme.
	determine now the virtual medium can be used to treat reat world problems.
Hamilton T, Burback L, Smith-MacDonald L, et al. Moving Toward and Through Trauma: Participant Experiences of Multi-Modal Motion-Assisted Memory Desensitization and Reconsolidation (3MDR). <i>Front Psychiatry</i> . 2021;12:779829. Published 2021 Dec 22. doi:10.3389/fpsyt.2021.7798 29	<b>Introduction:</b> Military members and Veterans are at risk of developing combat- related, treatment-resistant posttraumatic stress disorder (TR-PTSD) and moral injury (MI). Conventional trauma-focused therapies (TFTs) have shown limited success. Novel interventions including Multi-modal Motion-assisted Memory Desensitization and Reconsolidation therapy (3MDR) may prove successful in treating TR-PTSD. <b>Objective:</b> To qualitatively study the experiences of Canadian military members and Veterans with TR-PTSD who received the 3MDR intervention. <b>Methods:</b> This study explored qualitative data from a larger mixed- method waitlist control trial testing the efficacy of 3MDR in military members and veterans. Qualitative data were recorded and collected from 3MDR sessions, session debriefings and follow-up interviews up to 6 months post- intervention; the data were then thematically analyzed. <b>Results:</b> Three themes emerged from the data: (1) the participants' experiences with 3MDR; (2) perceived outcomes of 3MDR; and (3) keys to successful 3MDR treatment. Participants expressed that 3MDR provided an immersive environment, active engagement and empowerment. The role of the therapist as a coach and "fireteam partner" supports the participants' control over their therapy. The multi-modal nature of 3MDR, combining treadmill-walking toward self-selected trauma imagery with components of multiple conventional TFTs, was key to helping participants engage with and attribute new meaning to the memory of the traumatic experience. <b>Discussion:</b> Preliminary thematic analysis of participant experiences of 3MDR indicate that 3MDR has potential as an effective intervention for combat-related TR-PTSD, with significant functional, well-being and relational improvements reported post- intervention. <b>Conclusion:</b> Military members and Veterans are at risk of
	needed into 3MDR and its use with other trauma-affected populations.





Hao J, He Z, Yu X, Remis A. Comparison of immersive and non-immersive virtual reality for upper extremity functional recovery in patients with stroke: a systematic review and network meta- analysis. <i>Neurol Sci</i> . 2023;44(8):2679-2697. doi:10.1007/s10072-023- 06742-8	<b>Objective:</b> This systematic review aimed to compare the effects of immersive and non-immersive virtual reality on upper extremity function in stroke survivors by employing a network meta-analysis approach. <b>Data sources:</b> MEDLINE, Embase, CINAHL Plus, APA PsycINFO, and Scopus were searched. Virtual reality was used for upper extremity rehabilitation; dose-matched conventional rehabilitation was used for comparison. Fugl-Meyer Assessment was used to assess upper extremity function. Searches were limited to English language randomized controlled trials. <b>Methods:</b> Two independent reviewers conducted study selection, data extraction, and quality assessment. Methodological quality was assessed using the Physiotherapy Evidence Database scale. A random- effects frequentist network meta-analysis was conducted by assuming a common random-effects standard deviation for all comparisons in the network. <b>Results:</b> Twenty randomized controlled trials with 813 participants were included, with each study evaluated as good quality. Immersive virtual reality systems were most effective at improving upper extremity function, followed by non-immersive virtual reality systems, then non-immersive gaming consoles of Microsoft Kinect and Nintendo Wii. Conventional rehabilitation was least effective. Immersive virtual reality was estimated to induce 1.39 (95% confidence interval (CI): 0.25, 2.53) and 1.38 (95% CI: 0.55, 2.20) standard mean differences of improvements in upper extremity function, compared to Nintendo Wii intervention and conventional rehabilitation, respectively. <b>Conclusion:</b> This systematic review and network meta-analysis highlights the superior effects of immersive virtual reality to non-immersive virtual reality systems and gaming
Heinrich C, Morkisch N, Langlotz T, Regenbrecht H, Dohle C. Feasibility and psychophysical effects of immersive virtual reality- based mirror therapy. <i>J</i> <i>Neuroeng Rehabil</i> . 2022;19(1):107. Published 2022 Oct 7. doi:10.1186/s12984-022- 01086-4	Background: Virtual reality (VR) has been used as a technological medium to deliver mirror therapy interventions with people after stroke in numerous applications with promising results. The recent emergence of affordable, off-the-shelf head-mounted displays (like the Oculus Rift or HTC Vive) has opened the possibility for novel and cost-effective approaches for immersive mirror therapy interventions. We have developed one such system, ART-VR, which allows people after stroke to carry out a clinically-validated mirror therapy protocol in an immersive virtual environment and within a clinical setting. Methods: A case cohort of 11 people with upper limb paresis following first time stroke at an in-patient rehabilitation facility received three interventions over a one week period. Participants carried out the BeST mirror therapy protocol using our immersive VR system as an adjunct therapy to their standard rehabilitation program. Our clinical feasibility study investigated intervention outcomes, virtual reality acceptance and user experience. Results: The results show that the combination of an immersive VR system and mirror therapy protocol is feasible for clinical use. 9 out of 11 participants showed some improvement of their affected hand after the intervention. The vast majority of the participants (9/11) reported experiencing some psycho-physical effects, such as tingling or paraesthesia, in the affected limb during the intervention. Conclusions: Our findings show that immersive VR-based mirror therapy is feasible and shows effects comparable to those of conventional mirror therapy.





Hitching R, Hoffman HG,	Over the past 20 years, there has been a significant reduction in the incidence of
Garcia-Palacios A, et al. The	adverse events associated with sedation outside of the operating room. Non-
Emerging Role of Virtual	pharmacologic techniques are increasingly being used as peri-operative
Reality as an Adjunct to	adjuncts to facilitate and promote anxiolysis, analgesia and sedation, and to
Procedural Sedation and	reduce adverse events. This narrative review will briefly explore the emerging
Anesthesia: A Narrative	role of immersive reality in the peri-procedural care of surgical patients.
Review. J Clin Med.	Immersive virtual reality (VR) is intended to distract patients with the illusion of
2023;12(3):843. Published	"being present" inside the computer-generated world, drawing attention away
2023 Jan 20.	from their anxiety, pain, and discomfort. VR has been described for a variety of
doi:10.3390/jcm12030843	procedures that include colonoscopies, venipuncture, dental procedures, and
	burn wound care. As VR technology develops and the production costs
	decrease, the role and application of VR in clinical practice will expand. It is
	important for medical professionals to understand that VR is now available for
	prime-time use and to be aware of the growing body in the literature that
	supports VR.
Hoffman HG, Boe DA,	Introduction: Affordable virtual reality (VR) technology is now widely available.
Rombokas E, et al. Virtual	Billions of dollars are currently being invested into improving and mass
reality hand therapy: A new	producing VR and augmented reality products. <b>Purpose of the study:</b> The
tool for nonopioid analgesia	purpose of the present study is to explore the potential of immersive VR to make
for acute procedural pain,	physical therapy/occupational therapy less painful, more fun, and to help
hand rehabilitation, and VR	motivate patients to cooperate with their hand therapist. <b>Discussion:</b> The
embodiment therapy for	following topics are covered: a) psychological influences on pain perception, b)
phantom limb pain. J Hand	the logic of how VR analgesia works, c) evidence for reduction of acute
Ther. 2020;33(2):254-262.	procedural pain during hand therapy, d) recent major advances in VR
doi:10.1016/j.jht.2020.04.00	technology, and e) future directions-immersive VR embodiment therapy for
1	phantom limb (chronic) pain. <b>Conclusion:</b> VR hand therapy has potential for a
	wide range of patient populations needing hand therapy, including acute pain
	and potentially chronic pain patients. Being in VR helps reduce the patients'
	pain, making it less painful for patients to move their hand/fingers during hand
	therapy, and gamified VR can help motivate the patient to perform therapeutic
	hand exercises, and make hand therapy more fun. In addition, VR camera-based
	hand tracking technology may be used to help therapists monitor how well
	patients are doing their hand therapy exercises, and to quantify whether
	adherence to treatment increases long-term functionality. Additional research
	and development into using VR as a tool for hand therapist is recommended for
	both acute pain and persistent pain patient populations.





Hoffman HG, Patterson DR, Carrougher GJ, Sharar SR. Effectiveness of virtual reality-based pain control with multiple treatments. *Clin J Pain*. 2001;17(3):229-235. doi:10.1097/00002508-200109000-00007 **Objective:** The current study explored whether immersive virtual reality continues to reduce pain (via distraction) with repeated use. Setting: The study was conducted in a burn care unit at a regional trauma center. **Patients:** Seven patients aged 9-32 years (mean age of 21.9 years; average of 23.7% total body surface area burned [range, 3-60%]) performed range-of-motion exercises of their injured extremity under an occupational therapist's direction on at least 3 separate days each. Intervention: For each physical therapy session, each patient spent equal amounts of time in virtual reality and in the control condition (no distraction). The mean duration of physical therapy in virtual reality was 3.5, 4.9, and 6.4 minutes for the first, second, and third session, respectively. Condition order was randomized and counter-balanced. Outcome **measures:** For each of the three physical therapy sessions, five visual analog pain scores for each treatment condition served as the dependent variables. **Results:** Pain ratings were statistically lower when patients were in virtual reality, and the magnitude of pain reduction did not diminish with repeated use of virtual reality. The results of this study may be examined in more detail at www.vrpain.com. Conclusions: Although the small sample size limits generalizability. results provide converging preliminary evidence that virtual reality can function as a strong nonpharmacological pain reduction technique for burn patients during physical therapy. Results suggest that virtual reality does not diminish in analgesic effectiveness with three (and possibly more) uses. Virtual reality may also have analgesic potential for other painful procedures or pain populations. Practical implications are discussed.





Hoffman HG, Patterson DR, Seibel E, Soltani M, Jewett- Leahy L, Sharar SR. Virtual reality pain control during burn wound debridement in the hydrotank. <i>Clin J Pain</i> . 2008;24(4):299-304. doi:10.1097/AJP.0b013e3181 64d2cc	<b>Objective:</b> Most burn-injured patients rate their pain during burn wound debridement as severe to excruciating. We explored the adjunctive use of water-friendly, immersive virtual reality (VR) to distract patients from their pain during burn wound debridement in the hydrotherapy tank (hydrotank). <b>Setting:</b> This study was conducted on inpatients at a major regional burn center. <b>Patients:</b> Eleven hospitalized inpatients ages 9 to 40 years (mean age, 27 y) had their burn wounds debrided and dressed while partially submerged in the hydrotank. <b>Intervention:</b> Although a nurse debrided the burn wound, each patient spent 3 minutes of wound care with no distraction and 3 minutes of wound care in VR during a single wound care session (within-subject condition order randomized). <b>Outcome measures:</b> Three 0 to 10 graphic rating scale pain scores (worst pain, time spent thinking about pain, and pain unpleasantness) for each of the 2 treatment conditions served as the primary dependent variables. <b>Results:</b> Patients reported significantly less pain when distracted with VR [eg, "worst pain" ratings during wound care dropped from "severe" (7.6) to "moderate" (5.1)]. The 6 patients who reported the strongest illusion of "going inside" the virtual world reported the greatest analgesic effect of VR on worst pain ratings, dropping from severe pain (7.2) in the no VR condition to mild pain (3.7) during VR. <b>Conclusions:</b> Results provide the first available evidence from a controlled study that immersive VR can be an effective nonpharmacologic pain reduction technique for burn patients experiencing severe to excruciating pain during wound care. The potential applications of VR analgesia to other painful procedures (eg, movement or exercise therapy) and other pain populations are discussed
Hoffman HG, Patterson DR, Soltani M, Teeley A, Miller W, Sharar SR. Virtual reality pain control during physical therapy range of motion exercises for a patient with multiple blunt force trauma injuries. <i>Cyberpsychol</i> <i>Behav</i> . 2009;12(1):47-49. doi:10.1089/cpb.2008.0056	Patients with severe blunt force trauma injuries (e.g., multiple fractures and/or internal injuries) often experience severe to excruciating pain during medical procedures. We explored the adjunctive use of immersive virtual reality (VR) to distract a patient with multiple blunt trauma injuries from his procedural pain during physical therapy. The patient was a 32-year-old male hospitalized after suffering upper and lower extremity injuries when he was hit by a semi truck as a pedestrian. While a nurse assisted the patient's passive range of motion (ROM) leg exercises over two days, the patient spent a total of 10 minutes of physical therapy with no distraction and 10 minutes in VR (within-subjects design, order randomized). Three 0 to 10 graphic-rating-scale pain scores for each of the two treatment conditions served as the primary dependent variables. The patient reported a reduction in pain when distracted with VR. "Pain unpleasantness" ratings during physical therapy dropped from "severe" (mean = 8.5) to "mild/moderate" (4.5). The patient's ROM was 1 degree less during VR on day 1, but the patient achieved 15 degrees greater ROM during VR on day 2. The present study provides preliminary evidence that immersive VR can be an effective adjunctive, nonpharmacologic pain-reduction technique for a patient with multiple blunt trauma injuries experiencing severe pain during physical therapy. The potential utility of VR analgesia for movement or exercise therapy for patients with blunt force trauma injuries should be explored in controlled studies.





Hong S, Lee G. Effects of an Immersive Virtual Reality Environment on Muscle Strength, Proprioception, Balance, and Gait of a Middle-Aged Woman Who Had Total Knee Replacement: A Case Report. <i>Am J Case Rep</i> . 2019;20:1636-1642. Published 2019 Nov 7. doi:10.12659/AJCR.918521	<b>Background:</b> The purpose of this case study was to apply a training program using virtual reality to a middle-aged woman who had total knee replacement surgery and to investigate its effects on her muscle strength, proprioception, balance, and gait ability. <b>Case Report:</b> The subject who participated in this study was a 62-year-old woman, who had been diagnosed with moderate osteoarthritis and had a total knee replacement. Post-operative treatment consisted of virtual reality training along with range of motion exercise of the knee joint, light quadriceps isometric exercise, and conventional physical therapy. This also included thermal and electric therapy for pain control conducted on 10 occasions (5 times a week for 2 weeks). Total treatment time, which included 30 min of conventional physical therapy, was 60 min. Measurement of the subject's lower extremity muscle strength after intervention decreased to 9.43 s, and the error in proprioception decreased to 1.5°. In addition, balance score increased to 56 points, and the time taken to measure gait ability decreased to 9.87 s. <b>Conclusions:</b> The patient responded positively to rehabilitation using virtual reality, and her muscle strength, proprioception, balance, and gait ability improved. These results suggest that the application of rehabilitative training through virtual reality for total knee replacement patients warrants further study and consideration
Jahn FS, Skovbye M, Obenhausen K, Jespersen AE, Miskowiak KW. Cognitive training with fully immersive	Cognitive impairment occurs across several neuropsychiatric diseases and impede everyday functioning and quality of life. Fully immersive Virtual Reality (VR) aid motivation and engagement and therefore has a potential to help overcome the obstacles in the field of cognitive rehabilitation. The aim of this
virtual reality in patients with	systematic review is to investigate whether VR can be a useful intervention in
disorders: A systematic review of randomized controlled trials. <i>Psychiatry</i>	randomized controlled trials following the PRISMA guidelines in databases Pubmed, Embase and PsychInfo. The trials were all evaluated through Cochrane Collaboration's Risk of Bias. The studies were conducted in patients with mild
Research. 2021;300:113928. doi:10.1016/j.psychres.2021 .113928	cognitive impairment (k=4), schizophrenia (k=3), ADHD (k=1), or stroke (k=1) and involved 6-12 weeks of training. Overall, results showed improvement in some domains of cognition, primarily executive function and attention. The studies were pilot studies with 6-34 participants per treatment group. Risk of bias was either high (k=3) or moderate (some concerns) (k=6). Key reasons were
	suboptimal statistical analyses and lack of clarification on randomization and blinding of participants and assessors. In conclusion, this review found promising evidence for VR cognitive rehabilitation for neuropsychiatric illnesses. However, larger and methodologically stronger studies are warranted to establish the full potential of VR.





Jo S, Jang H, Kim H, Song C. 360° immersive virtual reality-based mirror therapy for upper extremity function and satisfaction among stroke patients: a randomized controlled trial. *Eur J Phys Rehabil Med*. 2024;60(2):207-215. doi:10.23736/S1973-9087.24.08275-3 **Background:** Stroke is a leading cause of long-term disability worldwide; therefore, an effective rehabilitation strategy is fundamental. Mirror therapy (MT) has been a popular approach for upper extremity rehabilitation, but it presents some limitations. Recent advancements in virtual reality (VR) technology have introduced immersive VR-based MT, potentially overcoming these limitations and enhancing rehabilitation outcomes. **Aim:** This study aimed to evaluate the effectiveness of a novel 360° immersive virtual reality-based MT (360MT) in upper extremity rehabilitation for stroke patients, comparing it to traditional MT (TMT) and conventional physical therapy control group (CG). Design: A prospective, active control, assessor blinded, parallel groups, randomized controlled trial. **Population:** Forty-five participants with chronic stroke within six months of onset. Methods: The participants were randomly allocated to 360MT, TMT, or CG groups. Outcome measures included Fugl-Meyer Assessment for Upper Extremity (FMA-UE), Box and Block Test (BBT), and Manual Function Test (MFT). Additionally, patient experience and satisfaction in the groups of 360MT and TMT were assessed through questionnaires and interviews. Results: Results revealed that the 360MT group showed significantly greater improvements in FMA-UE, MFT and BBT compared to TMT (P<0.05) and CG (P<0.001) groups. Patient experience and satisfaction were more favorable in the 360MT group, with participants reporting higher engagement and motivation. **Conclusions:** 360MT appears to be a promising approach for upper extremity rehabilitation in stroke patients, providing better outcomes and higher patient satisfaction. However, further research is needed to confirm these findings and strengthen the evidence base for 360MT in stroke rehabilitation. Clinical rehabilitation impact: 360MT demonstrated notably enhanced upper extremity rehabilitation outcomes as well as better patient satisfaction among chronic stroke patients within six months of onset compared to traditional MT and conventional physical therapy. This novel approach not only fostered functional improvements but also elevated levels of engagement and motivation among participants, suggesting a promising future application in stroke rehabilitation framework.





Kamaraj DC, Dicianno BE, Mahajan HP, Buhari AM, Cooper RA. Interrater Reliability of the Power Mobility Road Test in the Virtual Reality-Based Simulator-2. <i>Arch Phys Med</i> <i>Rehabil</i> . 2016;97(7):1078- 1084. doi:10.1016/j.apmr.2016.02. 005	<b>Objective:</b> To assess interrater reliability of the Power Mobility Road Test (PMRT) when administered through the Virtual Reality-based SIMulator-version 2 (VRSIM-2). <b>Design:</b> Within-subjects repeated-measures design. <b>Setting:</b> Participants interacted with VRSIM-2 through 2 display options (desktop monitor vs immersive virtual reality screens) using 2 control interfaces (roller system vs conventional movement-sensing joystick), providing 4 different driving scenarios (driving conditions 1-4). Participants performed 3 virtual driving sessions for each of the 2 display screens and 1 session through a real-world driving course (driving condition 5). The virtual PMRT was conducted in a simulated indoor office space, and an equivalent course was charted in an open space for the real-world assessment. After every change in driving condition, participants completed a self-reported workload assessment questionnaire, the Task Load Index, developed by the National Aeronautics and Space Administration. <b>Participants:</b> A convenience sample of electric-powered wheelchair (EPW) athletes (N=21) recruited at the 31st National Veterans Wheelchair Games. <b>Interventions:</b> Not applicable. <b>Main outcome measures:</b> Total composite PMRT score. <b>Results:</b> The PMRT had high interrater reliability (intraclass correlation coefficient [ICC]>.75) between the 2 raters in all 5 driving conditions. Post hoc analyses revealed that the reliability analyses had >80% power to detect high ICCs in driving conditions 1 and 4 and could be used to assess EPW driving performance virtually in VRSIM-2. However, further psychometric assessment is necessary to assess the feasibility of administering the CMTP.
Kiper P, Baba A, Alhelou M,	<b>Introduction:</b> Despite many devices are helpful for motion analysis, there is still
et al. Assessment of the	no established standard technique for the assessment of cervical spine
cervical spine mobility by	mobility. <b>Objective:</b> To compare differences in using immersive or non-
immersive and non-	Immersive virtual reality (VR) for the assessment of the sensorimotor movement
Flectromyogr Kinesiol.	were asked to perform head rotation, flexion, extension, lateral flexion, reaching
2020;51:102397.	and repositioning tasks with the head. The same tasks were performed
doi:10.1016/j.jelekin.2020.1	interacting with both non-immersive and immersive virtual reality. Random
02397	sequence determined which of the environments was used as first assessment.
	Range of motion and kinematics i.e. number of completed targets, time of
	execution (seconds), spatial length (cm), angle distance (*), jerk of the cervical
	system. <b>Results:</b> The following variables were significantly larger in immersive
	than non-immersive VR: head right rotation ( $p = 0.027$ ), extension ( $p = 0.047$ ),
	flexion (p = 0.000), time (p = 0.001), spatial length (p = 0.004), jerk target (p =
	0.032), trajectory repositioning (p = 0.003), jerk target repositioning (p = 0.007). A
	regression model showed that assessment in both VR environments can be
	Influenced by dependent and independent variables. <b>Conclusions:</b> Immersive
	VR in healthy adults.





Levin MF, Magdalon EC, Michaelsen SM, Quevedo AA. Quality of Grasping and the Role of Haptics in a 3-D Immersive Virtual Reality Environment in Individuals With Stroke. *IEEE Trans Neural Syst Rehabil Eng.* 2015;23(6):1047-1055. doi:10.1109/TNSRE.2014.23 87412 Reaching and grasping parameters with and without haptic feedback were characterized in people with chronic post-stroke behaviors. Twelve (67 ± 10 years) individuals with chronic stroke and arm/hand paresis (Fugl-Meyer Assessment-Arm: ≥ 46/66 pts) participated. Three dimensional (3-D) temporal and spatial kinematics of reaching and grasping movements to three objects (can: cylindrical grasp; screwdriver: power grasp; pen: precision grasp) in a physical environment (PE) with and without additional haptic feedback and a 3-D virtual environment (VE) with haptic feedback were recorded. Participants reached, grasped and transported physical and virtual objects using similar movement strategies in all conditions. Reaches made in VE were less smooth and slower compared to the PE. Arm and trunk kinematics were similar in both environments and glove conditions. For grasping, stroke subjects preserved aperture scaling to object size but used wider hand apertures with longer delays between times to maximal reaching velocity and maximal grasping aperture. Wearing the glove decreased reaching velocity. Our results in a small group of subjects suggest that providing haptic information in the VE did not affect the validity of reaching and grasping movement. Small disparities in movement parameters between environments may be due to differences in perception of object distance in VE. Reach-to-grasp kinematics to smaller objects may be improved by better 3-D rendering. Comparable kinematics between environments and conditions is encouraging for the incorporation of high quality VEs in rehabilitation programs aimed at improving upper limb recovery.





Lewis CH, Griffin MJ. Human factors consideration in clinical applications of virtual reality. *Stud Health Technol Inform*. 1997;44:35-56. Virtual reality environments have many potential applications in medicine, including surgical training, tele-operated robotic surgery, assessment and rehabilitation of behavioural and neurological disorders and diagnosis, therapy and rehabilitation of physical disabilities. Although there is much potential for the use of immersive virtual reality environments in clinical applications, there are problems which could limit their ultimate usability. Some users have experienced side-effects during and after exposure to virtual reality environments. The symptoms include ocular problems, disorientation and balance disturbances, and nausea. Susceptibility to side-effects can be affected by age, ethnicity, experience, gender and physical fitness, as well as the characteristics of the display, the virtual environment and the tasks. The characteristics of the virtual reality system have also been shown to affect the ability of users to perform tasks in a virtual environment. Many of these effects can be attributed to delays between the sampling of head and limb positions and the presentation of an appropriate image on the display. The introduction of patients to virtual reality environments, for assessment, therapy or rehabilitation, raises particular safety and ethical issues. Patients exposed to virtual reality environments for assessment and rehabilitation may have disabilities which increase their susceptibility to certain side-effects. Special precautions therefore need to be taken to ensure the safety and effectiveness of such virtual reality applications. These precautions include minimisation of possible side-effects at the design stage. Factors are identified which are likely to affect the incidence of side-effects during and after exposures, and which need to be understood in order to minimise undesirable consequences. There is also a need for the establishment of protocols for monitoring and controlling exposures of patients to virtual reality environments. Issues are identified which need to be included in such protocols.





Lheureux A, Lebleu J, Frisque C, et al. Immersive Virtual Reality to Restore Natural Long-Range Autocorrelations in Parkinson's Disease Patients' Gait During Treadmill Walking. <i>Front</i> <i>Physiol</i> . 2020;11:572063. Published 2020 Sep 23. doi:10.3389/fphys.2020.572 063	Effects of treadmill walking on Parkinson's disease (PD) patients' spatiotemporal gait parameters and stride duration variability, in terms of magnitude [coefficient of variation (CV)] and temporal organization [long range autocorrelations (LRA)], are known. Conversely, effects on PD gait of adding an optic flow during treadmill walking using a virtual reality headset, to get closer to an ecological walk, is unknown. This pilot study aimed to compare PD gait during three conditions: Overground Walking (OW), Treadmill Walking (TW), and immersive Virtual Reality on Treadmill Walking (iVRTW). Ten PD patients completed the three conditions at a comfortable speed. iVRTW consisted in walking at the same speed as TW while wearing a virtual reality headset reproducing an optic flow. Gait parameters assessed were: speed, step length, cadence, magnitude (CV) and temporal organization (evenly spaced averaged Detrended Fluctuation Analysis, $\alpha$ exponent) of stride duration variability. Motion sickness was assessed after TW and iVRTW using the Simulator Sickness Questionnaire (SSQ). Step length was greater ( $p = 0.008$ ) and cadence lower ( $p = 0.009$ ) during iVRTW compared to TW while CV was similar ( $p = 0.177$ ). $\alpha$ exponent was similar during OW ( $0.77 \pm 0.07$ ) and iVRTW ( $0.76 \pm 0.09$ ) ( $p = 0.553$ ). During TW, $\alpha$ exponent ( $0.85 \pm 0.07$ ) was higher than during OW ( $p = 0.039$ ) and iVRTW ( $p = 0.016$ ). SSQ was similar between TW and iVRTW ( $p = 0.809$ ). iVRTW is tolerable, could optimize TW effects on spatiotemporal parameters while not increasing CV in PD. Furthermore, iVRTW could help to capture the natural LRA of PD gait in laboratory settings and could potentially be a challenging second step in PD gait
Long J, Shen L, Cai Q, Xiao S, Chen Z. Novel Approach to Transfer of Coordination	We have previously shown that healthy subjects can transfer coordination skills to the unpracticed hand by performing a unimanual task with the other hand and visualizing a bimanual action using a game-like interactive system. However,
Skills to the Paretic Hand by Improving the Efficiency of Cortical Network. <i>IEEE Trans</i> <i>Neural Syst Rehabil Eng</i> .	hand after stroke and its underlying neural mechanism remain unknown. Here, using a game-like interactive system for visualization during physical practice in an immersive virtual reality environment, we examined coordination skill
doi:10.1109/TNSRE.2022.32 21738	subjects and 13 chronic and sub-acute stroke patients. The bimanual movement task was defined as simultaneously drawing non-symmetric three-sided squares (e.g., U and C), while the training strategy was performing a unimanual task with the right/nonparetic hand and visualizing a bimanual action. We found large
	decreases in the intra-hand temporal and spatial measures for movement in the unpracticed/paretic hand after training. Furthermore, a substantial reduction in the inter-hand temporal and spatial interference was observed after training.
	Additionally, we examined the related cortical network evolution using EEG in both the healthy subjects and stroke patients. Our studies show that the cortical
	network became more efficient after training in the healthy subjects and stroke patients. These results demonstrate that our proposed method could contribute
	to the transference of coordination skill to the paretic/unpracticed hand by promoting the efficiency of cortical networks.





Longo UG, Carnevale A,	Background: Virtual Reality (VR) systems have been increasingly used across
Andreoli F, et al. Immersive	several medical fields. A crucial preliminary step for developing optimized VR-
virtual reality for shoulder	based applications for rehabilitation purposes is identifying potential
rehabilitation: evaluation of	interventions to meet the requirements necessary to satisfy end-users' needs.
a physical therapy program	This study aims to assess the acceptability, usability, and appropriateness of a
executed with oculus quest	VR physical therapy program executed with Oculus Quest 2 by expert
2. BMC Musculoskelet	physiotherapists of shoulder musculoskeletal rehabilitation. Methods: Eleven
Disord, 2023:24(1):859.	physiotherapists were enrolled to test a VR program for shoulder
Published 2023 Nov 2	musculoskeletal rehabilitation. At the end of each session, physiotheranists
doi:10.1186/s12891-023-	completed three questionnaires about the acceptability usability and
06861-5	appropriateness of the VR system and application investigating aspects such as
00001 3	wearability safety stability ease of control comfort size utility playability
	and use mode. <b>Besults:</b> The accentability questionnaire revealed that all the
	and use mode. <b>Results.</b> The acceptability questionnal revealed that all the
	physiotherapists found the VR system easy to wear and control, very confident,
	and sale. The usability questionnaire showed that most physiotherapists (73%)
	found the VR application entertaining, although only 45% said the system could
	be used independently by patients without the support of a therapist. Many
	physiotherapists found the use of the VR application appropriate for patients
	with rotator cuff tears treated conservatively (63.6%) or surgically (54.5%), for
	patients with shoulder osteoarthritis treated conservatively (72.7%), for patients
	with shoulder osteoarthritis after surgical treatment (63.6%). 91% of
	physiotherapists think it would be best for patients to use the VR system under
	the supervision of a therapist and not independently in a home setting.
	<b>Conclusions:</b> The use of VR in orthopaedic rehabilitation is encouraging,
	although further efforts are needed to increase the independent use of patients
	without the supervision of a physiotherapist. Moreover, future studies should
	strive to ensure the clinical effectiveness of VR rehabilitation in reaching
	therapeutic goal settings.
Matamala-Gomez M, Slater	Recent evidence supports the use of immersive virtual reality (immersive VR) as
M, Sanchez-Vives MV.	a means of applying visual feedback techniques in neurorehabilitation. In this
Impact of virtual	study, we investigated the benefits of an embodiment-based immersive VR
embodiment and exercises	training program for orthopedic upper limb rehabilitation, with the aim of
on functional ability and	improving the motor functional ability of the arm and accelerating the
range of motion in	rehabilitation process in patients with a conservatively managed distal radius
orthopedic rehabilitation. Sci	fracture. We designed a rehabilitation program based on developing ownership
Rep. 2022:12(1):5046.	over a virtual arm and then exercising it in immersive VR. We carried out a
Published 2022 Mar 23.	between 3-group controlled trial with 54 patients (mean age = $61.80 \pm 14.18$ ); 20
doi:10.1038/s41598-022-	patients were assigned to the experimental training group (immersive VR). 20 to
08917-3	the conventional digit mobilization (CDM) training control group, and 14 to a
	non-immersive (non-immersive VB) training control group. We found that
	functional recovery of the arm in the immersive VR group was correlated with the
	awnorship and agonou acores over the virtual arm. We also found larger range of
	ioint movements and lower disability of the fractured arm compared with
	joint movements and tower disability of the fractured arm compared with
	patients in the Non-Immersive VK and CDM groups. Feeling embodied in a Virtual
	body can be used as a renabilitation tool to speed up and improve motor
	functional recovery of a fractured arm after the immobilization period.





Mazurek J, Cieślik B,	Objective: This research aimed to determine the efficacy of VR therapy in
Wrzeciono A, Gajda R,	mitigating symptoms of depression, anxiety, and stress among older adults
Szczepańska-Gieracha J.	following arthroplasty surgery and to comprehend the influence of psychological
Immersive Virtual Reality	improvement on changes in functional outcomes. <b>Methods:</b> Utilizing a parallel-
Therapy Is Supportive for	group randomized controlled trial design, the study involved 68 osteoarthritis
Orthopedic Rehabilitation	patients who had recently undergone either total hip or knee arthroplasty.
among the Elderly: A	Subjects were split into two groups. The experimental group underwent eight VR
Randomized Controlled	therapy sessions during their rehabilitation, while the control group was given
Trial. J Clin Med.	standard care. Assessments encompassed both psychological and functional
2023;12(24):7681. Published	outcomes, with tools like the Hospital Anxiety and Depression Scale, Perceived
2023 Dec 14.	Stress Scale, and the Barthel Index, among others. The experimental group
doi:10.3390/jcm12247681	showcased notable enhancements in both psychological and functional areas
	compared to the control group. <b>Results:</b> A significant ( <i>p</i> value of < 0.001)
	relationship was found between psychological progress and functional recovery,
	indicating that psychological factors can serve as predictors for functional
	outcomes. <b>Conclusions:</b> The findings emphasize the promising role of VR
	therapy as a beneficial addition to the rehabilitation process for older adults'
	post-hip and knee arthroplasty. The integration of psychological interventions in
	standard rehabilitation practices appears valuable, but further studies are
	needed to ascertain the long-term advantages of such an approach.
Micheluzzi V, Navarese EP,	Virtual reality offers a multisensory experience to patients, allowing them to
Merella P, et al. Clinical	hear, watch, and interact in a virtual environment. Immersive virtual reality is
application of virtual reality	particularly suitable for the purpose of completely isolating patients from the
in patients with	external environment to transport them away from the suffering related to the
cardiovascular disease:	disease. On this state of the art, we summarize the available literature on the
state of the art. Front	effectiveness of virtual reality on various physical and psychological outcomes
Cardiovasc Med.	in patients with atherosclerotic cardiovascular disease. Virtual reality has been
2024;11:1356361. Published	employed in the cardiovascular field in various settings such as cardiac
2024 Apr 3.	rehabilitation, interventional cardiology, and cardiac surgery. This technology
doi:10.3389/fcvm.2024.1356	offers promising opportunities to improve several outcomes related to
361	cardiovascular disease, but further research is needed to entirely capture its
	benefits and to standardize the intervention.





<b>Background and objective:</b> Duration of rehabilitation and active participation are crucial for gait rehabilitation in the early stage after stroke onset. Virtual reality (VR) is an innovative tool providing engaging and playful environments that could promote intrinsic motivation and higher active participation for non- ambulatory stroke patients when combined with robot-assisted gait training (RAGT). We have developed a new, fully immersive VR application for RAGT, which can be used with a head-mounted display and wearable sensors providing real-time gait motion in the virtual environment. The aim of this study was to validate the use of this new device and assess the onset of cybersickness in healthy participants before testing the device in stroke patients. <b>Materials and</b> <b>Methods:</b> Thirty-seven healthy participants were included and performed two sessions of RAGT using a fully immersive VR device. They physically walked with the Gait Trainer for 20 min in a virtual forest environment. The occurrence of cybersickness, sense of presence, and usability of the device were assessed with three questionnaires: the Simulator Sickness Questionnaire (SSQ), the Presence Questionnaire (PQ), and the System Usability Scale (SUS). <b>Results:</b> All of the participants completed both sessions. Most of the participants (78.4%) had no significant adverse effects (SSQ < 5). The sense of presence in the virtual environment was particularly high (106.42 ± 9.46). Participants reported good usability of the device (86.08 ± 7.54). <b>Conclusions:</b> This study demonstrated the usability of our fully immersive VR device for gait rehabilitation and did not lead to cybersickness. Future studies should evaluate the same parameters and the effectiveness. Future studies when ambulater utracke metainter.
<b>Objective:</b> To evaluate the efficacy of different forms of virtual reality (VR) treatments as either immersive virtual reality (IVR) or non-immersive virtual reality (NIVR) in comparison to conventional therapy (CT) in improving physical and psychological status among stroke patients. <b>Methods:</b> The literature search was conducted on seven databases: ACM Digital Library, Medline (via PubMed), Cochrane, IEEE Xplore, Web of Science, Scopus, and science direct. The effect sizes of the main outcomes were calculated using Cohen's d. Pooled results were used to present an overall estimate of the treatment effect using a random-effects model. <b>Results:</b> A total of 22 randomized controlled trials were evaluated. 3 trials demonstrated that immersive virtual reality improved upper limb activity, function and activity of daily life in a way comparable to CT. 18 trials showed that NIVR had similar benefits to CT for upper limb activity and function, balance and mobility, activities of daily living and participation. A comparison between the different forms of VR showed that IVR may be more beneficial than NIVR for upper limb training and activities of daily life. <b>Conclusions:</b> This study found out that IVR therapies may be more effective than NIVR but not CT to improve upper limb activity, function, and daily life activities. However, there is no evidence of the durability of IVR treatment. More research involving studies with larger samples is needed to assess the long-term





Nunnerley J, Gupta S, Snell D, King M. Training wheelchair navigation in immersive virtual environments for patients with spinal cord injury - end- user input to design an effective system. <i>Disabil</i> <i>Rehabil Assist Technol</i> . 2017;12(4):417-423. doi:10.1080/17483107.2016. 1176259	<b>Purpose:</b> A user-centred design was used to develop and test the feasibility of an immersive 3D virtual reality wheelchair training tool for people with spinal cord injury (SCI). <b>Method:</b> A Wheelchair Training System was designed and modelled using the Oculus Rift headset and a Dynamic Control wheelchair joystick. The system was tested by clinicians and expert wheelchair users with SCI. Data from focus groups and individual interviews were analysed using a general inductive approach to thematic analysis. <b>Results:</b> Four themes emerged: Realistic System, which described the advantages of a realistic virtual environment; a Wheelchair Training System, which described participants' thoughts on the wheelchair training applications; Overcoming Resistance to Technology, the obstacles to introducing technology within the clinical setting; and Working outside the Rehabilitation Bubble which described the protective hospital environment. <b>Conclusions:</b> The Oculus Rift Wheelchair Training System has the potential to provide a virtual rehabilitation setting which could allow wheelchair users to learn valuable community wheelchair use in a safe environment. Nausea appears to be a side effect of the system, which will need to be resolved before this can be a viable clinical tool. Implications for Rehabilitation Immersive virtual reality shows promising benefit for wheelchair training in a rehabilitation setting. Early engagement with consumers can improve product development.
Paralkar S, Varas-Diaz G,	Introduction: Virtual reality (VR) has been described as an emerging therapeutic
Wang S, Bhatt T. Motor adaptation to real-life external environments using immersive virtual reality: A pilot study. <i>J Bodyw Mov</i> <i>Ther</i> . 2020;24(4):152-158. doi:10.1016/j.jbmt.2020.06. 031	strategy to promote motor adaptation in different populations. The aim of this study was to investigate the effect of virtual environment demands, provided by an immersive VR system, on kinematic and spatio-temporal gait parameters in healthy young participants. <b>Methods:</b> Fifteen healthy young participants participated in this experimental study performing, in sequence, a baseline natural walking (NW) block, two different virtual environment walking blocks (snowy and crowded conditions), and a mixed walking block (including NW, snowy, and crowded conditions). Participants' Center-of-Mass (COM) excursion angle, medio-lateral (ML) COM excursion, step length, and walking speed were analyzed for each trial. <b>Results:</b> COM excursion angle and ML-COM excursion increased significantly during the first snowy and crowded VR trials compared to NW trials, while walking speed and step length decreased only for the snowy conditions. COM excursion angle and ML-COM excursion increased significantly from the first to the fourth VR snowy trial and decreased from the first to the fourth VR snowy trial and decreased from the first to the fourth VR snowy trial and decreased from the first to the fourth VR snowy trial and decreased from the first to the fourth VR crowded trial. Participants retained the acquired motor adaptations even after the mixed block. <b>Conclusion:</b> This study showed that kinematic and spatio-temporal gait parameters of young participants changed according to the virtual environment demands provided for each virtual scenario. In addition, all participants showed a consistent gait adaptation process to each virtual environment across the VR trials. The present findings highlight the impact of VR for gait adaptation, suggesting that VR training could modify motor behavior and enhance the motor adaptation process in healthy voung participants





Parker SM, Andreasen SC, Ricks B, Kaipust MS, Zuniga J, Knarr BA. Comparison of brain activation and functional outcomes between physical and virtual reality box and block test: a case study. *Disabil Rehabil Assist Technol*. 2024;19(2):273-280. doi:10.1080/17483107.2022. 2085334 **Purpose:** Immersive Virtual Reality (VR) systems allow for highly repetitive tasks to be performed within a virtual environment that increases practice in home environments. VR can increase access to rehabilitation by reducing access barriers. However, rehabilitation outcomes between immersive VR systems and conventional physical rehabilitation are not well understood. The purpose of this case study was to assess the use of a custom clinically based VR simulation for testing gross hand dexterity with an individual with chronic stroke. Materials and methods: The participant performed the box and blocks test (BBT) in an immersive VR environment and a physical environment. Three trials of the BBT were performed with their less-affected and affected hands each in both environments while measuring cortical activity using fNIRS. Rests were given between trials and environment conditions. **Results:** Our results show that there was no statistical difference in the number of blocks moved between the physical and VR BBT for both the affected and less-affected hands. Furthermore, our results also indicate no statistically significant difference between the physical BBT and VR BBT conditions on contralateral motor cortex activation, suggesting that cortical involvement is comparable between physical and VR conditions. **Conclusions:** These results suggest that an immersive VR system may be able to elicit functional and motor cortex activations that are comparable to the conventional physical BBT. Importantly, these findings highlights the potential benefits of VR therapy as a remote therapy intervention and/or to increase the effectiveness and practicality of current in-person rehabilitation programs. Implications for rehabilitation: These findings highlight the potential benefits of immersive virtual reality as a remote therapy intervention. Immersive virtual reality use has potential benefits to increase the effectiveness and practicality of current in-person rehabilitation programs.





Patsaki I, Dimitriadi N, Despoti A, et al. The effectiveness of immersive virtual reality in physical recovery of stroke patients: A systematic review. *Front Syst Neurosci*. 2022;16:880447. Published 2022 Sep 22. doi:10.3389/fnsys.2022.880 447 Background: Over the past few years, technological innovations have been increasingly employed to augment the rehabilitation of stroke patients. Virtual reality (VR) has gained attention through its ability to deliver a customized training session and to increase patients' engagement. Virtual reality rehabilitation programs allow the patient to perform a therapeutic program tailored to his/her needs while interacting with a computer-simulated environment. Purpose: This study aims to investigate the effectiveness of a fully immersive rehabilitation program using a commercially available head-mounted display in stroke patients. Methods: A systematic search was conducted in three databases, namely, PubMed, Google Scholar, and PEDro. Four hundred thirty-two references were identified. The keywords used for the literature search were in English, which are given as follows: immersive, virtual reality, neurorehabilitation, stroke, and head-mounted display. Additionally, applicable articles were identified through screening reference lists of relevant articles. **Results:** Only 12 studies used head-mounted display for immersing the patient into the virtual world. Apart from the feasibility of this new technology, a range of benefits were identified, especially in terms of functional ability as measured by FIM or Barthel, the Action Research arm Test, Box and Block Test, Fugl-Meyer assessment of physical performance, strength, and balance outcomes. **Conclusion:** The results from this review support the potential beneficial effect of fully immersive virtual reality in the rehabilitation of stroke patients, maximizing recovery through increased motivation and adherence.




Patterson DR, Drever S, Soltani M, et al. A comparison of interactive immersive virtual reality and still nature pictures as distraction-based analgesia in burn wound care. *Burns*. 2023;49(1):182-192. doi:10.1016/j.burns.2022.02 .002 Purpose: Non-pharmacologic adjuncts to opioid analgesics for burn wound debridement enhance safety and cost effectiveness in care. The current study explored the feasibility of using a custom portable water-friendly immersive VR hardware during burn debridement in adults, and tested whether interactive VR would reduce pain more effectively than nature stimuli viewed in the same VR goggles. Methods: Forty-eight patients with severe burn injuries (44 adults and 4 children) had their burn injuries debrided and dressed in a wet wound care environment on Study Day 1, and 13 also participated in Study Day 2. **Intervention:** The study used a within-subject design to test two hypotheses (one hypothesis per study day) with the condition order randomized. On Study Day 1, each individual (n = 44 participants) spent 5 min of wound care in an interactive immersive VR environment designed for burn care, and 5 min looking at still nature photos and sounds of nature in the same VR goggles. On Study Day 2 (n = 12 adult participants and one adolescent from Day 1), each participant spent 5 min of burn wound care with no distraction and 5 min of wound care in VR, using a new water-friendly VR system. On both days, during a post-wound care assessment, participants rated and compared the pain they had experienced in each condition. Outcome Measures on Study Days 1 and 2: Worst pain during burn wound care was the primary dependent variable. Secondary measures were ratings of time spent thinking about pain during wound care, pain unpleasantness, and positive affect during wound care. **Results:** On Study Day 1, no significant differences in worst pain ratings during wound care were found between the computer-generated world (Mean = 71.06, SD = 26.86) vs. Nature pictures conditions (Mean = 68.19, SD = 29.26; t < 1, NS). On secondary measures, positive affect (fun) was higher, and realism was lower during computer-generated VR. No significant differences in pain unpleasantness or "presence in VR" between the two conditions were found, however. VR VS. NO VR. (STUDY DAY 2): Participants reported significantly less worst pain when distracted with adjunctive computer generated VR than during standard wound care without distraction (Mean = 54.23, SD = 26.13 vs 63.85, SD = 31.50, t(11) = 1.91, p < .05, SD = 17.38). In addition, on Study Day 2, "time spent thinking about pain during wound care" was significantly less during the VR condition, and positive affect was significantly greater during VR, compared to the No VR condition. **Conclusion:** The current study is innovative in that it is the first to show the feasibility of using a custom portable water-friendly immersive VR hardware during burn debridement in adults. However, contrary to predictions, interactive VR did not reduce pain more effectively than nature stimuli viewed in the same VR goggles.





Pedroli E, Greci L, Colombo D, et al. Characteristics, Usability, and Users Experience of a System Combining Cognitive and Physical Therapy in a Virtual Environment: Positive Bike. <i>Sensors (Basel)</i> . 2018;18(7):2343. Published 2018 Jul 19. doi:10.3390/s18072343	We present the architecture and usability evaluation of virtual reality system- "Positive Bike"-designed for improving cognitive and motor conditions in frail elderly patients. The system consists of a cycle-ergometer integrated in an immersive virtual reality system (CAVE) which allows combining motor and cognitive exercises according to a "dual-task" paradigm. We tested the usability and user's experience of the prototype in a pilot evaluation study that involved five elderly patients. The prototype was tested in one-session training to understand the limitations and areas for improvement of our system. The evaluation consisted in (i) usability assessment using the system usability scale; (ii) evaluation of user's engagement using the flow state scale; and (iii) expert evaluation involving interviews with domain experts. Results showed a good usability, both for system usability scale and the semi-structured interview. The level of flow (i.e., enjoyment with the task at hand) measured using the short flow state scale, was also high. Analysis of semi-structured interview carried out with domain experts provided further indications to improve the system. Overall, these findings show that, despite some limitations, the system is usable and provides an enjovable user's experience.
Distrack E. Dullman C	<b>Objective:</b> This article reviews the evolution literature shout the use of nevel
McGuiro A Lleing Virtual	motheds of rehabilitation using virtual reality interventions for people living with
Poolity and Videogramos for	nections of reliabilitation using virtual reality interventions for people using with
Troumatic Brain Injury	SCOPUS, and Cochrana Library databases were searched using the terms
Pobabilitation: A Structured	"virtual reality" OP "video games" AND "traumatic brain injury " Included studios
Literature Beview, Games	investigated therapeutic use of virtual reality in adults with a brain trauma
$H_{0.0}$ the L 2014:2(4):202 214	resulting from acquired closed head injuny reported outcomes that included
$f_{12}$	measures of motor or cognitive functionality, reported outcomes that included
doi.10.1089/g411.2014.0013	reviewed journal written in English <b>Pasults:</b> Eighteen articles fulfilled inclusion
	criteria. Eight wore case studies, five studies had a quasi experimental design
	with a pre-post comparison, and five were pilot randomized control trials or
	comparative studies. The virtual reality systems used were commercial or
	custom designed for the study and ranged from expensive fully immersive
	systems to cheap online games or videogames. In before-after comparisons
	improvements in balance were seen in four case studies and two small
	randomized control trials. Between group comparisons in these randomized
	control trials showed no difference between virtual reality and traditional
	therapy. Post-training improvements were also seen for upper extremity
	functions (five small studies) and for various cognitive function measures (four
	case studies and one nilot randomized control trial). Attitudes of participants
	toward virtual reality interventions was more positive than for traditional therapy
	(three studies) <b>Conclusions:</b> The evidence that the use of virtual reality in
	rehabilitation of traumatic brain injury improves motor and cognitive
	functionality is currently very limited. However, this approach has the potential
	to provide alternative possibly more affordable and available rebabilitation
	therapy for traumatic brain injury in settings where access to therapy is limited
	by geographical or financial constraints.





Qian J, McDonough DJ, Gao Z. The Effectiveness of Virtual Reality Exercise on Individual's Physiological, Psychological and Rehabilitative Outcomes: A Systematic Review. Int J Environ Res Public Health. 2020;17(11):4133. Published 2020 Jun 10. doi:10.3390/ijerph17114133 **Objective purpose:** This review synthesized the literature examining the effects of virtual reality (VR)-based exercise on physiological, psychological, and rehabilitative outcomes in various populations. **Design:** A systematic review. Data sources: 246 articles were retrieved using key words, such as "VR", "exercise intervention", "physiological", "psychology", and "rehabilitation" through nine databases including Academic Search Premier and PubMed. Eligibility criteria for selecting studies: 15 articles which met the following criteria were included in the review: (1) peer-reviewed; (2) published in English; (3) randomized controlled trials (RCTs), controlled trials or causalcomparative design; (4) interventions using VR devices; and (5) examined effects on physiological, psychological, and/or rehabilitative outcomes. Descriptive and thematic analyses were used. **Results:** Of the 12 articles examining physiological outcomes, eight showed a positive effect on physical fitness, muscle strength, balance, and extremity function. Only four articles examined the effects on psychological outcomes, three showed positive effects such that VR exercise could ease fatigue, tension, and depression and induce calmness and enhance quality of life. Nine articles investigated the effects of VR-based exercise on rehabilitative outcomes with physiological and/or psychological outcomes, and six observed significant positive changes. In detail, patients who suffered from chronic stroke, hemodialysis, spinal-cord injury, cerebral palsy in early ages, and cognitive decline usually saw better improvements using VRbased exercise. **Conclusion:** The findings suggest that VR exercise has the potential to exert a positive impact on individual's physiological, psychological, and rehabilitative outcomes compared with traditional exercise. However, the quality, quantity, and sample size of existing studies are far from ideal. Therefore, more rigorous studies are needed to confirm the observed positive effects.





Reale G, Fusco A, Calciano R, et al. The Immediate Effects of Immersive Virtual Reality on Autonomic Nervous System Function in Patients with Disorders of Consciousness after Severe Acquired Brain Injury: A Pilot Study. *J Clin Med*. 2023;12(24):7639. Published 2023 Dec 12. doi:10.3390/jcm12247639 Disorders of Consciousness (DoCs) after severe acquired brain injury involve substantial impairment of cognition and physical functioning, requiring comprehensive rehabilitation and support. Technological interventions, such as immersive Virtual Reality (VR), have shown promising results in promoting neural activity and enhancing cognitive and motor recovery. VR can induce physical sensations that may activate the Autonomic Nervous System (ANS) and induce ANS-regulated responses. This study aimed to investigate the effects of immersive VR on the ANS in patients with DoCs through the analysis of the electrodermal activity (EDA). EDA was measured with a wearable device during a single immersive VR session consisting of static and dynamic videos depicting naturalistic environments. A pilot case-control study was conducted with 12 healthy participants and 12 individuals with DoCs. Results showed higher EDA values in patients than in healthy participants (*p* = 0.035), suggesting stronger autonomic activation during immersive VR exposure, while healthy subjects, in turn, showed a decrease in EDA values. Our results revealed a significant interaction between conditions and groups (p = 0.003), with patients showing significantly increased EDA values from the baseline compared to dynamic video observation (p = 0.014) and final rest (p = 0.007). These results suggest that immersive VR can elicit sympathetic arousal in patients with DoCs. This study highlights the potential of immersive VR as a tool to strengthen autonomic responses in patients with impaired consciousness.





Ren Y, Wang Q, Liu H, Wang	<b>Objective:</b> To examine the effectiveness of virtual reality (VR)-based
G, Lu A. Effects of immersive	rehabilitation training in improving cognition, motor function, and daily
and non-immersive virtual	functioning in patients with mild cognitive impairment and dementia. Data
reality-based rehabilitation	sources: A systematic review of published literature was conducted using
training on cognition, motor	PubMed, Web of Science, Elsevier, Embase, Cochrane, CNKI, Networked Digital
function, and daily	Library of Theses and Dissertations. <b>Methods:</b> The search period was from
functioning in patients with	inception to 7 October 2023. Eligible studies were randomized controlled trials
mild cognitive impairment or	evaluating the efficacy of VR-based rehabilitation training in patients with mild
dementia: A systematic	cognitive impairment or dementia versus control subjects. Methodologic quality
review and meta-	was assessed with the Cochrane risk of bias tool, and outcomes were
analysis. Clin Rehabil.	calculated as the standard mean difference between participant groups with
2024;38(3):305-321.	95% confidence interval. <b>Results:</b> A total of 21 randomized controlled trials with
doi:10.1177/0269215523121	1138 patients were included. The meta-analysis showed that VR-based
3476	rehabilitation training had significant effects on Montreal Cognitive Assessment
	(SMD: 0.50: 95%CI: 0.05 to 0.95: $P = 0.030$ ). Trail-making test A (SMD: -0.38:
	95%Cl: -0.61 to -0.14: $P = 0.002$ ) and Berg Balance Scale scores (SMD: 0.79)
	95%Cl: 0.13 to 1.45; $P = 0.020$ ). A subgroup analysis revealed that the type of VR
	and duration and frequency of interventions had statistically significant effects
	and duration and meter function. <b>Conclusion:</b> VP based rehabilitation training in
	on cognition and motor function. <b>Conclusion:</b> vn-based renabilitation training is
	a benencial nonpharmacologic approach for managing mild cognitive
	Impairment or dementia. Immersive VR-based training had greater effects on
	cognition and motor function than non-immersive VR-based training, but non-
	immersive VR-based training was more convenient for patients with limitations
	imposed by their disease. Also, an intervention lasting 5-8 weeks and for >30 min
	at a frequency of $\geq$ 3 times/week achieved the best results. It indicated that a
	longer intervention cycle may not achieve the best intervention effect and
	training duration and schedule should be carefully considered when managing
	patients.
Riem LI, Schmit BD,	Immersive virtual reality provides a safe and cost effective approach to
Beardsley SA. The Effect of	administrating balance disruption during ambulation. Previous research has
Discrete Visual	explored the effects of applying continuous perturbations in a virtual
Perturbations on Balance	environment to challenge balance. This pilot study investigates the ability to
Control during Gait. Annu Int	disrupt balance with discrete visual perturbations during ambulation in healthy
Conf IEEE Eng Med Biol Soc.	young adults. During the study participants walked on a treadmill within a virtual
2020;2020:3162-3165.	environment. As they walked the entire visual scene was intermittently shifted to
doi:10.1109/EMBC44109.20	the left or right 1 meter over 1 second. The results demonstrate a significant
20.9176303	decrease in step length ( $p \le 0.05$ ) and change in center of mass excursion ( $p \le 0.05$ )
	0.05) across participants (N=13). Changes in gait lasted up to three steps after
	application suggesting a consistent challenge to dynamic balance control as a
	result of the discrete visual perturbation. Further, participants did not
	demonstrate a reduction in response to the discrete visual perturbation with
	repeated exposure. The results indicate that discrete visual perturbations of a
	virtual scene can be used to challenge gait and modulate conter of mass succe
	The use of visual porturbations within a virtual environment to challenge
	The use of visual perturbations within a virtual environment to challenge
	dynamic balance could provide a safer and more affordable avenue for balance
	rehabilitation by reducing the need for systems that physically perturb balance.





Rudschies C, Schneider I.	Virtual agents (VAs) and immersive virtual reality (VR) applications broaden the
Ethical, legal, and social	opportunities for accessing healthcare by transposing certain processes from
implications (ELSI) of virtual	the analogue world into a virtual realm. While these innovations offer a number
agents and virtual reality in	of advantages including improved access for individuals in diverse geographic
healthcare. Social Science &	locations and novel therapeutic options, their implementation raises significant
Medicine. 2024;340:116483.	ethical, social, and legal implications. Key considerations pertain to the doctor-
doi:10.1016/j.socscimed.20	patient relationship, privacy and data protection, justice, fairness, and equal
23.116483	access as well as to issues of accountability, liability, and safety. This paper
	conducts a comprehensive review of the existing literature to analyse the
	ethical, social, and legal ramifications of employing VAs and VR applications in
	healthcare. It examines the recommended strategies to mitigate potential
	adverse effects and addresses current research gaps in this domain.
Rutkowski S, Szary P, Sacha	Objectives: This cross-sectional, randomly assigned study aimed to assess the
J, Casaburi R. Immersive	influence of immersive virtual reality (VR) on exercise tolerance expressed as the
Virtual Reality Influences	duration of a submaximal exercise test (ET) on a cycle ergometer. <b>Methods:</b> The
Physiologic Responses to	study enrolled 70 healthy volunteers aged 22-25years. Each participant
Submaximal Exercise: A	performed an ET with and without VR. Time- and frequency-domain heart rate
Randomized, Crossover	variability (HRV) parameters were analyzed for the first 3min (T1), the last 3min
Trial. Front Physiol.	(T2), and the time at which the shorter of the two tests terminated (Tiso). In the
2021;12:702266. Published	time domain, a SD of R-R intervals (SDNN) and a root mean square of successive
2021 Sep 30.	R-R interval differences (RMSSD) in milliseconds were computed. The following
doi:10.3389/fphys.2021.702	spectral components were considered: low frequency (LF), high frequency (HF),
266	total power (TP), and LF/HF ratio. The study was registered in ClinicalTrials.gov
	(NCT04197024). Results: Compared to standard ET, tests in immersive VR
	lasted significantly longer (694 vs. 591s, $p$ <0.00001) and were associated with
	lower HR response across the range of corresponding exercise levels, averaging
	5-8 beats/min. In the multiple regression analysis, the ET duration was positively
	determined by male sex, immersion in VR, and negatively determined by HRT1
	and RMSSDT1. <b>Conclusion:</b> Exercising in VR is associated with lower HR which
	allowed subjects to exercise for a longer time before reaching target heart rate
	(HR). In addition, the increase in exercise duration was found to be related to an
	adjustment in autonomic nervous activity at a given work rate favoring
	parasympathetic predominance.





Rutkowski S, Szczegielniak J,	Anxiety has been estimated to occur in 21-96% and depression in 27-79% of
Szczepańska-Gieracha J.	patients with chronic obstructive pulmonary disorder (COPD). We found a
Evaluation of the Efficacy of	scarcity of literature providing evidence on how virtual reality (VR) therapy
Immersive Virtual Reality	affects the intensity of depressive and anxiety symptoms and stress levels in
Therapy as a Method	COPD patients undergoing in-hospital pulmonary rehabilitation (PR). This study
Supporting Pulmonary	enrolled 50 COPD patients with symptoms of stress, depression, and anxiety,
Rehabilitation: A	randomly assigned to one of two groups. The two groups participated in the
Randomized Controlled	traditional PR programme additionally: the VR-group performed 10 sessions of
Trial. J Clin Med.	immersive VR-therapy and the control group performed 10 sessions of Schultz
2021;10(2):352. Published	autogenic training. Comparison of the changes in stress levels and depressive
2021 Jan 18.	and anxiety symptoms was the primary outcome. Analysis of the results showed
doi:10.3390/jcm10020352	a reduction in stress levels only in the VR-group ( $p < 0.0069$ ), with a medium
	effect size (d = 0.353). The symptoms of depression ( $p < 0.001$ , d = 0.836) and
	anxiety ( $p < 0.0009$ , d = 0.631) were statistically significantly reduced only in the
	VR-group, with a strong effect size. The enrichment of pulmonary rehabilitation
	with immersive VR therapy brings benefits in terms of mood improvement and
	reduction in anxiety and stress in patients with COPD.
Sakabe N, Altukhaim S,	The long-term effects of impairment have a negative impact on the quality of life
Hayashi Y, Sakurada T, Yano	of stroke patients in terms of not using the affected limb even after some
S, Kondo T. Enhanced Visual	recovery (i.e., learned non-use). Immersive virtual reality (IVR) has been
Feedback Using Immersive	introduced as a new approach for the treatment of stroke rehabilitation. We
VR Affects Decision Making	propose an IVR-based therapeutic approach to incorporate positive
Regarding Hand Use With a	reinforcement components in motor coordination as opposed to constraint-
Simulated Impaired	induced movement therapy (CIMT). This study aimed to investigate the effect of
Limb. Front Hum Neurosci.	IVR-reinforced physical therapy that incorporates positive reinforcement
2021;15:677578. Published	components in motor coordination. To simulate affected upper limb function
2021 Jun 11.	loss in patients, a wrist weight was attached to the dominant hand of
doi:10.3389/fnhum.2021.67	participant. Participants were asked to choose their right or left hand to reach
7578	toward a randomly allocated target. The movement of the virtual image of the
	upper limb was reinforced by visual feedback to participants, that is, the
	participants perceived their motor coordination as if their upper limb was
	moving to a greater degree than what was occurring in everyday life. We found
	that the use of the simulated affected limb was increased after the visual
	feedback enhancement intervention, and importantly, the effect was maintained
	even after gradual withdrawal of the visual amplification. The results suggest
	that positive reinforcement within the IVR could induce an effect on decision
	making in hand usage.





Saldana D, Neureither M, Schmiesing A, et al. Applications of Head- Mounted Displays for Virtual Reality in Adult Physical Rehabilitation: A Scoping Review. <i>Am J Occup Ther</i> . 2020;74(5):7405205060p1- 7405205060p15. doi:10.5014/ajot.2020.04144 2	Importance: Head-mounted displays for virtual reality (HMD-VR) may be used as a therapeutic medium in physical rehabilitation because of their ability to immerse patients in safe, controlled, and engaging virtual worlds. <b>Objective:</b> To explore how HMD-VR has been used in adult physical rehabilitation. <b>Data</b> <b>sources:</b> A systematic search of MEDLINE, Embase, Cochrane Library, CINAHL, Web of Science, PsycINFO, and ERIC produced 11,453 abstracts, of which 777 underwent full-text review. <b>Study selection and data collection:</b> This scoping review includes 21 experimental studies that reported an assessment or intervention using HMD-VR in a physical rehabilitation context and within the scope of occupational therapy practice. <b>Findings:</b> HMD-VR was used for assessment and intervention for patients with a range of disorders, including stroke, multiple sclerosis, spinal cord injury, and Parkinson's disease. <b>Conclusions and relevance:</b> HMD-VR is an emerging technology with many uses in adult physical rehabilitation. Higher quality clinical implementation studies are needed to examine effects on patient outcomes. <b>What this article adds:</b> We review existing research on how immersive virtual reality (e.g., using head-mounted displays) has been used for different clinical populations in adult physical rehabilitation and highlight emerging opportunities in this field for occupational therapists.
Sánchez-Herrera-Baeza P,	Background: Parkinson's disease is a neurodegenerative disorder that causes
Cano-de-la-Cuerda R, Oña-	impaired motor functions. Virtual reality technology may be recommended to
Simbaña ED, et al. The	optimize motor learning in a safe environment. The objective of this paper was to
Impact of a Novel Immersive	evaluate the effects of a novel immersive virtual reality technology used for
Virtual Reality Technology	serious games (Oculus Rift 2 plus leap motion controller-OR2-LMC) for upper
Associated with Serious	timb outcomes (muscle strength, coordination, speed of movements, line and gross devtority). Another objective was to obtain qualitative data for participants'
Disease Patients on Unner	experiences related to the intervention <b>Methods:</b> A mixed methods intervention
Limb Behabilitation: A Mixed	(embedded) study was used with a qualitative design after a technology
Methods Intervention	intervention (quantitative design). The intervention and qualitative design
Study. Sensors (Basel).	followed international guidelines and were integrated into the method and
2020;20(8):2168. Published	reporting subheadings. <b>Results:</b> Significant improvements were observed in
2020 Apr 11.	strength ( $p = 0.028$ ), fine ( $p = 0.026$ to 0.028) and gross coordination dexterity,
doi:10.3390/s20082168	and speed movements ( $p = 0.039$ ) in the affected side, with excellent
	compliance (100%) and a high level of satisfaction (3.66 $\pm$ 0.18 points out of the
	maximum of 4). No adverse side effects were observed. Qualitative findings
	described patients' perspectives regarding OR2-LMC treatment, facilitators and
	barriers for adherence, OR2-LMC applications, and treatment improvements.
	<b>Conclusions:</b> The intervention snowed positive results for the upper limbs, with
	elements of discordance, expansion, and confirmation between qualitative and
	quantitative results.





Sauchelli S, Brunstrom JM. Virtual reality exergaming improves affect during physical activity and reduces subsequent food consumption in inactive adults. *Appetite*. 2022;175:106058. doi:10.1016/j.appet.2022.10 6058 An individual's affective (i.e. emotional) response to exercise may play an important role in post-exercise eating behaviour for some individuals. Taking advantage of advances in fully immersive virtual reality (VR) technology, this study aimed to: a) examine whether VR exergaming can improve the psychological response to exercise in inactive adults, and b) assess the extent to which this improvement reduces post-exercise appetite and eating behaviour. In a cross-over study, 34 adults not meeting the World Health Organisation's physical activity recommendations completed two exercise sessions on a stationary bike; one while engaging in a VR exergame and one without VR. Monitoring enabled heart rate, energy expenditure, and duration across conditions to be closely matched. The Physical Activity Enjoyment Scale, Feeling Scale, Felt Arousal Scale and Borg's Ratings of Perceived Exertion were measured to capture the affective responses to exercise. Appetite and eating behaviour were evaluated using visual-analogue scales, a computerised food preference task, and intake at a post-exercise buffet meal. Cycling in VR elicited greater exercise enjoyment (p < 0.001,  $\eta 2p = 0.62$ ), pleasure (p < 0.001,  $\eta_{2p} = 0.47$ ), and activation (p < 0.001,  $\eta_{2p} = 0.55$ ). VR exergaming did not alter perceived physical exertion (p = 0.64), perceived appetite (p = 0.68), and preference for energy dense (p = 0.78) or sweet/savoury foods (p = 0.90) compared to standard exercise. However, it did result in a mean 12% reduction in post-exercise food intake (mean difference: 105.9 kcal; p < 0.01;  $\eta 2p = 0.20$ ) and a decrease in relative food intake (p < 0.01; n2p = 0.20), although interindividual differences in response to VR exergaming were observed. The integration of VR in a cycling workout improves the affective experience of physical activity for inactive adults and reduces subsequent food intake. Virtual reality technology shows potential as an adjunct tool to support adults in weight management programmes become more active, especially for those individuals who are prone to eat in excess after physical activity.





Scandola M, Togni R, Tieri G, et al. Embodying their own wheelchair modifies extrapersonal space perception in people with spinal cord injury. <i>Exp Brain</i> 2632. doi:10.1007/s00221- 019-05618-8Despite the many links between body representation, acting and perceiving the environment, no research has to date explored whether specific tool embodiment in conditions of sensorimotor deprivation influences extrapersonal space perception. We tested 20 spinal cord injured (SCI) individuals to investigate whether specific wheelchair embodiment interacts with extrapersonal space representation. As a measure of wheelchair embodiment, we used a Body View Enhancement Task in which participants (either sitting in their own wheelchair or in one which they had never used before) were asked to respond promptly to flashing lights presented on their above- and below-lesion body parts. Similar or slower reaction times (RT) to stimuli on the body and wheelchair indicate, respectively, the presence or absence of tool embodiment. The RTs showed that the participants embodied their own wheelchair but not the oother one. Moreover, they coded their deprived lower limbs as external objects and, when not in their own wheelchair, also showed disownership of their intact upper limbs. To measure extrapersonal space perception, we used a novel, ad hoc designed paradigm in which the participants, but only when they were in their own wheelchair. The results demonstrate for the first time that tool embodiment modifies extrapersonal space estimations.Scapin S, Echevarría- Guanilo ME, Boeira Fuculo Junior PR, Gonçalves N, Rocha PK, Coimbra R. Virtual Reality in the treatment of burn patients: A systematic review. <i>Burns.</i> Aim: To identify studies that approach immersive virtual realities and its main effects in the treatment of thur patients. A systematic demonstrate the as		
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		beneficial results in the treatment of burn patients.





Scherer MR, Weightman MM, Radomski MV, Davidson LF, McCulloch KL. Returning service members to duty following mild traumatic brain injury: exploring the use of dual-task and multitask assessment methods. *Phys Ther*. 2013;93(9):1254-1267. doi:10.2522/ptj.20120143 Within the last decade, more than 220,000 service members have sustained traumatic brain injury (TBI) in support of military operations in Iraq and Afghanistan. Mild TBI may result in subtle cognitive and sensorimotor deficits that adversely affect warfighter performance, creating significant challenges for service members, commanders, and clinicians. In recent conflicts, physical therapists and occupational therapists have played an important role in evaluating service member readiness to return to duty (RTD), incorporating research and best practices from the sports concussion literature. Because premorbid (baseline) performance metrics are not typically available for deployed service members as for athletes, clinicians commonly determine duty readiness based upon the absence of postconcussive symptoms and return to "normal" performance on clinical assessments not yet validated in the military population. Although practices described in the sports concussion literature guide "return-to-play" determinations, resolution of symptoms or improvement of isolated impairments may be inadequate to predict readiness in a military operational environment. Existing clinical metrics informing RTD decision making are limited because they fail to emphasize functional, warrior task demands and they lack versatility to assess the effects of comorbid deficits. Recently, a number of complex task-oriented RTD approaches have emerged from Department of Defense laboratory and clinical settings to address this gap. Immersive virtual reality environments, field-based scenario-driven assessment programs, and militarized dual-task and multitask-based approaches have all been proposed for the evaluation of sensorimotor and cognitive function following TBI. There remains a need for clinically feasible assessment methods that can be used to verify functional performance and operational competence in a variety of practice settings. Complex and ecologically valid assessment techniques incorporating dual-task and multitask methods may prove useful in validating return-to-activity requirements in civilian and military populations.





Segear S, Chheang V, Baron L, Li J, Kim K, Barmaki RL. Visual Feedback and Guided Balance Training in an Immersive Virtual Reality Environment for Lower Extremity Rehabilitation. *Comput Graph*. 2024;119:103880. doi:10.1016/j.cag.2024.01.0 07 Balance training is essential for physical rehabilitation procedures, as it can improve functional mobility and enhance cognitive coordination. However, conventional balance training methods may have limitations in terms of motivation, real-time objective feedback, and personalization, which a virtual reality (VR) setup may better provide. In this work, we present an immersive VR training environment for lower extremity balance rehabilitation with real-time guidance and feedback. The VR training environment immerses the user in a 3D ice rink model where a virtual coach (agent) leads them through a series of balance poses, and the user controls a trainee avatar with their own movements. We developed two coaching styles: positive-reinforcement and autonomous-supportive, and two viewpoints of the trainee avatar: first-person and third-person. The proposed environment was evaluated in a user study with healthy, non-clinical participants (n = 16, 24.4 ± 5.7 years old, 9 females). Our results show that participants showed stronger performance in the positivereinforcement style compared to the autonomous-supportive style. Additionally, in the third-person viewpoint, the participants exhibited more stability in the positive-reinforcement style compared to the autonomous-supportive style. For viewpoint, participants exhibited stronger performance in the first-person viewpoint compared to third-person in the autonomous-supportive style, while they were comparable in the positive-reinforcement style. We observed no significant effects on the foot height and number of mistakes. Furthermore, we report the analysis of user performance with balance training poses and subjective measures based on questionnaires to assess the user experience, usability, and task load. The proposed VR balance training could offer an interactive, adaptive, and engaging environment and open new potential research directions for lower extremity rehabilitation.





Shah SHH, Karlsen AST, Solberg M, Hameed IA. A social VR-based collaborative exergame for rehabilitation: codesign, development and user study. *Virtual Real*. Published online November 28, 2022. doi:10.1007/s10055-022-00721-8 Immersive virtual reality (VR)-based exercise video games (exergames) are increasingly being employed as a supportive intervention in rehabilitation programs to promote engagement in physical activity, especially for elderly users. A multifaceted and iterative codesign process is essential to develop sustainable exergaming solutions. The social aspect is considered one of the key motivating factors in exergames; however, research on the social aspect of VR exergames has been limited. Previous studies have relied on competitiveness in exergames, but research has shown that competition can lead to adverse effects on users. With the aim of motivating elderly individuals to participate in physical exercise and improving social connectedness during rehabilitation, this work presents a social VR-based collaborative exergame codesigned with elderly participants and therapists. This exergame stimulates full-body exercise and supports social collaboration among users through a collaborative game task. Furthermore, this article presents a user study based on a mixed-methods approach to gather user feedback on exergame design and the effect of social collaboration versus playing alone in a VR exergame in terms of physical exertion and motivation. This study spanned five weeks (99 exergaming sessions) with 14 elderly participants divided into two groups, one playing collaboratively and the other playing individually. Between-group comparisons were performed at baseline (first week) and in the fourth week, and within-group comparisons were performed in the fifth week, when the participants played the exergame in counterbalanced order. In contrast to the first week, the participants exergaming collaboratively in the fourth week reported significantly higher intrinsic motivation on all subscales (enjoyment: p < 0.02, effort: p < 0.002, usefulness: p < 0.01) and physical exertion (p < 0.001) than those playing alone. Thereafter, exergaming in counterbalanced order during the fifth week resulted in significant differences (medium to large effect size) within groups. The participants found the social VR gameplay enjoyable and agreed that collaboration played a vital role in their motivation. They reported various health benefits, a minimal increase in symptoms of simulator sickness, and excellent usability scores (83.75±13.3). In this work, we also identify various key design principles to support healthcare professionals, researchers and industrial experts in developing ergonomic and sustainable VR-based exergames for senior citizens.





Sharar SR, Carrougher GJ, Nakamura D, Hoffman HG, Blough DK, Patterson DR. Factors influencing the efficacy of virtual reality distraction analgesia during postburn physical therapy: preliminary results from 3 ongoing studies. *Arch Phys Med Rehabil*. 2007;88(12 Suppl 2):S43-S49. doi:10.1016/j.apmr.2007.09. 004 **Objective:** To assess the efficacy and side effects of immersive virtual reality (VR) distraction analgesia, as well as patient factors associated with VR analgesic efficacy in burn patients who require passive range-of-motion (ROM) physical therapy (PT). **Design:** Prospective, randomized, controlled, withinsubject trials. Setting: Regional level I burn center in a university-affiliated urban hospital. Participants: Patients (age range, 6-65y) who required passive ROM PT in sessions lasting 3 to 15 minutes after cutaneous burn injury. Interventions: Standard analgesic (opioid and/or benzodiazepine) care and standard analgesic care plus immersive VR distraction. Main outcome measure: Self-reported subjective pain ratings (0 to 100 graphic rating scale). **Results:** A total of 146 treatment comparisons were made in 88 subjects, 75% of whom were children ages 6 to 18 years. Compared with standard analgesic treatment alone, the addition of VR distraction resulted in significant reductions in subjective pain ratings for worst pain intensity (20% reduction), pain unpleasantness (26% reduction), and time spent thinking about pain (37% reduction). Subjects' age, sex, ethnicity, size of initial burn injury, or duration of therapy session did not affect the analgesic effects of VR distraction. Nausea with the standard care plus VR distraction condition was infrequent (15%) and mild, with 85% of the subjects reporting no nausea. Children provided higher subjective reports of "presence" in the virtual environment and "realness" of the virtual environment than did adults, but age did not affect the analgesic effects of VR distraction. Conclusions: When added to standard analgesic therapy, VR distraction provides a clinically meaningful degree of pain relief to burn patients undergoing passive ROM PT. Multiple patient factors do not appear to affect the analgesic effect. Immersive VR distraction is a safe and effective nonpharmacologic technique with which to provide adjunctive analgesia to facilitate patient participation in rehabilitation activities.





Sip P, Kozłowska M, Czysz D, Daroszewski P, Lisiński P. Perspectives of Motor Functional Upper Extremity Recovery with the Use of Immersive Virtual Reality in Stroke Patients. *Sensors (Basel)*. 2023;23(2):712. Published 2023 Jan 8. doi:10.3390/s23020712 Stroke is one of the leading causes of disability, including loss of hand manipulative skills. It constitutes a major limitation in independence and the ability to perform everyday tasks. Among the numerous accessible physiotherapeutic methods, it is becoming more common to apply Virtual Reality "VR". The aim of this study was to establish whether immersive VR was worth considering as a form of physical therapy and the advisability of applying it in restoring post-stroke hand function impairment. A proprietary application Virtual Mirror Hand 1.0 was used in the research and its effectiveness in therapy was compared to classical mirror therapy. A total of 20 survivors after ischaemic stroke with comparable functional status were divided into a study group (n = 10) and control group (n = 10). Diagnostic tools included 36-Item Short Form Survey "SF-36" and the Fugl-Meyer Assessment Upper Extremity "FMA-UE". Collected metrics showed a normal distribution and the differences in mean values were tested by the student's t-test. In both, the study and control groups' changes were recorded. A statistically significant outcome for FMA-UE and SF-36 measured by the student's t-test for dependent or independent samples (p > 0.05) were obtained in both groups. Importantly, proven by conducted studies, an advantage of VR proprietary application was subjective sensations amelioration in pain and sensory impressions. Applying Virtual Mirror Hand 1.0 treatment to patients after a stroke appears to be a good solution and definitely provides the opportunity to consider VR applications as an integral part of the neurorehabilitation process. These results give a basis to plan further largerscale observation attempts. Moreover, the development of the Virtual Mirror Hand 1.0 as an innovative application in physiotherapy may become equivalent to classical mirror therapy in improving the quality and effectiveness of the treatment used for post-stroke patients.





Solcà M, Ronchi R, Bello- Ruiz J, et al. Heartbeat- enhanced immersive virtual reality to treat complex regional pain syndrome. <i>Neurology</i> . 2018;91(5):e479-e489. doi:10.1212/WNL.00000000 00005905	<b>Objectives:</b> To develop and test a new immersive digital technology for complex regional pain syndrome (CRPS) that combines principles from mirror therapy and immersive virtual reality and the latest research from multisensory body processing. <b>Methods:</b> In this crossover double-blind study, 24 patients with CRPS and 24 age- and sex-matched healthy controls were immersed in a virtual environment and shown a virtual depiction of their affected limb that was flashing in synchrony (or in asynchrony in the control condition) with their own online detected heartbeat (heartbeat-enhanced virtual reality [HEVR]). The primary outcome measures for pain reduction were subjective pain ratings, force strength, and heart rate variability (HRV). <b>Results:</b> HEVR reduced pain ratings, improved motor limb function, and modulated a physiologic pain marker (HRV). These significant improvements were reliable and highly selective, absent in control HEVR conditions, not observed in healthy controls, and obtained without the application of tactile stimulation (or movement) of the painful limb, using a readily available biological signal (the heartbeat) that is most often not consciously perceived (thus preventing placebo effects). <b>Conclusions:</b> Next to these specific and well-controlled analgesic effects, immersive HEVR allows the application of prolonged and repeated doses of digital therapy, enables the automatized integration with existing pain treatments, and avoids application of painful bodily cues while minimizing the active involvement of the patient and therapist.
Song YH, Lee HM. Effect of Immersive Virtual Reality- Based Bilateral Arm Training in Patients with Chronic Stroke. <i>Brain Sci</i> . 2021;11(8):1032. Published 2021 Aug 3. doi:10.3390/brainsci110810 32	Virtual reality (VR)-based therapies are widely used in stroke rehabilitation. Although various studies have used VR techniques for bilateral upper limb training, most have been only semi-immersive and have only been performed in an artificial environment. This study developed VR content and protocols based on activities of daily living to provide immersive VR-based bilateral arm training (VRBAT) for upper limb rehabilitation in stroke patients. Twelve patients with chronic stroke were randomized to a VRBAT group or a normal bilateral arm training (NBAT) group and attended 30-min training sessions five times a week for four weeks. At the end of the training, there was a significant difference in upper limb function in both groups ( $p < 0.05$ ) and in the upper limb function sensory test for proprioception in the NBAT group ( $p < 0.05$ ). There was no significant between-group difference in upper limb muscle activity after training. The relative alpha and beta power values for electroencephalographic measurements were significantly improved in both groups. These findings indicate that both VRBAT and NBAT are effective interventions for improving upper limb function and electroencephalographic activity in patients with chronic stroke.





Summers SJ, Antcliff S, Waddington G, Wallwork S. Reliability and learning effects of repeated exposure to the Bertec Balance Advantage sensory organisation test in healthy individuals. *Gait Posture*. 2022;93:205-211. doi:10.1016/j.gaitpost.2022. 02.004 Background: The Sensory Organisation Test (SOT) of computerised dynamic posturography (CDP) is a well-established clinical test used to measure postural control. Advances in technology have enabled new CDP systems to use immersive virtual reality, such as the Bertec<sup>®</sup> Balance Advantage<sup>®</sup>. While the Bertec provides an innovative approach to posturography, the reliability and learning effects of the Bertec in administering the SOT has not been thoroughly investigated. **Research question:** To evaluate the reliability and performance during repeated administration of the Bertec® Balance Advantage® SOT. **Methods:** Fourteen healthy adults (age 27.17 ± 5.5years; 10 females) participated. Each participant performed five SOTs over three sessions. The first two sessions were approximately two days apart and the third one month later. In the first two sessions, two SOTs were conducted, and in the third session, one was performed. Composite, equilibrium, and ratio scores were used for analysis. Results: Poor within-session reliability was found in the first session for the composite score (ICC: 0.73, 95% CI: 0.32-0.91), which improved by the second session (ICC: 0.84, 95% CI: 0.58-0.94). Poor within-session reliability (ICC < 0.5) was found for all ratio and equilibrium scores, except for the equilibrium score of condition 3, which demonstrated moderate reliability (ICC: 0.84, 95% CI: 0.57-0.95). Poor between-session reliability was found for all outcomes. There was an increase in the composite and equilibrium scores for conditions 5 and 6 over the 5 tests, which plateaued after the fourth test, and were retained at 1 month. **Significance:** The data demonstrate a steady increase in performance with repeated exposure to the Bertec SOT, which was maintained one month later, indicating a learning effect. We recommend that a minimum of two familiarisation sessions should be administered to establish baseline performance and improve reliability.





Szczepańska-Gieracha J, Jóźwik S, Cieślik B, Mazurek J, Gajda R. Immersive Virtual Reality Therapy as a Support for Cardiac Rehabilitation: A Pilot Randomized-Controlled Trial. <i>Cyberpsychol Behav</i> <i>Soc Netw</i> . 2021;24(8):543- 549. doi:10.1089/cyber.2020.029 7	Depression and anxiety can significantly reduce the effectiveness of cardiac rehabilitation (CR). Several studies have assessed the effectiveness of virtual reality (VR)-based interventions for symptoms of anxiety and depression; however, they do not relate to patients with heart disease. The aim of this study was to assess the effects of VR therapy on the mental state of patients with coronary artery disease (CAD). Thirty-four CAD patients with elevated anxiety or depression symptoms were recruited. After randomization, 17 participants were assigned to the intervention group, and 17 to the control group. Both groups underwent standard CR for outpatients. In the intervention group, eight VR therapy sessions were applied. In the control group, eight sessions of Schultz' Autogenic Training were applied. To assess patient mental states, Hospital Anxiety and Depression Scale (HADS) and Perception of Stress Questionnaire (PSQ) were used, before and after 4 weeks of CR. In the intervention group, a significant decrease in HADS score was observed (19.46 pretreatment vs. 15.73 post-treatment, <i>p</i> = 0.003), HADS-Anxiety subscale decreased by 16.0 percent ( <i>p</i> = 0.01) and HADS-Depression by 23.0 percent ( <i>p</i> = 0.003). Similarly, a significant decrease in PSQ was recorded at 12.8 percent (64.73 vs. 56.47, <i>p</i> = 0.03). In the control group, HADS and PSQ data did not change. VR therapy significantly reduced the severity of depressive symptoms, anxiety, and stress levels in CAD patients undergoing CR. Immersive VR therapy effectively supports the CB of individuals with anxiety-depressive symptoms.
Takahashi R, Yabe H, Hibino T, et al. The study of exercise therapy using a virtual reality system on healthy subjects assuming hospital use and intradialytic exercise. <i>Nagoya J Med Sci</i> . 2023;85(3):490-503. doi:10.18999/nagjms.85.3.4 90	This study aimed to investigate the basic data on the effectiveness and safety of the system in healthy subjects using an immersive virtual reality (VR) exercise system specialized for therapeutic exercise therapy during dialysis or hospital use. A total of 15 healthy adult subjects performed four exercises, namely lifting and rowing exercises using VR and each movement exercise without VR (control). The simulator sickness questionnaire (SSQ) was administered pre- and post-operatively to assess for VR sickness. Blood pressure, heart rate (HR), rating of perceived exhaustion, Profile of Mood States 2nd Edition Japanese version, and muscle activity (iEMG) were measured using electromyography. The correlation between changes in mood states and HR or iEMG results was examined. The SSQ measured post-VR exercise was 11.2 (18.7-7.5) and 11.2 (7.5-29.9) points in the lifting and rowing VR, respectively. The HR in lifting (VR, 82.5 $\pm$ 12.7 vs control, 71.6 $\pm$ 10.6 bpm, <i>P</i> <0.05) and rowing (VR, 94.2 $\pm$ 13.1 vs control. No significant differences were observed between the other variables.
	There was a positive correlation between HR and negative mood in the lifting VR condition (r=0.64, $P$ <0.05), but not in the control group. Contrastingly, there was a positive correlation between iEMG and negative mood in rowing control (r=0.56), but not VR. Safety was confirmed, with no VR sickness or discontinuation of the system. Exercise therapy using VR resulted in a higher exercise load. This VR system has the potential for additional effective intradialytic exercises and hospital use.





Tao G, Garrett B, Taverner T, Cordingley E, Sun C. Immersive virtual reality health games: a narrative review of game design. *J Neuroeng Rehabil*. 2021;18(1):31. Published 2021 Feb 11. doi:10.1186/s12984-020-00801-3 **Background:** High quality head-mounted display based virtual reality (HMD-VR) has become widely available, spurring greater development of HMD-VR health games. As a behavior change approach, these applications use HMD-VR and game-based formats to support long-term engagement with therapeutic interventions. While the bulk of research to date has primarily focused on the therapeutic efficacy of particular HMD-VR health games, how developers and researchers incorporate best-practices in game design to achieve engaging experiences remains underexplored. This paper presents the findings of a narrative review exploring the trends and future directions of game design for HMD-VR health games. **Methods:** We searched the literature on the intersection between HMD-VR, games, and health in databases including MEDLINE, Embase, CINAHL, PsycINFO, and Compendex. We identified articles describing HMD-VR games designed specifically as health applications from 2015 onwards in English. HMD-VR health games were charted and tabulated according to technology, health context, outcomes, and user engagement in game design. Findings: We identified 29 HMD-VR health games from 2015 to 2020, with the majority addressing health contexts related to physical exercise, motor rehabilitation, and pain. These games typically involved obstacle-based challenges and extrinsic reward systems to engage clients in interventions related to physical functioning and pain. Less common were games emphasizing narrative experiences and non-physical exercise interventions. However, discourse regarding game design was diverse and often lacked sufficient detail. Game experience was evaluated using primarily ad-hoc questionnaires. User engagement in the development of HMD-VR health games primarily manifested as user studies. Conclusion: HMD-VR health games are promising tools for engaging clients in highly immersive experiences designed to address diverse health contexts. However, more in-depth and structured attention to how HMD-VR health games are designed as game experiences is needed. Future development of HMD-VR health games may also benefit from greater involvement of end-users in participatory approaches.





Vallageas V, Aissaoui R, Willaert I, Labbe DR. Embodying a self-avatar with a larger leg: its impacts on motor control and dynamic stability. *IEEE Trans Vis Comput Graph*. 2024;30(5):2066-2076. doi:10.1109/TVCG.2024.337 2084 Several studies have shown that users of immersive virtual reality can feel high levels of embodiment in self-avatars that have different morphological proportions than those of their actual bodies. Deformed and unrealistic morphological modifications are accepted by embodied users, underlying the adaptability of one's mental map of their body (body schema) in response to incoming sensory feedback. Before initiating a motor action, the brain uses the body schema to plan and sequence the necessary movements. Therefore, embodiment in a self-avatar with a different morphology, such as one with deformed proportions, could lead to changes in motor planning and execution. In this study, we aimed to measure the effects on movement planning and execution of embodying a self-avatar with an enlarged lower leg on one side. Thirty participants embodied an avatar without any deformations, and with an enlarged dominant or non-dominant leg, in randomized order. Two different levels of embodiment were induced, using synchronous or asynchronous visuotactile stimuli. In each condition, participants performed a gait initiation task. Their center of mass and center of pressure were measured, and the margin of stability (MoS) was computed from these values. Their perceived level of embodiment was also measured, using a validated questionnaire. Results show no significant changes on the biomechenical variables related to dynamic stability. Embodiment scores decreased with asynchronous stimuli, without impacting the measures related to stability. The body schema may not have been impacted by the larger virtual leg. However, deforming the self-avatar's morphology could have important implications when addressing individuals with impaired physical mobility by subtly influencing action execution during a rehabilitation protocol.





van Gelderen MJ, Nijdam MJ, Haagen JFG, Vermetten E. Interactive Motion-Assisted Exposure Therapy for Veterans with Treatment-Resistant Posttraumatic Stress Disorder: A Randomized Controlled Trial. *Psychother Psychosom*. 2020;89(4):215-227. doi:10.1159/000505977 Background: Veterans with posttraumatic stress disorder (PTSD) tend to benefit less from evidence-based treatments than other PTSD populations. A novel virtual reality and motion-assisted exposure therapy, called 3MDR, provides treatment in an immersive, personalized and activating context. **Objective:** To study the efficacy of 3MDR for veterans with treatment-resistant PTSD. Method: In a randomized controlled trial (n = 43) 3MDR was compared to a nonspecific treatment component control group. Primary outcome was clinicianrated PTSD symptoms at baseline, after 3MDR, and at the 12-week and 16-week follow-up (primary end point). Intention-to-treat analyses of covariance and mixed models were applied to study differences between groups at the end point and over the course of intervention, controlling for baseline scores. **Results:** The decrease in PTSD symptom severity from baseline to end point was significantly greater for 3MDR as compared to the control group, with a large effect size (F[1, 37] = 6.43, p = 0.016, d = 0.83). No significant between-group difference was detected in the course of PTSD symptoms during treatment when including all time points. The dropout rate was low (7%), and 45% of the patients in the 3MDR group improved clinically. The number needed to treat was 2.86. **Conclusions:** In this trial, 3MDR significantly decreased PTSD symptoms in veterans with, on average, a history of 4 unsuccessful treatments. The low dropout rate may be indicative of high engagement. However, a lack of significant differences on secondary outcomes limits conclusions that can be drawn on its efficacy and underlines the need for larger phase III trials. These data show emerging evidence for 3MDR and its potential to progress PTSD treatment for veterans.





Objective: To evaluate the literature on the effectiveness of virtual reality (VR)-Vassantachart AY, Yeo E, Chau B. Virtual and and augmented reality (AR)-based treatments for phantom limb pain (PLP) in Augmented Reality-based postamputation or brachial plexus avulsion (BPA) populations. **Treatments for Phantom** Methods: Multiple databases were queried in July 2021 with the keywords "virtual reality," "augmented reality," and "phantom limb pain." Included studies Limb Pain: A Systematic Review. Innov Clin Neurosci. utilized VR or AR to treat PLP with outcome measurement. Two independent 2022;19(10-12):48-57. reviewers assessed methodological quality using the Physiotherapy Evidence Databsae (PEDro) Scale and the Methodological Index for Nonrandomized Studies (MINORS) scoring. Studies were separated into immersive and nonimmersive AR/VR systems, with further categorization according to the specific methodologies used. Results: Of 110 results from the database queries, 20 publications met the inclusion criteria. There was one unblinded, randomized, control trial (RCT), one single-blinded, randomized, crossover trial (RCxT), three comparative case series, 13 noncomparative case series, and two case reports. Seven of the 20 studies were classified as nonimmersive. Six studies reported decreased PLP after AR/VR treatments, of which four reported significant reductions. One study reported a reduction in PLP with no significant difference from control conditions. Thirteen of the 20 studies were classified as immersive AR/VR. Twelve studies reported decreased PLP after AR/VR treatments, of which eight reported significant reductions. One study found no change in PLP, compared to baseline. Conclusion: The number of studies using AR/VR in PLP treatment has expanded since a 2017 review on the topic. The majority of these studies offer support for the efficacy of treating PLP with AR/VR-based treatments. Research has expanded on the customization, outcome measurements, and statistical analysis of AR/VR treatments. While results are promising, most publications remain at the case series level, and clinical indications should be cautioned. With improvements in the quality of evidence, there remain avenues for further investigations, including increased sampling, randomization, optimization of treatment duration, and comparisons to alternative therapies. Wang Z, Lv J, Hou Y, Song D. Combining virtual reality (VR) with rehabilitation robots has the potential to Enhancing experience: enhance rehabilitation training and neural functional recovery. However, there is Investigating the impact of limited research on designing VR scenes and evaluating the impact of such systems on participants' cognitive and experiential aspects when using different personal perspectives in virtual reality rehabilitation robots. This study aimed to examine the effects of different gaming with lower limb rehabilitation modes (first-person perspective and third-person perspective) and robot robots on participants' involvement on participants' motivation, experience, task load, and motivation, experience, and engagement. Thirty-two participants underwent gait rehabilitation training, engagement. International providing feedback on their experiences after each condition. The findings Journal of Industrial revealed that the first-person perspective mode increased motivation, Ergonomics. experience, task performance, and engagement. On the other hand, robot-2024;99:103496. assisted participation improved motivation but decreased the overall doi:10.1016/j.ergon.2023.10 experience. These results indicate that the first-person perspective mode takes 3496 precedence over the third-person perspective mode in terms of embodied gaming and the development of rehabilitation tasks.





Weber LM, Nilsen DM, Gillen G, Yoon J, Stein J. ImmersiveObjective: This study was designed to examine the feasibility of immersive virtual reality mirror therapy for upper limb paresis after stroke using a head- mounted display and provide preliminary evidence of efficacy. Design: Ten outpatients with chronic stroke, upper limb hemiparesis, and a low predisposition for motion sickness completed a 12-session program of 30 mins each of immersive virtual reality mirror therapy. The virtual reality system provided the illusion of movement in the hemiparetic upper limb while suppressing the visual representation of the nonparetic side. Feasibility was assessed via patient compliance, adverse event tracking, the System Usability Scale, and the Simulator Sickness Questionnaire. Preliminary efficacy was evaluated using the Fugl-Meyer Upper Extremity and Action Research Arm Test. Results: Immersive virtual reality mirror therapy for patients with chronic stroke was safe, well-tolerated, and without adverse events, such as simulator sickness. Motor outcomes revealed a small improvement for the Fugl-Meyer Upper Extremity for 21.7 (SD = 8.68) to 22.8 (SD = 9.19) that did not achieve statistical significance (P = 0.084). Conclusions: Four weeks of immersive virtual reality mirror therapies for stroke survivors.Wender C. Immersive virtual reality to relieve exercise- induced pain caused by aerobic cycling. Pain Manag. 2022;12(5):665-674.Chronic pain and ics comorbidities, oran difference. Immersive virtual reality apports regular physical exercise as an effective long-term against pain and common comorbidities, exercise-induced pain and kinesiophobia are significant barriers to participation and adherence. Immersive virtual reality is a powerful short-term pain reliever, that, when combined with exercise, can help overcome these barriers. This perspective argues for the use		
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		exercise and virtual reality treatment techniques to mitigate chronic pain.





Winter C, Kern F, Gall D, Latoschik ME, Pauli P, Käthner I. Immersive virtual reality during gait rehabilitation increases walking speed and motivation: a usability evaluation with healthy participants and patients with multiple sclerosis and stroke. *J Neuroeng Rehabil*. 2021;18(1):68. Published 2021 Apr 22. doi:10.1186/s12984-021-00848-w **Background:** The rehabilitation of gait disorders in patients with multiple sclerosis (MS) and stroke is often based on conventional treadmill training. Virtual reality (VR)-based treadmill training can increase motivation and improve therapy outcomes. The present study evaluated an immersive virtual reality application (using a head-mounted display, HMD) for gait rehabilitation with patients to (1) demonstrate its feasibility and acceptance and to (2) compare its short-term effects to a semi-immersive presentation (using a monitor) and a conventional treadmill training without VR to assess the usability of both systems and estimate the effects on walking speed and motivation. Methods: In a within-subjects study design, 36 healthy participants and 14 persons with MS or stroke participated in each of the three experimental conditions (VR via HMD, VR via monitor, treadmill training without VR). **Results:** For both groups, the walking speed in the HMD condition was higher than in treadmill training without VR and in the monitor condition. Healthy participants reported a higher motivation after the HMD condition as compared with the other conditions. Importantly, no side effects in the sense of simulator sickness occurred and usability ratings were high. No increases in heart rate were observed following the VR conditions. Presence ratings were higher for the HMD condition compared with the monitor condition for both user groups. Most of the healthy study participants (89%) and patients (71%) preferred the HMD-based training among the three conditions and most patients could imagine using it more frequently. Conclusions: For the first time, the present study evaluated the usability of an immersive VR system for gait rehabilitation in a direct comparison with a semi-immersive system and a conventional training without VR with healthy participants and patients. The study demonstrated the feasibility of combining a treadmill training with immersive VR. Due to its high usability and low side effects, it might be particularly suited for patients to improve training motivation and training outcome e.g. the walking speed compared with treadmill training using no or only semi-immersive VR. Immersive VR systems still require specific technical setup procedures. This should be taken into account for specific clinical use-cases during a cost-benefit assessment.





Yan S, Shen S, Lu Q, et al. Virtual reality working memory training improves cognitive performance of acute and remitted patients with major depressive disorder. *J Affect Disord*. 2024;344:267-276. doi:10.1016/j.jad.2023.10.06 7 Background: Cognitive training is effective in treating neuropsychological impairment in patients with major depressive disorder (MDD), and virtual reality (VR) is a promising tool to provide such training. However, studies using VRbased working memory (WM) training in treating depressed patients' cognitive impairment are extremely scarce and how it affects cognitive performance remains unclear. Therefore, we aimed to determine the efficacy of VR-WM training in acute and remitted depressed patients and try to investigate its potential mechanisms. Methods: Forty-two patients with MDD (22 acute patients and 20 remitted patients) received 20-session VR-WM training, while 22 healthy controls (HC) received no intervention. WM and other cognitive domains' performance were assessed by the Massachusetts General Hospital Cognitive and Physical Functioning Questionnaire (CPFQ) and the MATRICS Consensus Cognitive Battery (MCCB) before and after the intervention. Depressive symptoms were assessed by the 24-item Hamilton Depression Rating Scale (24-HDRS) at the same time points. **Results:** Acute and remitted MDD patients both exhibited significant improvements from pre- to post-training in WM, processing speed, visual learning, reasoning and problem-solving, and total cognition (all p < 0.05). Significant groups-by-time interactions were observed for the 24-HDRS score (p < 0.05). Mediation analysis showed that 24-HDRS score partially mediated the association between the effect of VR-WM training on WM and total cognition performance in total depressive samples. Conclusions: VR-WM training effectively improved WM and other cognitive domains' performance in both acute and remitted MDD patients. Besides, VR-WM training improves WM and total cognition performance in MDD patients partially via the enhancement of depressive symptoms.





Yang YS, Koontz AM, Hsiao YH, Pan CT, Chang JJ. Assessment of Wheelchair Propulsion Performance in an Immersive Virtual Reality Simulator. Int J Environ Res Public Health. 2021;18(15):8016. Published 2021 Jul 29. doi:10.3390/ijerph18158016 Maneuvering a wheelchair is an important necessity for the everyday life and social activities of people with a range of physical disabilities. However, in real life, wheelchair users face several common challenges: articulate steering, spatial relationships, and negotiating obstacles. Therefore, our research group has developed a head-mounted display (HMD)-based intuitive virtual reality (VR) stimulator for wheelchair propulsion. The aim of this study was to investigate the feasibility and efficacy of this VR stimulator for wheelchair propulsion performance. Twenty manual wheelchair users (16 men and 4 women) with spinal cord injuries ranging from T8 to L2 participated in this study. The differences in wheelchair propulsion kinematics between immersive and nonimmersive VR environments were assessed using a 3D motion analysis system. Subjective data of the HMD-based intuitive VR stimulator were collected with a Presence Questionnaire and individual semi-structured interview at the end of the trial. Results indicated that propulsion performance was very similar in terms of start angle (p = 0.34), end angle (p = 0.46), stroke angle (p = 0.76), and shoulder movement (p = 0.66) between immersive and non-immersive VR environments. In the VR episode featuring an uphill journey, an increase in propulsion speed (p < 0.01) and cadence (p < 0.01) were found, as well as a greater trunk forward inclination (p = 0.01). Qualitative interviews showed that this VR simulator made an attractive, novel impression and therefore demonstrated the potential as a tool for stimulating training motivation. This HMD-based intuitive VR stimulator can be an effective resource to enhance wheelchair maneuverability experiences.





Yun SJ, Hyun SE, Oh BM, Seo HG. Fully immersive virtual reality exergames with dualtask components for patients with Parkinson's disease: a feasibility study. *J Neuroeng Rehabil*. 2023;20(1):92. Published 2023 Jul 18. doi:10.1186/s12984-023-01215-7 Background: Dual-task training in Parkinson's disease (PD) improves spatiotemporal gait parameters, cognition, and quality of life. Virtual reality (VR) has been used as a therapeutic tool for patients to participate in activities in a safe environment, engage in multisensory experiences, and improve motivation and interest in rehabilitation. This study aimed to investigate the feasibility of fully immersive VR exergames with dual-task components in patients with PD. Methods: We developed VR exergames (go/no-go punch game, go/no-go stepping game, and number punch game) to improve habitual behavior control using motor-cognitive dual-task performance in patients with PD. The participants underwent 10 sessions 2-3 times a week, consisting of 30 min per session. The Unified Parkinson's Disease Rating Scale, Timed Up and Go test (TUG) under single- and dual-task (cognitive and physical) conditions, Berg balance scale (BBS), Stroop test, trail-making test, and digit span were evaluated before and after intervention. The Simulator Sickness Questionnaire (SSQ) was used to assess VR cybersickness. Usability was assessed using a self-reported questionnaire. Results: Twelve patients were enrolled and completed the entire training session. The mean age of participants was 73.83 ± 6.09 years; mean disease duration was 128.83 ± 76.96 months. The Hoehn and Yahr stages were 2.5 in seven patients and 3 in five patients. A significant improvement was observed in BBS and Stroop color-word test (p = 0.047 and p = 0.003, respectively). TUG time and dual-task interferences showed positive changes, but these changes were not statistically significant. The median SSQ total score was 28.05 (IQR: 29.92), 13.09 (IQR: 11.22), and 35.53 (IQR: 52.36) before, after the first session, and after the final session, respectively; the differences were not significant. Overall satisfaction with the intervention was 6.0 (IQR: 1.25) on a 7-point Likert-type scale. Conclusions: Fully immersive VR exergames combined with physical and cognitive tasks may be used for rehabilitation of patients with PD without causing serious adverse effects. Furthermore, the exergames using dual-task components improved executive function and balance. Further development of VR training content may be needed to improve motor and dual-task performances.





Zak M, Sikorski T, Krupnik S, et al. Physiotherapy Programmes Aided by VR Solutions Applied to the Seniors Affected by Functional Capacity Impairment: Randomised Controlled Trial. *Int J Environ Res Public Health*. 2022;19(10):6018. Published 2022 May 15. doi:10.3390/ijerph19106018 Modern technologies are presently harnessed in response to a complex challenge of providing physiotherapeutic management in older adults. Fully immersive virtual reality (VR) solutions are acknowledged to viably enhance the overall effectiveness of traditional physiotherapeutic methods. A total of 60 community-dwelling older adults (over 75 years of age) were recruited for the study protocol. They were subsequently randomly split into four equally sized study groups (VR, CVR, OCULUS, and the classic programme group (OTAGO), and the physiotherapy sessions were pursued in the subjects' homes for 3 weeks, 3 times a week, for 30 min in each group. At the first measurement point, respective study groups differed significantly in functional performance, as expressed in gait (POMA G) and individual static balance. The post hoc analysis indicated significantly higher scores in POMA G for the classic programme group vs. the results of the VR and CVR groups. On the other hand, the OCULUS group held significantly higher scores in individual balance and TUG, as compared to the other groups (p < 0.001). Making use of a virtual reality (VR) environment in the physiotherapeutic management of community-dwelling older adults appreciably enhanced individual functional performance, especially in terms of static balance. Physiotherapy management aided by VR technology solutions offers a viable alternative to traditional physiotherapeutic regimens (e.g., OTAGO programme) in enhancing individual functional performance. The innovatively self-designed VIRTUAL REALITY COMPREHENSIVE REHABILITATION ROOMS (VRCRR) solution may help out in pursuing a complex physiotherapy programme on an individual basis within one's own home environment.





## Table 3: Mental Health Care

Citation	Abstract
Antici EE, Kuhlman KR,	Background: Social anxiety disorder (SAD) places a profound burden on public
Treanor M, Craske MG.	health and individual wellbeing. Systemic inflammation may be important to the
Salivary CRP predicts	onset and maintenance of SAD, and anti-inflammatory treatments have shown
treatment response to virtual	promise in relieving symptoms of SAD. In the present study, we conducted
reality exposure therapy for	secondary analyses on data from a randomized clinical trial to determine
social anxiety disorder.	whether C-reactive protein (CRP) concentrations and social anxiety symptoms
Brain, Behavior, and	decreased over the course of virtual reality exposure therapy, and whether
Immunity. 2024;118:300-	changes in social anxiety symptoms as a function of treatment varied as a
309.	function of CRP. <b>Method:</b> Adult participants (N = 78) with a diagnosis of SAD
doi:10.1016/j.bbi.2024.03.00	(59 % female) were randomized to receive exposure therapy alone, or exposure
2	therapy supplemented with scopolamine. Social anxiety symptoms, salivary
	CRP, and subjective units of distress were measured across three exposure
	therapy sessions, at a post-treatment extinction retest, and at a 1-month follow-
	up. <b>Results:</b> CRP decreased over the course of treatment, $b = -0.03$ (SE = 0.01),
	p =.02 95 %CI [–0.06, –0.004], as did all social anxiety symptom domains and
	subjective distress. Higher CRP was associated with greater decreases from pre-
	treatment to 1-month follow-up in fear, b = $-0.45$ (SE = 0.15), p = .004 95 %CI
	[−0.74, −0.15], and avoidance, b = −0.62 (SE = 0.19), p =.002 95 %CI [−1.01,
	-0.23], and in-session subjective distress from pre-treatment to post-treatment,
	b = -0.42 (SE = 0.21), p =.05 95 %CI [-0.83, -0.001]. However, declines in CRP
	were not correlated with declines in fear, $r = -0.07$ , p =.61, or avoidance,
	r = $-0.10$ , p = .49, within-persons. <b>Conclusions:</b> Virtual reality exposure therapy
	may be associated with an improvement in systemic inflammation in patients
	with severe SAD. Pre-treatment CRP may also be of value in predicting which
	patients stand to benefit the most from this treatment.





Atuel HR, Kintzle S.	Objective: The present study compares the effectiveness of a standardized
Comparing the training	peer-to-peer role play (RP) and a virtual client-trainer (VC-T) in training graduate-
effectiveness of virtual	level students in the development of interviewing and clinical skills related to
reality and role play among	working with the military population. The study examines each training modality
future mental health	in six areas: (a) self-efficacy, (b) initial engagement, (c) recognizing and
providers. Psychol Trauma.	responding to symptoms of posttraumatic stress disorder, (d) recognizing and
2021;13(6):657-664.	responding to symptoms of suicide, (e) military cultural competence, and (f)
doi:10.1037/tra0000997	overall competence. <b>Method:</b> A quasi-experimental nonequivalent groups study
	design was used. The sample comprised students enrolled in a graduate-level
	program (RP = 61; VC-T = 75). Participants completed pretest measures,
	attended training, and completed posttest measures. <b>Results:</b> Broadly, the
	findings revealed that RP and the VC-T are equally effective in increasing
	trainees' self-efficacy, recognition and response to posttraumatic stress
	disorder symptoms, recognition and response to suicide symptoms, military
	cultural competence, and overall competence. These results suggest that
	regardless of training modality, trainees demonstrated increased clinical skills
	and competencies needed for working with the military population.
	<b>Conclusions:</b> The results suggest that both RP and the VC-T are equally
	effective, which opens the possibilities of implementing the VC-T as a training
	tool that has greater reach compared with RP. As more graduate programs offer
	an online version of their traditional on-ground coursework, the VC-T is an
	opportunity to have 1 training platform for both on-ground and online students.
Beidel DC, Frueh BC, Neer	Virtual reality exposure therapy (VRET) realistically incorporates traumatic cues
SM, et al. Trauma	into exposure therapy and holds promise in the treatment of combat-related
management therapy with	posttraumatic stress disorder (PTSD). In a randomized controlled trial of 92 Iraq
virtual-reality augmented	and Afghanistan veterans and active duty military personnel with combat-
exposure therapy for	related PTSD, we compared the efficacy of Trauma Management Therapy (TMT;
combat-related PTSD: A	VRET plus a group treatment for anger, depression, and social isolation) to VRET
randomized controlled trial.	plus a psychoeducation control condition. Efficacy was evaluated at mid- and
Journal of Anxiety Disorders.	post-treatment, and at 3- and 6-month follow-up. Consistent with our
2019;61:64-74.	hypothesis, VRET resulted in significant decreases on the Clinician Administered
doi:10.1016/j.janxdis.2017.0	PTSD Scale and the PTSD Checklist-Military version for both groups. Also
8.005	consistent with our hypothesis, significant decreases in social isolation
	occurred only for those participants who received the TMT group component.
	There were significant decreases for depression and anger for both groups,
	although these occurred after VRET and before group treatment. All treatment
	gains were maintained six-months later. Although not part of the original
	hypotheses, sleep was not improved by either intervention and remained
	problematic. The results support the use of VRET as an efficacious treatment for
	combat-related PTSD, but suggest that VRET alone does not result in optimal
	treatment outcomes across domains associated with PTSD.





Beidel DC, Frueh BC, Neer SM, Lejuez CW. The efficacy of Trauma Management Therapy: A controlled pilot investigation of a three-week intensive outpatient program for combat-related PTSD. *Journal of Anxiety Disorders*. 2017;50:23-32. doi:10.1016/j.janxdis.2017.0 5.001

Despite the 8–18.5% of returning Operation Iraqi Freedom (OIF), Operation Enduring Freedom (OEF) and Operation New Dawn (OND) veterans who are suffering from posttraumatic stress disorder (PTSD), few receive empirically supported treatments. Among those that do, the dropout rate is high and more than 50% retain their diagnosis after treatment. This study evaluated the efficacy of Trauma Management Therapy (TMT), delivered in a 3-week intensive outpatient (IOP) format. TMT combines virtual-reality augmented individual exposure therapy with a group intervention to address social isolation, anger, and depression. One hundred twelve (112) OIF/OEF/OND veterans and active duty personnel participated. Assessment included measures of PTSD, sleep, depression, anger, guilt, and social isolation, administered at post-treatment, 3month, and 6-month follow-up. The effect size for TMT delivered in an IOP format was 2.06, with 65.9% no longer meeting diagnostic criteria for PTSD. There were similar positive effects in other domains and treatment gains were maintained at 6-month follow-up. The results are discussed regarding the need for efficacious, multi-component interventions that can be delivered safely and rapidly, and the potential of this approach towards that end.





Borisova N, Moore N, Sira Mahalingappa S, et al. Virtual Reality-Based Interventions for Treating Depression in the Context of COVID-19 Pandemic: Inducing the Proficit in Positive Emotions as a Key Concept of Recovery and a Path Back to Normality. *Psychiatr Danub*. 2022;34(Suppl 8):276-284. Background: During the COVID-19 pandemic as much as 40% of the global population reported deterioration in depressive mood, whereas 26% experienced increased need for emotional support. At the same time, the availability of on-site psychiatric care declined drastically because of the COVID-19 preventive social restriction measures. To address this shortfall, telepsychiatry assumes a greater role in mental health care services. Among various on-line treatment modalities, immersive virtual reality (VR) environments provide an important resource for adjusting the emotional state in people living with depression. Therefore, we reviewed the literature on VR-based interventions for depression treatment during the COVID-19 pandemic. **Subjects and methods:** We searched the PubMed and Scopus databases, as well as the Internet, for full-length articles published during the period of 2020-2022 citing a set of following key words: "virtual reality", "depression", "COVID-19", as well as their terminological synonyms and word combinations. The inclusion criteria were: 1) the primary or secondary study objectives included the treatment of depressive states or symptoms; 2) the immersive VR intervention used a head-mounted display (HMD); 3) the article presented clinical study results and/or case reports 4) the study was urged by or took place during the COVID-19-associated lockdown period. Results: Overall, 904 records were retrieved using the search strategy. Remarkably, only three studies and one case report satisfied all the inclusion criteria elaborated for the review. These studies included 155 participants: representatives of healthy population (n=40), a case report of a patient with major depressive disorder (n=1), patients with cognitive impairments (n=25), and COVID-19 patients who had survived from ICU treatment (n=89). The described interventions used immersive VR scenarios, in combination with other treatment techniques, and targeted depression. The most robust effect, which the VR-based approach had demonstrated, was an immediate post-intervention improvement in mood and the reduction of depressive symptoms in healthy population. However, studies showed no significant findings in relation to both short-term effectiveness in treatment of depression and primary prevention of depressive symptoms. Also, safety issues were identified, such as: three participants developed mild adverse events (e.g., headache, "giddiness", and VR misuse behavior), and three cases of discomfort related to wearing a VR device were registered. Conclusions: There has been a lack of appropriately designed clinical trials of the VR-based interventions for depression since the onset of the COVID-19 pandemic. Moreover, all these studies had substantial limitations due to the imprecise study design, small sample size, and minor safety issues, that did not allow us making meaningful judgments and conclude regarding the efficacy of VR in the treatment of depression, taking into account those investigations we have retrieved upon the inclusion criteria of our particularistic review design. This may call for randomized, prospective studies of the short-term and long-lasting effect of VR modalities in managing negative affectivity (sadness, anxiety, anhedonia, selfguilt, ignorance) and inducing positive affectivity (feeling of happiness, joy, motivation, self-confidence, viability) in patients suffering from clinical depression.





Bridge P, Mehta J, Keane P, et al. A virtual reality environment for supporting mental wellbeing of students on remote clinical placement: A multi-methods evaluation. *Nurse Education Today*. 2024;138:106184. doi:10.1016/j.nedt.2024.106 184 Background: Nursing and Allied Health Profession (NAHP) students undertake clinical placements as part of their pre-registration training. The remote nature of some placement sites, shiftwork and the emotionally challenging nature of the workload has led to mental wellbeing issues in many students. Aim: This project aimed to evaluate a novel 3D immersive virtual reality environment that supports mental wellbeing for NAHP students on clinical placement. It comprises a calming 3D tropical beach environment where students and tutors can meet for reflection and mutual support. Design: A multi-methods design gathered quantitative impact data with validated measurement tools and qualitative output related to the lived experience of students. Settings and participants: All 600 pre-registration NAHP students within the institution undertaking clinical placements were invited to participate, irrespective of mental wellbeing status. Students were randomly assigned to either a VR or Conventional cohort; all participants received the control support mechanism in a subsequent placement. Methods: All participants completed an initial demographic and Readiness for Therapy survey followed by weekly Beck Anxiety and Depression Inventories during placement. All participants were invited to a semi-structured interview. Results: Overall, 32 participants engaged with the application; although the VR cohort demonstrated improved scores on both Beck inventories, these were not statistically significant. This is probably due to the low response rate for the control cohort. A total of 15 interviews were conducted and several themes emerged from the data in relation. to both experiential outcomes (escapism, anonymity and sense of community) and instrumental outcomes (calming, mindfulness and combatting loneliness). Conclusions: User feedback indicates that a VR environment can provide a calming escape from the pressures and anxiety arising from clinical placement for healthcare students. The relaxing beach environment facilitated mindfulness meditation and the additional opportunities for pseudo-anonymous interactions with peers and tutors were well received by students.





Brimelow RE, Thangavelu K,	Objectives: To assess the feasibility of using group-based fully immersive virtual
Beattie R, Dissanayaka NN.	reality (VR) across multiple sessions to reduce behavioral and psychological
Feasibility of Group-Based	symptoms (BPSs), including depression, anxiety, and agitated behaviors, in
Multiple Virtual Reality	cognitively diverse aged care residents. <b>Design:</b> A 6-session feasibility trial was
Sessions to Reduce	conducted within a residential aged care facility using convenience sampling to
Behavioral and	recruit N = 25 residents of varying cognitive capacity. Groups of 5 residents
Psychological Symptoms in	viewed 360-degree videos on a wireless head-mounted display to provide fully
Persons Living in Residential	immersive VR experiences. Setting and participants: Half of the participants
Aged Care. Journal of the	recruited from the 160-bed facility had a diagnosis of dementia (48%), whereas
American Medical Directors	assessment with the Psychogeriatric Assessment Scale for cognitive impairment
Association. 2022;23(5):831-	revealed that 64% experienced cognitive impairment (mild 20%, moderate 16%,
837.e2.	and severe 28%). Additionally, 32% of participants had an existing anxiety or
doi:10.1016/j.jamda.2021.07	depression diagnosis. <b>Measures:</b> The Cornell Scale for Depression in Dementia,
.026	Generalized Anxiety Disorder 7-item, and Cohen Mansfield Agitation Inventory–
	Short were used to assess changes in persisting BPS pre- to postintervention
	period. The Person-Environment Apathy Rating apathy subscale, Observed
	Emotions Rating Scale, and a visual analog scale (Smileometer) were used to
	assess immediate mood responses from residents at every VR session. VR
	tolerability and resident feedback was also recorded. <b>Results:</b> Pleasure
	(z = $-5.892$ , P < .001) and general alertness (z = $-2.455$ , P = .014) of participants
	improved at VR sessions, whereas apathy diminished (z = $-5.275$ , P < .001).
	Compared to baseline, post-intervention depression was significantly lowered
	(z = -2.60, P = .009), whereas agitation increased $(z = -2.98, P = .003)$ . No
	significant changes in anxiety were observed. The quality of 360-degree videos
	and the device used did not induce any major VR-related negative side effects.
	<b>Conclusions and implications:</b> Overall group-based VR reduced depressive
	symptoms and apathy, and induced a positive emotional response in most
	residents, with few observed side effects. Results indicate feasibility of group-
	based VR technological innovation within RAC.





Brite II. Dham T. Visanta B	The size of this study was to determine the increasive virtual reality based
Brito H, Pham I, Vicente B.	The aim of this study was to determine the immersive virtual reality-based
Effect of sensorimotor	sensorimotor renabilitation (IVR-SRB) effect on mental nealth (global mental
renabilitation based on an	nealth, depression, anxiety and well-being) in older adults. Methods: This study
immersive virtual reality	was experimental, with a sample of 111 older adults (control-experimental),
model on mental health. Int J	considering an application of IVR-SRB in four different virtual settings with
Geriatr Psychiatry. Published	exteroceptive synchronization, proprioceptive and vestibular stimuli, for 6
online April 2, 2021.	weeks. <b>Outcome variables:</b> symptoms associated with depression and anxiety;
doi:10.1002/gps.5541	positive mental health (psychological well-being). A descriptive and inferential
	approach was used to analyze the data, and the ANCOVA test was used to
	compare the post-intervention groups, controlled by the baseline; In case of
	baseline moderation, a linear regression model was applied to identify the level
	of moderation and a region of significance analysis. <b>Results:</b> An IVR-SRB
	positive net effect was found in the reduction of symptoms of global mental
	health ( $p < 0.0001$ ) and depression ( $p < 0.0001$ ), without baseline moderation.
	The anxiety scores showed moderation at the beginning (p < 0.0001; b = -0.53),
	identifying that the greater the presence of anxiety symptoms, the greater the
	effect of IVR-SRB in reducing these symptoms; its effect is present from scores
	of 2.9 (Goldberg-12). There were no changes in well-being. <b>Conclusion:</b> IVR-SRB
	is recognized as a great intervention tool among elderly population, showing its
	multidimensional approach capacity, properly responding to the reduction of
	symptoms associated with mental disorders.
Brungardt A. Wibben A.	<b>Background:</b> Music therapy (MT) and virtual reality (VR) have shown favorable
Tompkins AF. et al. Virtual	patient-reported outcomes during serious illness. <b>Objectives:</b> To evaluate
Reality-Based Music Therapy	implementation measures of feasibility, usability, and acceptability of a VR-
in Palliative Care: A Pilot	based MT intervention. <b>Design:</b> A pilot implementation study of a two-day VR-MT
Implementation Trial.	intervention using mixed methods. Patients created a personalized soundtrack
Palliat Med. 2021:24(5):736-	with a music therapist, and then paired the soundtrack with a 360° VB
742.	environment, Setting/Subjects: Hospitalized patients with palliative care
doi:10.1089/jpm.2020.0403	needs. <b>Results:</b> Of 23 patients (ages 20-74 years, 52% women), 17 completed
	the intervention, including 39% during an intensive care unit stay. Participants
	scored usability above average. For satisfaction, 53% chose the highest rating
	Most participants spoke favorably of VR-MT describing pleasant emotional and
	physical responses. Participants provided feedback on length frequency of use
	VB ontions and timing of delivery <b>Conclusion</b> . This VB-MT intervention was
	feasible usable and accentable for hospitalized nalliative care nations. Further
	study will test VR-MT outcomes
	זנועץ שונו נפסו אח-וידו טענטווופס.





Mueller-Spahn F. From toy to tool: the development of immersive virtual reality environments for psychotherapy of specific phobias. <i>Stud Health</i> <i>Technol Inform.</i> 1998;58:103-111.	technology itself has been available for more than ten years now, there is still a certain amount of uncertainty among researchers and users as to whether VR will one day fulfill all it's promises. In this chapter we are giving an overview of the implementation of the technology in our mental health research facility in Basel, Switzerland. The development of two applications for use with claustrophobic and acrophobic patients perspectively serves just as an example within this context. Some may say, the chapter is too much based on technical considerations. Strictly speaking, VR is pure technology, even knowing that this special form of technology has sensory, psychological and even philosophical implications not known from other human computer interfaces so far. As far as we are concerned, the development of the technology for use within the mental health sector has merely just begun. As today's mostly used immersive output devices (Head-mounted Displays, shutter glasses) do not have a satisfactory resolution, do restrict movements and prevent multi-user-capabilities, there will be a soar of mental health applications the day some or at least the most important of these obstacles have been overcome.
Campbell D. Lugger S. Sigler	<b>Background:</b> Alzheimer's Disease (AD) a type of dementia that interferes with
GS. Turkelson C. Increasing	memory, thinking, and behavior is the most common type of dementia. As a
awareness, sensitivity, and	result, it is a leading contributor to death and disability for those over the age of
empathy for Alzheimer's	65. Therefore, future nurses must have the knowledge and skills to manage
dementia patients using	patients with AD in any setting spanning the healthcare continuum. <b>Objective:</b>
simulation. Nurse Education	The goal of this project was to evaluate perceptions of awareness, knowledge
Today, 2021:98:104764	and sensitivity of future nurses concerning AD patients before and after
doi:10.1016/i.nedt.2021.104	participation in a simulated virtual reality dementia experience.
764	<b>Design/Participants:</b> A guasi-experimental repeated measure pre-post design
	was used with a convenience sample of 163 undergraduate baccalaureate
	nursing students from three different courses at large public university in the
	Midwest. <b>Methods:</b> Students were placed in teams of four to participate in a 45-
	minute interactive simulated virtual reality dementia experience. Each session
	started with a 15-minute team pre-briefing session, followed by a 10-minute
	individual simulation, which was then followed by a 30-minute team debriefing
	session facilitated by faculty using the Plus/ Delta debriefing technique. The
	Dementia Attitudes Scale (DAS), The Knowledge About Memory Loss and Care
	Test (KAML-C), and the Healthcare Tour Survey were administered pre/post
	participation. Qualitative data was also collected from student reflections.
	<b>Results:</b> Statistically significant changes (p < 0.001) were noted in the pre/post
	DAS survey and the Healthcare Tour Survey. No significant change was noted on
	the KAML-C, although there was a trend towards improvement. No differences
	were noted between courses on any of the surveys. <b>Conclusion:</b> Using a virtual
	reality dementia experience proved to be a valuable strategy to increase student
	perceptions of awareness, knowledge, and sensitivity of AD. Further exploration
	is warranted to establish how these may be further facilitated to translate into
	improved care for those with AD.




Castro CA. The US	This paper reviews the psychological health research conducted in the United
framework for	States in support of combat veterans from Iraq and Afghanistan, using the
understanding, preventing,	Military Psychological Health Research Continuum, which includes foundational
and caring for the mental	science, epidemiology, etiology, prevention and screening, treatment, follow-up
health needs of service	care, and services research. The review is limited to those studies involving
members who served in	combat veterans and military families. This review discusses perplexing issues
combat in Afghanistan and	regarding the impact of combat on the mental health of service members such
Iraq: a brief review of the	as risk and resilience factors of mental health, biomarkers of posttraumatic
issues and the research. Eur	stress syndrome (PTSD), mental health training, psychological screening,
J Psychotraumatol.	psychological debriefing, third location decompression, combat and suicide, the
2014;5:10.3402/ejpt.v5.2471	usefulness of psychotherapy and drug therapy for treating PTSD, role of
3. Published 2014 Aug 14.	advanced technology, telemedicine and virtual reality, methods to reduce
doi:10.3402/ejpt.v5.24713	stigma and barriers to care, and best approaches to the dissemination of
	evidence-based interventions. The mental health research of special
	populations such as women, National Guardsmen and reservists, and military
	families is also presented. The review concludes by identifying future areas of
	research.
Cheng Y, Wang Y, Zhao W.	The coronavirus (COVID-19) pandemic and recent economic recession have
Shared Virtual Reality	been impacting many people's mental health. The experience of social
Experiences during the	distancing created new hardships for people who already reported symptoms of
COVID-19 Pandemic:	depression or anxiety. In these circumstances, new technologies, such as
Exploring the Gratifications	immersive virtual reality (VR) videos, could serve as useful tools for facilitating
and Effects of Engagement	interactions, emotional sharing, and information processing within a virtual
with Immersive Videos. Int J	environment. In this study, researchers aimed to enrich the information
Environ Res Public Health.	processing literature by focusing on the uses and gratifications of 360-degree VR
2022;19(9):5056. Published	videos during the pandemic. Through employing survey research with 1422
2022 Apr 21.	participants located in the U.S. and structural equation modeling for data
doi:10.3390/ijerph19095056	analysis, this study found that five types of gratification, including utilitarian (i.e.,
	navigation), hedonic (i.e., enjoyment), sensual (i.e., realism), social (i.e.,
	community), and symbolic (i.e., coolness), significantly motivated users to use
	such immersive videos. Simultaneously, data demonstrated that these five
	types of gratification could influence users' cognitive engagement with virtual
	content. In addition, such VR engagement facilitated users' positive attitudes
	toward immersive videos and continued usage of them. The findings provided
	practical implications for COVID-19 global recovery as well.





Chiu HM, Hsu MC, Ouyang WC. Effects of incorporating virtual reality training intervention into health care	High prevalence of cognitive impairment in older adults coupled with often missed and delayed diagnosis of dementia has raised interest in the nonpharmacologic interventions such as virtual reality (VR) technology for cognitive training, prevention or risk reduction. The present study aimed to
wellbeing in older adults with cognitive impairment: A randomized controlled trial. International Journal of	of cognitive function measured with a cognitive test battery and improvement of quality of life in older adults with cognitive impairment in long-term care facilities. A 1-hour session which was implemented weekly over 8 weeks, targeted mainly the sustained and selective attention, memory, cognitive
Human-Computer Studies. 2023;170:102957. doi:10.1016/j.ijhcs.2022.102 957	functions, and rule deduction. Each VRCTI session comprised 12 different tasks with different difficulty levels: baseline, intermediate, and advanced. The passive control group received usual care. In this study, sixty older adults (mean age = 80.35) were recruited and randomly assigned to either VR or control groups. Accuracy, error, and repetition rates were measured in each accuracy
	groups. Accuracy, error, and repetition rates were measured in each session. Compared to the control group, the VR group improved significantly in the overall cognitive composite score, driven by processing speed, working memory and cognitive domains. The VR group also perceived significant improvements in quality of life. Our results show that VRCTI can improve cognitive function and quality of life. When this pragmatic and effective intervention is implemented jointly with regular health care for older adults, it can be an adequate supplement strategy in maintaining cognitive health and protecting against
	cognitive decline for cognitively impaired older adults.
Cieślik B, Juszko K, Kiper P, Szczepańska-Gieracha J. Immersive virtual reality as support for the mental health of elderly women: a randomized controlled trial. <i>Virtual Real</i> . Published online May 7, 2023. doi:10.1007/s10055-023- 00797-w	Several forms of virtual reality (VR) have shown promise in treating mental disorders. However, there is a lack of research investigating the use of multicomponent immersive VR. Therefore, this study aimed to evaluate the effectiveness of an immersive virtual reality (IVR) intervention that incorporated Japanese garden aesthetics, relaxation, and elements of Erickson's psychotherapy in alleviating depression and anxiety symptoms among elderly women. Sixty women with depressive symptoms were randomly assigned to one of two treatment groups. Both groups received eight (twice a week for four weeks) low-intensity general fitness training sessions. The IVR group ( $n = 30$ ) received eight additional VR-based relaxation. As outcome measures, the geriatric depression scale (GDS; primary) and Hospital Anxiety and Depression Scale (HADS; secondary) were administered before and after the interventions. The protocol was registered in the ClinicalTrials.gov PRS database (Registration number: NCT05285501). Patients receiving IVR therapy exhibited a greater significant reduction in the GDS (adjusted mean post-difference of 4.10; 95% CI = 2.27-5.93) and HADS (2.95; 95% CI = 0.98-4.92) scores than those receiving the control intervention. In conclusion, IVR with elements of psychotherapy, relaxation, and garden aesthetics may alleviate the severity of depression and
	anxiety symptoms in elderly women.





Concannon BJ, Esmail S, Roduta Roberts M. Immersive Virtual Reality for the Reduction of State Anxiety in Clinical Interview Exams: Prospective Cohort Study. *JMIR Serious Games*. 2020;8(3):e18313. Published 2020 Jul 9. doi:10.2196/18313 Background: Immersive virtual reality (VR) with head-mounted display was used to determine if clinical interview simulation could reduce the anxiety levels of first-year occupational therapy (OT) students as they prepared for upcoming Objective Structured Clinical Examinations (OSCEs). Anxiety among health science students is a potential problem that may diminish their performance during OSCEs. This investigation aimed to fill the gap in the literature regarding the effectiveness of VR to reduce anxiety in OT students. Objective: This investigation aimed to uncover the effectiveness of immersive VR in reducing state anxiety in OT students who were preparing for OSCEs. Methods: A prospective, experimental, nonrandomized controlled trial compared levels of state anxiety, test anxiety, and academic self-efficacy in two groups of first-year OT students; these levels were measured at four different time points by selfreported psychometric scales, analyzed with a mixed factorial analysis of variance (ANOVA). Members of Phase 1 (NoVR) were not exposed to the VR simulation and acted as a control group for members of Phase 2 (YesVR), who were exposed to the VR simulation. VR simulation featured a virtual clinic and a standardized patient who students could interview in natural language. Measures of student study strategies and previous experience with VR were also recorded. **Results:** A total of 49 participants-29 in the NoVR group and 20 in the YesVR group-showed that state anxiety had a rise-then-fall trend, peaking at the time point just before the OSCE. At that point, the YesVR students showed significantly less state anxiety than did the NoVR students (t<sub>46.19</sub>=2.34, P=.02, Cohen d=0.65,  $\eta p_2$ =0.105). The mean difference was 6.78 units (95% CI 0.96-12.61). In similar trends for both groups, student test anxiety remained relatively static across the time points, while academic self-efficacy continually increased. A moderate positive correlation was found for total time spent studying and peak state anxiety (NoVR r=.46, n=28, P=.01; YesVR r=.52, n=19, P=.02). Conclusions: This investigation shows evidence of immersive VR's capability to reduce state anxiety in OT students preparing for clinical practical exams. Immersive VR simulation, used for the reduction of anxiety in health science students, can potentially lead to a future of positive mental health change from the virtual to the real world.





Costanzo ME, Leaman S, Jovanovic T, et al. Psychophysiological response to virtual reality and subthreshold posttraumatic stress disorder symptoms in recently deployed military. <i>Psychosom Med</i> . 2014;76(9):670-677. doi:10.1097/PSY.00000000 0000109	<b>Objective:</b> Subthreshold posttraumatic stress disorder (PTSD) has garnered recent attention because of the significant distress and functional impairment associated with the symptoms as well as the increased risk of progression to full PTSD. However, the clinical presentation of subthreshold PTSD can vary widely and therefore is not clearly defined, nor is there an evidence-based treatment approach. Thus, we aim to further the understanding of subthreshold PTSD symptoms by reporting the use of a virtual combat environment in eliciting distinctive psychophysiological responses associated with PTSD symptoms in a sample of subthreshold recently deployed US service members. <b>Methods:</b> Heart rate, skin conductance, electromyography (startle), respiratory rate, and blood pressure were monitored during three unique combat-related virtual reality scenarios as a novel procedure to assess subthreshold symptoms in a sample of 78 service members. The Clinician-Administered PTSD Scale was administered, and linear regression analyses were used to investigate the relationship between symptom clusters and physiological variables. <b>Results:</b> Among the range of psychophysiological measures that were studied, regression analysis revealed heart rate as most strongly associated with Clinician-Administered PTSD Scale-based measures hyperarousal (R = 0.11, p = .035,) reexperiencing (R = 0.24, p = .001), and global PTSD symptoms (R = 0.17, p = .003). <b>Conclusions:</b> Our findings support the use of a virtual reality environment in eliciting physiological
Crescentini C, Chittaro L,	Several studies in the literature have shown positive psychophysical effects
Capurso V, Sioni R, Fabbro F.	during or immediately after mindfulness meditation. However, the extent to
Psychological and	which such positive effects are maintained in real-life, stressful contexts,
physiological responses to	remains unclear. This paper investigates the effects of an 8-week mindfulness-
stressful situations in	oriented meditation (MOM) program on the psychological and physiological
Differences between years	responses evoked by immersive virtual environments (IVEs) that simulate
billerences between users	emergency situations that may occur in the. Before and after the 8-week period,
meditation and controls	course were administered self-report measures of mindfulness and anyiety and
Computers in Human	acted in the IVEs while a set of physiological parameters were recorded
Behavior 2016:59:304-316	Responses of MOM participants to the immersive virtual experiences were
doi:10 1016/i chb 2016 02 0	different from those of controls. MOM participants showed increased
31	mindfulness and decreased anxiety levels. They also showed decreased heart
	rate and corrugator muscle activity while facing IVEs. We explain these results in
	terms of the awareness and acceptance components of mindfulness. More
	generally, the present experimental methods could also open up new lines of
	research that combine psychological and physiological indices with ecologically
	valid stimuli provided by IVEs in an effort to increase understanding of the
	impact of mindfulness meditation on realistic life situations.





Cunha CR, Nunes A,	Nowadays, there is a growing need for rehabilitation associated with
Fernandes PO, et al. Using	demographic changes and health trends, with an increase in the prevalence of
Virtual Reality in the	non-communicable diseases and an aging population. Although well-being is
Development of an Index-	classically associated with a set of physical activities, the reality of today's
Engine of Physical and	society often shows that there is a lack of time available to develop activities
Emotional Sustainability.	that promote well-being. This fact is aggravated in aging populations by less
Procedia Computer Science.	mobility and greater isolation. In this domain, information and communication
2022;196:426-433.	technologies have greatly contributed to helping healthcare providers to develop
doi:10.1016/j.procs.2021.12.	new understanding, measurement and action strategies that promote the
032	physical and emotional well-being of their patients. Accordingly, the role of
	Virtual Reality has been shown to be promising for the generation of well-being.
	This article, as part of a broader funding project, reviews the state of the art of
	the role that Virtual Reality has played in the promotion of well-being, being an
	exercise of conceptualization that converges in the proposal of a conceptual
	model - an Index-Engine of Physical and Emotional Sustainability, which will be
	prototyped and field tested in the future.
Deng W, Hu D, Xu S, et al.	<b>Background:</b> Virtual reality exposure therapy (VRET) for PTSD is an emerging
The efficacy of virtual reality	treatment of remarkable promise, but its efficacy and safety are still unclear.
exposure therapy for PTSD	Our aim was to investigate the efficacy of VRET for individuals with PTSD, and to
symptoms: A systematic	identify the potential moderating variables associated with interventions.
review and meta-analysis.	Methods: Literature search was conducted via PubMed, Embase, Web of
Journal of Affective	Science, Cochrane Library, PsycInfo, Science Direct, and EBSCO. We identified
Disorders. 2019;257:698-	18 studies on PTSD including 13 randomized controlled trials (RCTs; 654
709.	participants) and 5 single-group trials (60 participants). <b>Results:</b> The main
doi:10.1016/j.jad.2019.07.08	effects analysis showed a moderate effect size (g = 0.327, 95% CI: 0.105–0.550,
6	p<0.01) for VRET compared to control conditions on PTSD symptoms. Subgroup
	analysis revealed that the effects of VRET were larger when compared to inactive
	groups (g = 0.567) than active control groups (g = 0.017). This finding was in
	agreement with depressive symptoms. A dose–response relationship existed
	with more VRET sessions showing larger effects. There was a long-range effect of
	VRET on PTSD symptoms indicating a sustained decrease in PTSD symptoms at
	3-month follow-up (g = 0.697) and 6-month follow-up (g = 0.848). The single-
	group trials analysis revealed that the VRET intervention had a significant effect
	on PTSD. Limitations: Many of the combat-related PTSD subjects resulted in
	uncertainty regarding meta-analytical estimates and subsequent conclusions.
	<b>Conclusions:</b> These findings demonstrated that VRET could produce significant
	PTSD symptoms reduction and supported its application in treating PTSD.





Detez L, Greenwood LM,	During slot machine gambling, near-miss outcomes occur when the final
Segrave R, et al. A	winning icon lands one position off the pay-line. To understand how near-misses
Psychophysiological and	promote gambling behaviour in healthy populations, autonomic arousal is often
Behavioural Study of Slot	used to index outcome response valence. Findings remain equivocal, possibly
Machine Near-Misses Using	owing to the limited ecological validity of computer simulations. Relevant
Immersive Virtual Reality. J	psychological traits, such as impulsivity, which increase the risk of problem
Gambl Stud. 2019;35(3):929-	gambling, are often not examined. Here, we used immersive virtual reality (VR) to
944. doi:10.1007/s10899-	investigate near-miss-induced changes in physiological arousal and VR
018-09822-z	gambling behaviour. Sixty adult participants with no history of problem gambling
	were immersed in a VR casino-bar where they engaged with a self-selected slot
	machine. Real-time heart rate (HR) data were acquired during immersion.
	Within-subjects analyses were conducted on HR and post-reinforcement
	pauses (PRPs; i.e., time taken to initiate next-spin) across wins, losses and near-
	misses. Significant HR acceleration occurred for both near-misses and losses
	compared to wins, indexing an initial orientation response. Both types of losses
	were associated with faster next-spin responses. Near-misses did not
	apparently have unique HB or PRP profiles from losses, although this may reflect
	our loss control condition, which in itself may have been a subtler near-miss
	outcome Impulsivity measured by the SUPPS-P was not associated with near-
	miss responses. Losses may encourage gambling as participants experience
	more immediate HB acceleration (indexing arousal unique to losing) and initiate
	faster responses. Future studies should clarify this effect by investigating
	nrohlem gampling cohorts and develop VB paradigms taking into consideration
	the current findings and limitations
Fabuia IV Van Caldaran MI	<b>Background:</b> Virtual reality expects thereby (V/DET) and sugmented reality
Von Zuidon M. ot al. Efficacy	ovposure therapy (APET) are digitally assisted psychotherapies that potentially
of immorsive PTSD	exposure therapy (ANET) are digitally assisted psychotherapies that potentially
trootmonte: A systematic	enhance position and stress disorder (FISD) treatment by increasing a
roviow of virtual and	patient's sense of presence during exposure therapy. This study affect to
augmented reality experies	as PTSD treatment Methods: A systematic electronic database search a
thorapy and a mote analysis	as FISD treatment. <b>Methous.</b> A systematic electronic database search, a
of virtual reality expension	systematic quality assessment and two meta-analyses were conducted in
therepy lournal of	VET for DTSD (n = 429) were found but no studies on the officiency of ADET. The
Devenietrie Desserat	vice for the studies were of a low quality and had betarageneous results
	Mate analysis about AVDET sutrastermed weither sentral (standardized mean
2021;143:516-527.	Meta-analyses showed VRET outperformed waitlist control (standardized mean
dol:10.1016/J.Jpsychires.202	difference –0.64 (95% CI - 1.05 to –0.22)) while no significant difference was
0.11.030	found between VRET and active treatment conditions (standardized mean
	difference –0.25 (95% CI –0.77 to 0.27)). <b>Conclusion:</b> VRET was superior to
	waitlist control groups and as effective as other psychotherapies. However, the
	results showed considerable heterogeneity due to the low number of studies
	and variety of VRET methods. VRET may be an effective alternative to current
	treatments and shows promise for the treatment of PTSD patients that have not
	responded to previous treatment. Future research should focus on high quality
	RCTs, including information on side effects and adverse events, with sufficient
	RCTs, including information on side effects and adverse events, with sufficient numbers of participants. This study recognizes a research gap regarding the





Falconer CJ, Rovira A, King	Background: Self-criticism is a ubiquitous feature of psychopathology and can
JA, et al. Embodying self-	be combatted by increasing levels of self-compassion. However, some patients
compassion within virtual	are resistant to self-compassion. <b>Aims:</b> To investigate whether the effects of
reality and its effects on	self-identification with virtual bodies within immersive virtual reality could be
patients with	exploited to increase self-compassion in patients with depression. <b>Method:</b> We
depression, <i>BIPsych Open</i> .	developed an 8-minute scenario in which 15 patients practised delivering
2016:2(1):74-80. Published	compassion in one virtual body and then experienced receiving it from
2016 Feb 15	themselves in another virtual body <b>Besults</b> : In an open trial, three repetitions of
doi:10.1192/bino.bp.115.00	this scenario led to significant reductions in depression severity and self-
2147	criticism as well as to a significant increase in solf compassion from baseline
2147	to A week fellow up. Feur petiente chewed elipically eignificant improvement
	to 4-week follow-up. Four patients showed cunically significant improvement.
	<b>Conclusions:</b> The results indicate that interventions using immersive virtual
	reality may have considerable clinical potential and that further development of
	these methods preparatory to a controlled trial is now warranted.
Falconer CJ, Slater M, Rovira	Virtual reality has been successfully used to study and treat psychological
A, et al. Embodying	disorders such as phobias and posttraumatic stress disorder but has rarely been
compassion: a virtual reality	applied to clinically-relevant emotions other than fear and anxiety. Self-criticism
paradigm for overcoming	is a ubiquitous feature of psychopathology and can be treated by increasing
excessive self-	levels of self-compassion. We exploited the known effects of identification with
criticism. PLoS One.	a virtual body to arrange for healthy female volunteers high in self-criticism to
2014;9(11):e111933.	experience self-compassion from an embodied first-person perspective within
Published 2014 Nov 12.	immersive virtual reality. Whereas observation and practice of compassionate
doi:10.1371/journal.pone.01	responses reduced self-criticism, the additional experience of embodiment also
11933	increased self-compassion and feelings of being safe. The results suggest
	potential new uses for immersive virtual reality in a range of clinical conditions.
Fernández-Sotos P.	Background and objective: Psychosocial impairment in schizophrenia is
Fernández-Caballero A.	related to deficits in functioning and quality of life. Virtual reality (VR) is an
Rodriguez-limenez B Virtual	interesting tool that has been started to use in remediation therapies. The aim of
reality for psychosocial	this study is to carry out a systematic review to describe the state-of-the-art in
remediation in	VB for nsychosocial interventions in schizonbrenia <b>Methods:</b> Publications from
schizonhrenia: a systematic	1st January 2000 to 1st July 2019 on VR-based interventions for psychosocial
roviow The European Journal	romodiation in schizonhronia wara raviowed in five databases: PubMed, Sconus
of Psychiatry 2020:24(1):1	PayelNEO JEEE Valore and ACM Digital Library <b>Beaulta:</b> From the initial
10	resulting ast of 144 publications, a final number of 7 publications were included
	All of the second secon
doi:10.1016/j.ejpsy.2019.12.	All of them showed positive results in the main target explored. Four studies
003	focused on social skills, two studies were aimed at improving job interview skills
	and one focused on social cognition. Samples were variable (from a case report
	to 64 participants). Three studies compared the intervention with a control
	condition and two studies specified the use of immersive virtual reality.
	<b>Conclusions:</b> VR offers an interesting and promising therapeutic option for
	patients suffering from schizophrenia, although more studies are needed to
	clarify if interventions based on VR are more effective than classical
	interventions.





Folke S, Roitmann N, Poulsen S, Andersen SB. Feasibility of Virtual Reality Exposure Therapy in the Treatment of Danish Veterans with Post-Traumatic Stress Disorder: A Mixed Method Pilot Study. *Cyberpsychol Behav Soc Netw.* 2023;26(6):425-431. doi:10.1089/cyber.2022.023 6 The BraveMind virtual reality exposure therapy (VRET) has been developed and has shown efficacy for U.S. service members and veterans. As the first study to date, the present study examined the feasibility of BraveMind VRET for non-U.S. military veterans. Moreover, the study sought to explore in-depth the participants' experiences with BraveMind VRET. Nine Danish veterans with posttraumatic stress disorder (PTSD) after deployment to Afghanistan participated in the study. PTSD, depression, and quality of life were assessed at pretreatment, post-treatment, and 3-month followup. The treatment consisted of 10 BraveMind VRET sessions. Semistructured interviews with treatment completers were conducted post-treatment to ascertain views about the treatment, in general, and the BraveMind VR system in particular. Thematic qualitative analysis was conducted at the semantic level using an inductive approach. There were significant reductions in pre- to post-treatment self-reported PTSD and significant improvements in quality of life. Treatment gains were maintained at 3month followup. Pre- to post-treatment Cohen's d effect sizes were large for selfreported PTSD (PTSD Checklist-Civilian Version [PCL-C]: *d* = 1.55). Qualitative results indicated that the virtual environment of the BraveMind VR system does not entirely map the reality of Danish soldiers in Afghanistan. However, this was not experienced as a hindering factor in therapy. Findings indicate that BraveMind VRET is an acceptable, safe, and effective treatment for Danish veterans with PTSD. The qualitative results emphasize the importance of a strong therapeutic alliance, as VRET is experienced as more emotional straining than regular trauma-focused therapy.





Fortuna K, Hill J, Chalker S, Ferron J. Certified Peer Support Specialists Training in Technology and Delivery of Digital Peer Support Services: Cross-sectional Study. *JMIR Form Res*. 2022;6(12):e40065. Published 2022 Dec 7. doi:10.2196/40065

Background: When the COVID-19 pandemic lockdown measures were instituted, the wide-scale necessity for remote mental health care increased among professional clinicians, such as psychiatrists, psychologists, social workers, and certified peer support (CPS) specialists. Factors contributing to increased demand include concern for the safety of loved ones, the safety of oneself, overall well-being, unemployment, and loneliness for older individuals. While demand continues to increase and a shortage of mental health professionals persists, understanding the training, technology, media, and delivery of digital peer support services can facilitate community-based support services to assist patients in coping with mental health symptoms between clinical encounters with licensed professionals. Digital peer support consists of asynchronous and synchronous, live or automated, peer support services such as applications, social media, and phone calls. **Objective:** The purpose of this cross-sectional study is to determine how digital peer support is delivered, by which technologies it is delivered, and how certified digital peer supporters are trained within the United States to inform future delivery of digital peer support. Methods: We used an online cross-sectional self-report survey developed alongside certified peer specialists. The study included questions regarding the types of peer support training and the delivery methods used within their practices. We advertised the survey through a certified peer support specialist listserve, Facebook, and Twitter. Results: Certified peer specialists provide mutual social emotional support to those with a similar mental health condition. Of certified peer specialists trained in CPS, the majority of CPS specialists were trained in peer support (418/426, 98.1%). Peer support specialists deliver services via telephone calls (182/293, 62.1%), via videoconference-based services (160/293, 54.6%), via SMS text messages (123/293, 42%), via smartphone apps (68/293, 23.2%), and via social media (65/293, 22.2%). Certified peer specialists deliver services through virtual reality (11/293, 3.8%) and through video games (6/293, 2%). Virtual reality and video games may represent emerging technologies to develop and deliver community-based support. **Conclusions:** This study examined the modes of digital peer support intervention as well as the training and demographic background of peer supporters. Given the demand for mental health care, digital peer support emerges as one option to increase access. These results suggest that CPS specialists commonly use SMS text messaging, phone calls, and videoconferences to engage in peer support. Less frequently, they may use diverse modes such as apps, social media, and video games. It is important to consider the backgrounds of peer supporters and the mediums of communication to best accommodate areas where access to peer support is emerging. Larger longitudinal studies and a variety of experimental designs may be considered to understand the efficacy of digital interventions and digital peer support training to direct optimal care.





Freeman D, Haselton P, Freeman J, et al. Automated psychological therapy using immersive virtual reality for treatment of fear of heights: a single-blind, parallelgroup, randomised controlled trial. *Lancet Psychiatry*. 2018;5(8):625-632. doi:10.1016/S2215-0366(18)30226-8 Background: Engaging, interactive, and automated virtual reality (VR) treatments might help solve the unmet needs of individuals with mental health disorders. We tested the efficacy of an automated cognitive intervention for fear of heights guided by an avatar virtual coach (animated using motion and voice capture of an actor) in VR and delivered with the latest consumer equipment. Methods: We did a randomised trial of automated VR versus usual care. We recruited adults aged older than 18 years with a fear of heights by radio advertisements in Oxfordshire, UK. We diagnosed fear of heights if participants scored more than 29 on the Heights Interpretation Questionnaire (HIQ). We randomly allocated participants by computer in a 1:1 ratio to either automated VR delivered in roughly six 30-min sessions administered about two to three times a week over a 2-week period (intervention group) or to usual care (control group). Randomisation was stratified by severity of fear of heights. The research team, who were unaware of the random allocation, administered three fear-ofheight assessments, at baseline (0 weeks), at the end of treatment (2 weeks), and at follow-up (4 weeks). The primary outcome measure was HIQ score (range 16-80, with higher scores indicating greater severity). This trial is registered with the ISRCTN registry, number ISRCTN11898283. Findings: Between Nov 25, 2017, and Feb 27, 2018, 100 individuals were enrolled and underwent randomisation, of whom 49 were assigned to the VR treatment group and 51 to the control group. All participants completed the 4-week follow-up. The mean total treatment time in VR was 124.43 min (SD 34.23). Compared with participants in the control group, the VR treatment reduced fear of heights at the end of treatment (mean change score -24.5 [SD 13.1] in the VR group vs -1.2 [7.3] in the control group; adjusted difference -24.0, 95% CI -27.7 to -20.3; Cohen's d=2.0; p<0.0001). The benefit was maintained at follow-up (mean change score -25.1 [SD 13.9] in the VR group vs -1.5 [7.8] in the control group; adjusted difference -24.3, 95% CI -27.9 to -20.6; Cohen's d=2.0; p<0.0001). The number needed to treat to at least halve the fear of heights was 1.3. No adverse events were reported. Interpretation: Psychological therapy delivered automatically by a VR coach can produce large clinical benefits. Evidence-based VR treatments have the potential to greatly increase treatment provision for mental health disorders.





Freeman D, Lambe S, Kabir T, et al. Automated virtual reality therapy to treat agoraphobic avoidance and distress in patients with psychosis (gameChange): a multicentre, parallel-group, single-blind, randomised, controlled trial in England with mediation and moderation analyses. *The Lancet Psychiatry*. 2022;9(5):375-388. doi:10.1016/S2215-0366(22)00060-8 Background: Automated delivery of psychological therapy using immersive technologies such as virtual reality (VR) might greatly increase the availability of effective help for patients. We aimed to evaluate the efficacy of an automated VR cognitive therapy (gameChange) to treat avoidance and distress in patients with psychosis, and to analyse how and in whom it might work. Methods: We did a parallel-group, single-blind, randomised, controlled trial across nine National Health Service trusts in England. Eligible patients were aged 16 years or older, with a clinical diagnosis of a schizophrenia spectrum disorder or an affective diagnosis with psychotic symptoms, and had self-reported difficulties going outside due to anxiety. Patients were randomly assigned (1:1) to either gameChange VR therapy plus usual care or usual care alone, using a permuted blocks algorithm with randomly varying block size, stratified by study site and service type. gameChange VR therapy was provided in approximately six sessions over 6 weeks. Trial assessors were masked to group allocation. Outcomes were assessed at 0, 6 (primary endpoint), and 26 weeks after randomisation. The primary outcome was avoidance of, and distress in, everyday situations, assessed using the self-reported Oxford Agoraphobic Avoidance Scale (O-AS). Outcome analyses were done in the intention-to-treat population (ie, all participants who were assigned to a study group for whom data were available). We performed planned mediation and moderation analyses to test the effects of gameChange VR therapy when added to usual care. This trial is registered with the ISRCTN registry, 17308399. Findings: Between July 25, 2019, and May 7, 2021 (with a pause in recruitment from March 16, 2020, to Sept 14, 2020, due to COVID-19 pandemic restrictions), 551 patients were assessed for eligibility and 346 were enrolled. 231 (67%) patients were men and 111 (32%) were women, 294 (85%) were White, and the mean age was 37.2 years (SD 12.5). 174 patients were randomly assigned to the gameChange VR therapy group and 172 to the usual care alone group. Compared with the usual care alone group, the gameChange VR therapy group had significant reductions in agoraphobic avoidance (O-AS adjusted mean difference -0.47, 95% CI -0.88 to -0.06; n=320; Cohen's d -0.18; p=0.026) and distress (-4·33, -7·78 to -0·87; n=322; -0·26; p=0·014) at 6 weeks. Reductions in threat cognitions and within-situation defence behaviours mediated treatment outcomes. The greater the severity of anxious fears and avoidance, the greater the treatment benefits. There was no significant difference in the occurrence of serious adverse events between the gameChange VR therapy group (12 events in nine patients) and the usual care alone group (eight events in seven patients; p=0.37). Interpretation: Automated VR therapy led to significant reductions in anxious avoidance of, and distress in, everyday situations compared with usual care alone. The mediation analysis indicated that the VR therapy worked in accordance with the cognitive model by reducing anxious thoughts and associated protective behaviours. The moderation analysis indicated that the VR therapy particularly benefited patients with severe agoraphobic avoidance, such as not being able to leave the home unaccompanied. gameChange VR therapy has the potential to increase the provision of effective psychological therapy for





	psychosis, particularly for patients who find it difficult to leave their home, visit
	local amenities, or use public transport.
Frost S, Kannis-Dymand L,	Immersion in nature provides various psychological benefits to well-being.
Schaffer V, et al. Virtual	Recent research examines whether these benefits can be replicated in virtual
immersion in nature and	reality (VR). This study aimed to systematically review the literature on the
psychological well-being: A	psychological effects on well-being of virtual immersion in nature. Databases
systematic literature review.	searched included Scopus, EBSCO, Web of Science, Psychnet, and Pubmed
Journal of Environmental	with inclusion of peer reviewed articles published in English, between 2015 and
Psychology.	2020 (inclusive to July 2020), in which the research design includes VR-based
2022;80:101765.	immersion in nature. A total of 21 quantitative studies were identified. Within
doi:10.1016/j.jenvp.2022.10	these articles, most employed quantitative research methodologies within an
1765	experimental design. In regard to psychological well-being, some evidence
	suggests that virtual immersion in nature significantly decreases negative affect.
	Conversely, other research found no change or an increase in negative affect.
	Generally, no significant differences were noted for positive affect. Physiological
	indicators of stress responses to virtual immersion in nature varied. Overall.
	research exploring the use of virtual reality immersion in nature is limited and the
	replication of the potential benefits gained from real immersion in nature is
	poorly understood. Future research is required to advance understanding and
	knowledge of the outcomes of virtual immersion in nature on human well-being
Găină MA. Szalontav AS.	<b>Background:</b> Colonoscopy related fear impairs the current gold standard
Stefănescu G. et al. State-of-	screening of colorectal cancer. Compared to other minimally invasive
the-Art Review on Immersive	procedures for cancer screening, colonoscopy-induced anxiety exceeds the
Virtual Reality Interventions	procedure through bowel preparation. Immersive virtual reality's (iVR) role in
for Colonoscopy-Induced	alleviating the complex stress-pain relationship encountered during medical
Anxiety and Pain. J Clin Med.	procedures is directly proportional to the rising affordability of state-of-the-art
2022:11(6):1670. Published	Head-Mounted-Displays (HMDs). <b>Objective:</b> to assess the effect of iVR on
2022 Mar 17.	patients' colonoscopy-induced anxiety and pain. Materials and methods: A
doi:10.3390/icm11061670	systematic search was conducted in PubMed. Cochrane Central Register of
	Controlled Trials. Web of Science. Embase and Scopus databases up to January
	2022. Clinical trials evaluating anxiety as an outcome were included without
	language restriction <b>Besults:</b> Four clinical trials were included: three on the
	nations' intraprocedural anxiety and one on nations education. Intraprocedural
	iVB interventions for colonoscopy-induced anxiety and pain revealed a similar
	effect as conventional sedation, while a statistically significant reduction was
	reported for non-sedated natients, iVR natient education improved the quality of
	howel preparation and reduced patient anxiety before colonoscopy
	<b>Conclusions:</b> The current research highlights the need to use high-end HMDs
	and appropriate interactive iVR software content for colonoscopy-induced
	any appropriate interactive intractive content for colonoscopy-induced
	double blinding and randomization of iVP studios can facilitate the doubles
	of iVP implementation for anyioty and poin management
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Garcia LM, Birckhead BJ, Krishnamurthy P, et al. Three-Month Follow-Up Results of a Double-Blind, Randomized Placebo- Controlled Trial of 8-Week Self-Administered At-Home Behavioral Skills-Based Virtual Reality (VR) for Chronic Low Back Pain. <i>The</i> <i>Journal of Pain</i> . 2022;23(5):822-840. doi:10.1016/j.jpain.2021.12. 002	Prior work established post-treatment efficacy for an 8-week home-based therapeutic virtual reality (VR) program in a double-blind, parallel arm, randomized placebo-controlled study. Participants were randomized 1:1 to 1 of 2 56-day VR programs: 1) a therapeutic immersive pain relief skills VR program; or 2) a Sham VR program within an identical commercial VR headset. Immediate post-treatment results demonstrated clinically meaningful and superior reduction for therapeutic VR compared to Sham VR for average pain intensity, indices of pain-related interference (activity, mood, stress but not sleep), physical function, and sleep disturbance. The objective of the current report was to quantify treatment effects to post-treatment month 3 and describe durability of effects. Intention-to-treat analyses revealed sustained benefits for both groups and superiority for therapeutic VR for pain intensity and multiple indices of pain-related interference (activity, stress, and newly for sleep; effect sizes ranged from drm = .56–.88) and physical function from pre-treatment to post-treatment month 3. The between-group difference for sleep disturbance was non-significant and pain-interference with mood did not survive multiplicity correction at 3 months. For most primary and secondary outcomes, treatment effects for therapeutic VR showed durability, and maintained superiority to Sham VR in the 3-month post-treatment period. Perspective: We present 3-month follow-up results for 8-week self-administered therapeutic virtual reality
	(VR) compared to Sham VR in adults with chronic low back pain. Across multiple pain indices, therapeutic VR had clinically meaningful benefits, and superiority over Sham VR. Home-based, behavioral skills VR yielded enduring analgesic
	benefits; longer follow-up is needed.
Garcia-Rodriguez O, Pericot- Valverde I, Gutiérrez- Maldonado J, Ferrer-García M, Secades-Villa R. Validation of smoking- related virtual environments for cue exposure therapy. <i>Addictive Behaviors</i> . 2012;37(6):703-708. doi:10.1016/j.addbeh.2012. 02.013	Craving is considered one of the main factors responsible for relapse after smoking cessation. Cue exposure therapy (CET) consists of controlled and repeated exposure to drug-related stimuli in order to extinguish associated responses. The main objective of this study was to assess the validity of 7 virtual reality environments for producing craving in smokers that can be used within the CET paradigm. Forty-six smokers and 44 never-smokers were exposed to 7 complex virtual environments with smoking-related cues that reproduce typical situations in which people smoke, and to a neutral virtual environment without smoking cues. Self-reported subjective craving and psychophysiological measures were recorded during the exposure. All virtual environments with smoking-related cues were able to generate subjective craving in smokers, while
	psychophysiological variable to craving increases was heart rate. The findings provide evidence of the utility of virtual reality for simulating real situations capable of eliciting craving. We also discuss how CET for smoking cessation can be improved through these virtual tools.





Geraets CNW, Van Der	Immersive virtual reality (VR) has been identified as a potentially revolutionary
Stouwe ECD, Pot-Kolder R,	tool for psychological interventions. This study reviews current advances in
Veling W. Advances in	immersive VR-based therapies for mental disorders. VR has the potential to
immersive virtual reality	make psychiatric treatments better and more cost-effective and to make them
interventions for mental	available to a larger group of patients. However, this may require a new
disorders: A new reality?	generation of VR therapeutic techniques that use the full potential of VR, such as
Current Opinion in	embodiment, and self-led interventions. VR-based interventions are promising,
Psychology. 2021;41:40-45.	but further well-designed studies are needed that use novel techniques and
doi:10.1016/j.copsyc.2021.0	investigate efficacy, efficiency, and cost-effectiveness of VR interventions
2.004	compared with current treatments. This will be crucial for implementation and
	dissemination of VR in regular clinical practice.
Gillespie GL, Farra S, Regan	<b>Background:</b> Virtual reality has promise as a training method within the affective
SL, Brammer SV. Impact of	domain, but investigation is still needed for intention to change behaviors based
immersive virtual reality	on social determinants of health. <b>Objective:</b> The objective of this study was to
simulations for changing	describe the self-reported changes in knowledge and/or attitudes and planned
knowledge, attitudes, and	behavior changes by healthcare workers for their future care of persons with
behaviors. Nurse Education	challenges to their social determinants of health following completion of a first-
<i>Today</i> . 2021;105:105025.	person virtual reality experience. <b>Design:</b> A descriptive qualitative design was
doi:10.1016/j.nedt.2021.105	used. <b>Settings:</b> This study was conducted in clinics and private practice settings
025	in Ohio (United States). <b>Participants:</b> This study was conducted with 206
	healthcare workers. Methods: Participants completed a virtual reality
	simulation followed by qualitative, open-ended questions about changes to their
	knowledge, attitudes, and behaviors. Responses were analyzed using a content
	analysis method. <b>Results:</b> Four overarching themes were derived from the
	qualitative data: (1) Acknowledgement of Social Determinants of Health, (2) An
	Improved Provider Experience for Patients, (3) Patient as a Person with Complex
	Needs, and (4) The Learning Experience. <b>Conclusion:</b> Findings suggest virtual
	reality has strong merits for impacting affective domain of learning
	demonstrated by increased empathy. Virtual reality along with increased
	empathy also helps improve attitudes and behaviors for the betterment of
	patients.





González-Gualda LM, Vicente-Querol MA, García AS, et al. An exploratory study of the effect of age and gender on face scanning during affect recognition in immersive virtual reality. *Sci Rep*. 2024;14(1):5553. Published 2024 Mar 6. doi:10.1038/s41598-024-55774-3 A person with impaired emotion recognition is not able to correctly identify facial expressions represented by other individuals. The aim of the present study is to assess eyes gaze and facial emotion recognition in a healthy population using dynamic avatars in immersive virtual reality (IVR). For the first time, the viewing of each area of interest of the face in IVR is studied by gender and age. This work in healthy people is conducted to assess the future usefulness of IVR in patients with deficits in the recognition of facial expressions. Seventy-four healthy volunteers participated in the study. The materials used were a laptop computer, a game controller, and a head-mounted display. Dynamic virtual faces randomly representing the six basic emotions plus neutral expression were used as stimuli. After the virtual human represented an emotion, a response panel was displayed with the seven possible options. Besides storing the hits and misses, the software program internally divided the faces into different areas of interest (AOIs) and recorded how long participants looked at each AOI. As regards the overall accuracy of the participants' responses, hits decreased from the youngest to the middle-aged and older adults. Also, all three groups spent the highest percentage of time looking at the eyes, but younger adults had the highest percentage. It is also noteworthy that attention to the face compared to the background decreased with age. Moreover, the hits between women and men were remarkably similar and, in fact, there were no statistically significant differences between them. In general, men paid more attention to the eyes than women, but women paid more attention to the forehead and mouth. In contrast to previous work, our study indicates that there are no differences between men and women in facial emotion recognition. Moreover, in line with previous work, the percentage of face viewing time for younger adults is higher than for older adults. However, contrary to earlier studies, older adults look more at the eyes than at the mouth. Consistent with other studies, the eyes are the AOI with the highest percentage of viewing time. For men the most viewed AOI is the eyes for all emotions in both hits and misses. Women look more at the eyes for all emotions, except for joy, fear, and anger on hits. On misses, they look more into the eyes for almost all emotions except surprise and fear.





Gray E, Erickson M, Bindler	Background: An opioid task force within an urban public health district sought
R, Eti DU, Wilson M.	to increase access to, and utilization of, non-opioid, nonpharmacologic
Experiencing COMFORT:	alternatives for pain management. Aims: The COMFORT (Community-engaged
Perceptions of Virtually-	Options to Maximize and Facilitate Opioid ReducTion) study was designed to
delivered Nonpharmacologic	provide virtual multidimensional integrated nonpharmacologic therapies via a
Therapies in Adults	cloud-based videoconferencing platform over six weeks to adults with chronic
Prescribed Opioids for	pain who were prescribed an opioid to investigate measurable health
Chronic Pain. <i>Pain</i>	improvements. Methods: A qualitative descriptive analysis explored
Management Nursing.	participants' experiences of a novel pain management intervention. A total of 19
2023;24(4):469-476.	participants consented to participate in the study and 15 completed six virtual
doi:10.1016/j.pmn.2023.04.	consultations with either yoga, massage, chiropractic, or physical therapists.
002	Semi-structured exit interviews were conducted, and data analyzed using
	content analysis. <b>Results:</b> Five main themes were identified, including unmet
	pain needs, self-care practices, incentive for participation, perception of a
	virtual environment, and benefits of the intervention. All participants reported at
	least minor benefits, with about half reporting improvement in pain levels, and
	some were able to reduce their opioid use. A virtual environment posed
	challenges for a few participants who found it more difficult to engage with than
	in-person therapy; others found the platform easy to navigate. <b>Conclusions:</b>
	Participants with chronic pain were open and willing to try a novel way to access
	nonpharmacologic consultations to address unmet pain needs. Virtual
	consultations with pain management experts may increase access to, and
	utilization of, complementary and integrative treatment modalities.
Habak S, Bennett J, Davies A,	Depression and suicidality are characterized by negative imagery as well as
Davies M, Christensen H,	impoverished positive imagery. Although some evidence exists supporting the
Boydell KM. Edge of the	link between positive imagery and enhanced mood, much work needs to be
Present: A Virtual Reality	done. This study explored the impact of an immersive virtual reality experience
Tool to Cultivate Future	(Edge of the Present-EOTP) on an individual's mood, state of well-being, and
Thinking, Positive Mood and	future thinking. Using a 10-min mixed reality experience, 79 individuals explored
Wellbeing. Int J Environ Res	virtual landscapes within a purposefully built, physical room. A pre and post
Public Health.	survey containing mental health measures were administered to each
2020;18(1):140. Published	participant. An optional interview following the virtual work was also conducted.
2020 Dec 28.	The results indicated that positive mood and well-being increased significantly
doi:10.3390/ijerph18010140	post-intervention. Hopelessness scores and negative mood decreased, whilst
	sense of presence was very high. This pilot study is among the first to assess the
	feasibility of a mixed reality experience as a potential platform for depression
	and suicide prevention by increasing well-being and mood as well as decreasing
	hopelessness symptoms.





Hamilton T, Burback L, Smith-MacDonald L, et al. Moving Toward and Through Trauma: Participant Experiences of Multi-Modal Motion-Assisted Memory Desensitization and Reconsolidation (3MDR). <i>Front Psychiatry</i> . 2021;12:779829. Published 2021 Dec 22. doi:10.3389/fpsyt.2021.7798 29	<b>Introduction:</b> Military members and Veterans are at risk of developing combat- related, treatment-resistant posttraumatic stress disorder (TR-PTSD) and moral injury (MI). Conventional trauma-focused therapies (TFTs) have shown limited success. Novel interventions including Multi-modal Motion-assisted Memory Desensitization and Reconsolidation therapy (3MDR) may prove successful in treating TR-PTSD. <b>Objective:</b> To qualitatively study the experiences of Canadian military members and Veterans with TR-PTSD who received the 3MDR intervention. <b>Methods:</b> This study explored qualitative data from a larger mixed- method waitlist control trial testing the efficacy of 3MDR in military members and veterans. Qualitative data were recorded and collected from 3MDR sessions, session debriefings and follow-up interviews up to 6 months post- intervention; the data were then thematically analyzed. <b>Results:</b> Three themes emerged from the data: (1) the participants' experiences with 3MDR; (2) perceived outcomes of 3MDR; and (3) keys to successful 3MDR treatment. Participants expressed that 3MDR provided an immersive environment, active engagement and empowerment. The role of the therapist as a coach and "fireteam partner" supports the participants' control over their therapy. The multi-modal nature of 3MDR, combining treadmill-walking toward self-selected trauma imagery with components of multiple conventional TFTs, was key to helping participants engage with and attribute new meaning to the memory of the traumatic experiences. <b>Discussion:</b> Preliminary thematic analysis of participant experiences of 3MDR indicate that 3MDR has potential as an effective intervention for combat-related TR-PTSD, with significant functional, well-being and relational improvements reported post- intervention. <b>Conclusion:</b> Military members and Veterans are at risk of developing TR-PTSD, with worse outcomes than in civilians. Further research is needed into 3MDR and its use with other trauma-affected populations.
Harvey PD, Depp CA, Rizzo AA, et al. Technology and Mental Health: State of the Art for Assessment and Treatment. <i>Am J Psychiatry</i> . 2022;179(12):897-914. doi:10.1176/appi.ajp.211212 54	Technology is ubiquitous in society and is now being extensively used in mental health applications. Both assessment and treatment strategies are being developed and deployed at a rapid pace. The authors review the current domains of technology utilization, describe standards for quality evaluation, and forecast future developments. This review examines technology-based assessments of cognition, emotion, functional capacity and everyday functioning, virtual reality approaches to assessment and treatment, ecological momentary assessment, passive measurement strategies including geolocation, movement, and physiological parameters, and technology-based cognitive and functional skills training. There are many technology-based approaches that are evidence based and are supported through the results of systematic reviews and meta-analyses. Other strategies in selection of applications for specific conditions, but in several areas, including cognitive training, randomized clinical trials are available to support these interventions. Some of these technology-based interventions have been approved by the U.S. Food and Drug administration, which has clear standards for which types of applications, and which claims about them, need to be reviewed by the agency and which are exempt





Harvey PD, Horan WP, Atkins	Background: Cognition and functional capacity predict functional outcomes in
AS, et al. Factor structure of	mental Illness. Traditional approaches conceptualize cognition as comprised of
cognitive performance and	domains, but many studies support a unifactorial structure. Some functional
functional capacity in	capacity measures may share a single-factor structure with cognition. In this
schizophrenia: Evidence for	study, we examined the factor structure of two measures of functional capacity,
differences across	a conventional assessment and a newer computerized assessment, testing for a
functional capacity	shared factor structure with cognition. <b>Methods:</b> Patients with schizophrenia
measures. Schizophr Res.	and healthy controls were examined with the MATRICS Consensus Cognitive
2020;223:297-304.	Battery (MCCB), the UCSD Performance Based Skills Assessment (UPSA), and
doi:10.1016/j.schres.2020.0	the Virtual Reality Functional Capacity Assessment Tool (VRFCAT). Models of the
8.010	factor structures of the MCCB, UPSA, and VRFCAT were calculated, as were
	correlations between MCCB scores and individual VRFCAT objectives.
	<b>Results:</b> The MCCB, VRECAT, and UPSA all had unifactorial structures. The best
	fitting model of the correlations between MCCB and UPSA was a shared single
	factor, while the best fit for the relationship between MCCB and VRECAT had two
	factors. Correlations between the MCCB domain and composite scores and the
	VBECAT objectives suggested global rather than specific patterns of correlation
	<b>Discussion:</b> The relationship between cognitive performance and functional
	capacity was found to vary across functional capacity assessments. The LIPSA
	and MCCB were not differentiated into separate factors, suggesting that the
	LIPSA may overlap with neurocognitive performance. However, the VBECAT
	appears to measure functional abilities that are separable from vet correlated
	with neurocognitive performance. It may provide a more distinctive assessment
	of the functional capacity construct.
Harvey PD Khan & Atkins A	Virtual Reality (VR) approaches have had considerable success in measurement
Keefe BS Virtual reality	of functional capacity. However, it is not clear if factors other than cognitive
assessment of functional	impairment influence performance on VB measures. Many people with
capacity in people with	schizonhrenia have significant negative symptoms and they could reduce
Schizophrenia: Associations	engagement in assessment 158 natients with schizonhrenia performed the
with reduced emotional	VRECAT were tested with the MCCB were rated with the PANSS and were rated
experience and prediction of	on everyday functioning. Scores for reduced emotional experience and reduced
functional outcomes	expression were derived. Reduced emotional experience, but not reduced
Psychiatry Research	expression was correlated with socially relevant VBECAT subtasks and real-
2019.277.58-63	world social functioning. Performance on the socially relevant subtasks, but not
doi:10.1016/j.psychres.2019	the solitary subtasks, shared variance with work outcomes. MCCB performance
01 045	was associated with both subdomains, but socially relevant subtasks shared
.01.040	more variance. Patients with higher reduced emotional experience validly
	engaged in socially relevant VB simulations, as indexed by correlations with
	outcome measures. These natients had nonrer performance on socially relevant
	tasks than on solitary tasks. The differential validity of solitary ve socially
	relevant simulations was supported by differences in correlates, suggesting that
	assessments with a focus on performance of simulated socially relevant tasks
	assessments with a focus on performance of simulated socially relevant tasks
	coulo pe developea.





Heyse J, Depreeuw B, Van Daele T, et al. An adaptation algorithm for personalised virtual reality exposure therapy. *Computer Methods and Programs in Biomedicine*. 2022;225:107077. doi:10.1016/j.cmpb.2022.10 7077 **Background:** Anxiety disorders are highly prevalent in mental health problems. The lives of people suffering from an anxiety disorder can be severely impaired. Virtual Reality Exposure Therapy (VRET) is an effective treatment, which immerses patients in a controlled Virtual Environment (VE). This creates the opportunity to confront feared stimuli and learn how to deal with them, which may result in the reduction of anxiety. The configuration of these VEs requires extensive effort to maximize the potential of Virtual Reality (VR) and the effectiveness of the therapy. Manual configuration becomes infeasible when the number of possible virtual stimuli combinations is infinite. Due to the growing complexity, acquiring the skills to truly master a VR system is difficult and it increases the threshold for psychotherapists to use such useful systems. We therefore developed a prototype of a supportive algorithm to facilitate the use of VRET in a clinical setting. This automatized system assists psychotherapists to use the wide range of functionalities without burdening them with technical challenges. Thus, psychotherapists can focus their attention on the patient. Methods: In this paper both the prototype of the algorithm and a first proof of concept are described. The algorithm suggests environment configurations for VRET, tailored to the individual therapeutic needs of each patient. The system aims to maximize learning during exposure therapy for different combinations of stimuli by using the Rescorla–Wagner model as a predictor for learning. In a first proof of concept, the VE configurations suggested by the algorithm for three anonymized clinical vignettes were compared with prior manual configurations by two psychotherapists. **Results:** The prototype of the algorithm and a first proof of concept are described. The first proof of concept demonstrated the relevance and potential of the proposed system, as it managed to propose similar configurations for the clinical vignettes compared to those made by therapists. Nonetheless, because of the exploratory nature of the study, no claims can yet be made about its efficacy. **Conclusions:** With the increasing ubiquity of immersive technologies, this technology for assisted configuration of VEs could make VRET a valuable tool for psychotherapists.





Høeg ER, Andersen NB, Malmkjær N, Vaaben AH, Uth J. Hospitalized older adults' experiences of virtual reality-based group exercise therapy with cycle ergometers: An early feasibility study. *Computers in Human Behavior Reports*. 2023;11:100301. doi:10.1016/j.chbr.2023.100 301 Sedentary behavior among hospitalized older adults is a well-described challenge that can increase the risk of loss of function and mortality. Therefore, it is important to encourage physical activity (PA) during hospitalization. Exertion Games (exergames) have repeatedly been suggested as a tool to encourage and sustain motivation in rehabilitation programs. This article presents early findings from a convergent parallel mixed methods study that explored whether social presence and PA could be combined through the novel use of immersive virtual reality technology in a feasible group exercise constellation. Inpatients (n=10, 50% female, 80.3±8.2 years) were invited to participate in a bi-weekly VR group session. Most participants (62%) responded that it was a good experience to a large/great extent, which they would like to use repeatedly (76%). The technology was easy for untrained healthcare professionals and had minimal adverse events for the participants. However, a major finding illustrates that the enclosing immersiveness of the headset hindered conversation during exercise sessions. The exclusion of sight likely had a negative effect on forming relations between the participants, which conversely caused the participants to experience a lack of cohesion and relatedness with the other participants. VRmediated group therapy may be a promising solution to existing physiotherapy practices since it may incorporate basic psychological needs. However, to optimize for social interaction, future systems will need to afford a higher degree of social presence, e.g., through avatar embodiment in a shared virtual environment, to support older adults' autonomous motivation for PA through social interaction and novel technologies.





Hui H, Hong A, Gao J, Yu J, Wang Z. Efficacy of tDCS to enhance virtual reality exposure therapy response in acrophobia: A randomized controlled trial. *Journal of Psychiatric Research*. 2024;171:52-59. doi:10.1016/j.jpsychires.202 4.01.027 **Background:** Virtual reality exposure therapy (VRET) has been recognized as an effective treatment for specific phobias and has the potential to overcome the limitations of traditional exposure therapy. The pursuit of non-invasive brain stimulation provides a practical means of augmenting VRET. Transcranial direct current stimulation (tDCS), a non-invasive neuromodulation technique, stimulates the medial prefrontal cortex (mPFC), with the potential to enhance the effects of exposure therapy. Therefore, we conducted a randomized controlled trial to examine whether tDCS enhanced the effects of VRET in acrophobia. Method: This study recruited 64 college students with significant fear of height (based on the Acrophobia Questionnaire, AQ). Finally, 61 participants were randomly allocated to the tDCS active-stimulated group (n = 30) or the sham-stimulated group (n = 31). After stimulation, VRET was conducted, and clinical indices were recorded. The AQ was used as the first primary outcome, and Subjective Units of Distress (SUDS) and the Heights Interpretation Questionnaire (HIQ) were used as secondary outcomes. Result: There was a significant reduction in psychometric and behavioral anxiety measurements from pre to post treatment as indicated by main effects for the factor time (AQ-Anxiety: F (2.60) = 139.55, p < 0.001, η2 = 0.83; AQ-Avoidance: F (2.60) = 53.73, p < 0.001, n2 = 0.69; HIQ: F (2.60) = 128.12, p < 0.001, n2 = 0.81; STAI-Y-S: F (2.60) = 15.44, p < 0.001, η2 = 0.34; BAI: F (2.60) = 73.81, p < 0.001,  $\eta 2 = 0.71$ ). Compared with the sham-stimulated group, the reduction of AQ-Anxiety and SUDS in the first exposure trial (F (2,60) = 8.56, p = 0.001,  $\eta$ 2 = 0.23; t = 2.34, p = 0.024, d = 0.61) was significantly faster in the active group. At followup, there was also a further reduction in AQ anxiety and avoidance (Anxiety: M = 56.51 ± 27.19; main effect time F (1,60) = 25.16, p < 0.001,  $\eta 2 = 0.35$ ; Avoidance: M = 12.57 ± 7.97; main effect time F (1,60) = 31.40, p < 0.001,  $\eta 2 = 0.45$ ) without interaction time\*group (Anxiety: F (1.60) = 0.12, p = 0.740,  $\eta^2 = 0.00$ ; Avoidance: F (1.60) = 0.64, p = 0.430,  $\eta^2 = 0.02$ ). **Conclusion:** Results could be explained tDCS could accelerate the effects of VRET on acrophobia by stimulating mPFC, indicating that tDCS may be used as an enhancement technique for exposure therapy for specific phobias.





Jespersen AE, Bøen IS,	<b>Objectives:</b> Cognitive impairment is common across mood disorders (MD) and
Lumbye A. Nordentoft M.	psychosis-spectrum disorders (PSD) but there is a lack of real-life pro-cognitive
Glenthøi LB. Miskowiak KW.	training programmes. Fully immersive virtual reality (VR) has the potential to
Feasibility and effect of an	ensure motivating, engaging cognition training directly relevant to patients' daily
immersive virtual reality-	lives. This randomized, controlled proof-of-concept study investigated the
based platform for cognitive	feasibility and cognitive benefits of short-term VR-assisted training. <b>Methods:</b>
training in real-life scenarios	Forty patients with MD or PSD were randomized to one week of VR-assisted
in patients with mood - or	training (n = 20) or treatment as usual (TAU: $n = 20$ ). They were assessed at
psychotic disorders: A	baseline and after one week with a VR cognition test, neuropsychological tests.
randomized, controlled	and questionnaires regarding user experience. Patients in the training group
proof-of-concept study.	underwent two VR training sessions in a kitchen environment that involved
Neuroscience Applied.	solving tasks related to planning and cooking a meal using various cognitive
2023;2:101120.	strategies. They also completed two home assignments during which they
doi:10.1016/j.nsa.2023.1011	applied the acquired strategies. <b>Results:</b> The completion rate was 100%.
20	Patients reported high enjoyment and moderate-to-high presence in the VR
	environment and minimal motion sickness. VR training improved the global VR-
	based cognitive composite score with a large effect size compared with TAU
	(F(1, 38) = 11,29, p = .002, η2 = 0.23). Posthoc assessments of VR subtests
	showed that this improvement was driven primarily by a large effect on
	psychomotor speed (F(1, 38) = 22.78, $p < .001$ , $\eta 2 = 0.39$ ), but no effects were
	observed on other VR subtests or on traditional neuropsychological tests.
	Conclusion: VR-assisted cognition training showed high feasibility and
	improved aspects of cognition after only one week. We therefore plan a larger
	trial to investigate the cognitive benefits of four-weeks VR-assisted cognition
	training.
Jonathan NT, Bachri MR,	In the current time, Virtual Reality (VR) technologies are improving rapidly.
Wijaya E, Ramdhan D,	Virtual Reality (VR) allows the user to experience immersive environment that
Chowanda A. The efficacy of	they can interact with through the creation of a 3D digital world. Many studies
virtual reality exposure	have explored the potential efficacy of using Virtual Reality (VR) as a form of
therapy (VRET) with extra	exposure therapy to treat patients with mental health problems. In this paper,
intervention for treating	we explored the efficacy of using Virtual Reality Exposure Therapy (VRET) with
PTSD symptoms. Procedia	other extra intervention (e.g., medicine, extra hardware, etc.) to treat patients
Computer Science.	diagnosed with PTSD. The result indicates that some extra intervention does
2023;216:252-259.	influence the outcome by seeing the difference in CAPS score. The highest CAPS
doi:10.1016/j.procs.2022.12.	score difference of 17.7 is achieved by 3MDR which combines the use of VRET
134	(Virtual Reality Exposure Therapy), EMDR (Eye Movement Desensitization and
	Reprocessing) and walking on a treadmill.





Jones C, Miguel Cruz A, Smith-MacDonald L, Brown MRG, Vermetten E, Brémault-Phillips S. Technology Acceptance and Usability of a Virtual Reality Intervention for Military Members and Veterans With Posttraumatic Stress **Disorder: Mixed Methods** Unified Theory of Acceptance and Use of Technology Study. JMIR Form Res. 2022;6(4):e33681. Published 2022 Apr 21. doi:10.2196/33681

Background: Military members and veterans exhibit higher rates of injuries and illnesses such as posttraumatic stress disorder (PTSD) because of their increased exposure to combat and other traumatic scenarios. Novel treatments for PTSD are beginning to emerge and increasingly leverage advances in gaming and other technologies, such as virtual reality. Without assessing the degree of technology acceptance and perception of usability to the end users, including the military members, veterans, and their attending therapists and staff, it is difficult to determine whether a technology-based treatment will be used successfully in wider clinical practice. The Unified Theory of Acceptance and Use of Technology model is commonly used to address the technology acceptance and usability of applications in 5 domains. **Objective:** Using the Unified Theory of Acceptance and Use of Technology model, the purpose of this study was to determine the technology acceptance and usability of multimodal motion-assisted memory desensitization and reconsolidation (3MDR) on a virtual reality system in the primary user group (military members and veterans with treatment-resistant PTSD, 3MDR therapists, and virtual reality environment operators). Methods: This mixed methods embedded pilot study included military members (n=3) and veterans (n=8) with a diagnosis of combat-related PTSD, as well as their therapists (n=13) and operators (n=5) who completed prepost questionnaires before and on completion of 6 weekly sessions of 3MDR. A partial least squares structural equation model was used to analyze the questionnaire results. Qualitative data from the interviews were assessed using thematic analysis. **Results:** Effort expectancy, which was the most notable predictor of behavioral intention, increased after a course of 3MDR with the virtual reality system, whereas all other constructs demonstrated no significant change. Participants' expectations of the technology were met, as demonstrated by the nonsignificant differences in the pre-post scores. The key qualitative themes included feasibility and function, technical support, and tailored immersion. Conclusions: 3MDR via a virtual reality environment appears to be a feasible, usable, and accepted technology for delivering 3MDR to military members and veterans who experience PTSD and 3MDR therapists and operators who facilitate their treatment.





Jones C, Smith-MacDonald L, Miguel-Cruz A, et al. Virtual Reality-Based Treatment for Military Members and Veterans With Combat-Related Posttraumatic Stress Disorder: Protocol for a Multimodular Motion-Assisted Memory Desensitization and Reconsolidation **Randomized Controlled** Trial. JMIR Res Protoc. 2020;9(10):e20620. Published 2020 Oct 29. doi:10.2196/20620

Background: Military members are at elevated risk of operational stress injuries, including posttraumatic stress disorder (PTSD) and moral injury. Although psychotherapy can reduce symptoms, some military members may experience treatment-resistant PTSD. Multimodular motion-assisted memory desensitization and reconsolidation (3MDR) has been introduced as a virtual reality (VR) intervention for military members with PTSD related to military service. The 3MDR intervention incorporates exposure therapy, psychotherapy, eve movement desensitization and reconsolidation, VR, supportive counselling, and treadmill walking. Objective: The objective of this study is to investigate whether 3MDR reduces PTSD symptoms among military members with combatrelated treatment-resistant PTSD (TR-PTSD); examine the technology acceptance and usability of the Computer Assisted Rehabilitation ENvironment (CAREN) and 3MDR interventions by Canadian Armed Forces service members (CAF-SMs), veterans, 3MDR clinicians, and operators; and evaluate the impact on clinicians and operators of delivering 3MDR. Methods: This is a mixedmethods waitlist controlled crossover design randomized controlled trial. Participants include both CAF-SMs and veterans (N=40) aged 18-60 years with combat-related TR-PTSD (unsuccessful experience of at least 2 evidence-based trauma treatments). Participants will also include clinicians and operators (N=12) who have been trained in 3MDR and subsequently utilized this intervention with patients. CAF-SMs and veterans will receive 6 weekly 90minute 3MDR sessions. Quantitative and qualitative data will be collected at baseline and at 1, 3, and 6 months postintervention. Quantitative data collection will include multiomic biomarkers (ie, blood and salivary proteomic and genomic profiles of neuroendocrine, immune-inflammatory mediators, and microRNA), eye tracking, electroencephalography, and physiological data. Data from outcome measures will capture self-reported symptoms of PTSD, moral injury, resilience, and technology acceptance and usability. Qualitative data will be collected from audiovisual recordings of 3MDR sessions and semistructured interviews. Data analysis will include univariate and multivariate approaches, and thematic analysis of treatment sessions and interviews. Machine learning analysis will be included to develop models for the prediction of diagnosis, symptom severity, and treatment outcomes. **Results:** This study commenced in April 2019 and is planned to conclude in April 2021. Study results will guide the further evolution and utilization of 3MDR for military members with TR-PTSD and will have utility in treating other trauma-affected populations. Conclusions: The goal of this study is to utilize qualitative and quantitative primary and secondary outcomes to provide evidence for the effectiveness and feasibility of 3MDR for treating CAF-SMs and veterans with combat-related TR-PTSD. The results will inform a full-scale clinical trial and stimulate development and adaptation of the protocol to mobile VR apps in supervised clinical settings. This study will add to knowledge of the clinical effectiveness of 3MDR, and provide the first comprehensive analysis of biomarkers, technology acceptance and usability, moral injury, resilience, and the experience of clinicians and operators delivering 3MDR.





Jones C, Smith-MacDonald L, Van Veelen N, et al. Therapist and operator experiences utilizing multimodal motion-assisted Memory Desensitization and Reconsolidation (3MDR) for treatment of combat related posttraumatic stress disorder amongst military and veteran populations. Eur J Psychotraumatol. 2022;13(1):2062996. Published 2022 May 16. doi:10.1080/20008198.2022. 2062996

**Background:** As provisions of mental healthcare services to military and veteran populations increases the risk to service providers developing secondary traumatic stress (STS), efforts are needed to examine the impact of delivering novel interventions which may include 3MDR. As a virtual-reality supported intervention, 3MDR exposes the patient, therapist and operator to graphic and sensory stimuli (i.e. narratives, imagery, smells, and music) in the course of the intervention. 3MDR is actively being researched at multiple sites internationally within military and veteran populations. It is, therefore, crucial to ensure the safety and wellbeing of 3MDR therapists and operators who are exposed to potentially distressing sensory stimuli. **Objective:** The purpose of this study is to qualitatively examine the impact and experiences of STS amongst therapists and operators in delivering 3MDR. For this study, impact will be defined as therapists or operators experiencing perceived STS as a result of delivering 3MDR. Methods: This exploratory qualitative study recruited 3MDR therapists and operators (N = 18) from Canada, the Netherlands, the United Kingdom, and the United States who had previously delivered 3MDR therapy. Telephone or videoconferencing interviews were used to gather data that was subsequently transcribed and thematically analyzed. **Results:** Four themes emerged among the therapists (n = 13) and operators (n = 5): (1) personal cost and benefits of 3MDR, (2) professional paradox of a 3MDR therapist, (3) perceived effect of 3MDR on patients, and (4) recommendations for future 3MDR use. **Conclusions:** STS was not noted to be a significant challenge for 3MDR therapists and operators. Future research may investigate optimal means of providing training and ongoing support for 3MDR therapists and operators. Highlights: Secondary Traumatic Stress was not noted to be a significant challenge for 3MDR therapists and operators. Future research may investigate optimal means of providing training and ongoing support for 3MDR therapists and operators.





Juszko K, Kiper P, Wrzeciono A, Cieślik B, Gajda R, Szczepańska-Gieracha J. Factors associated with the effectiveness of immersive virtual therapy in alleviating depressive symptoms during sub-acute post-stroke rehabilitation: a gender comparison. *BMC Sports Sci Med Rehabil.* 2023;15(1):137. Published 2023 Oct 20. doi:10.1186/s13102-023-00742-z Background: The large-scale digitalization of healthcare has induced shifts in patient preferences, prompting the introduction of therapies utilizing novel technologies. In this context, the targeted application of these interventions is deemed as crucial as assessing their overall effectiveness. The aim of this study was to characterize the patient profile who benefited most from immersive virtual reality (VR) therapy. **Methods:** Based on the results from the previous randomized controlled trial study, we employed an exploratory study design to determine the factors associated with the most significant mental health improvement. A secondary analysis was conducted on a sample of 83 participants, with further analysis of participants with elevated depression symptoms, as indicated by a score of > 10 on the 30-item Geriatric Depression Scale (GDS-30). Both groups participated in a similar post-stroke rehabilitation program; however, the experimental group also received additional VR therapy through an immersive VR garden intervention. The GDS-30 was used to assess mood and depressive symptoms, and sociodemographic, cognitive status as well as stroke-related variables were considered as potential factors. Results: In both the experimental (mean change 5.3) and control groups (mean change 2.8), interventions significantly reduced depressive symptoms, with a more pronounced difference in the experimental group (p < 0.05). When examining gender differences, women exhibited greater improvement in the GDS, with mean between-group differences of 5.0 for the total sample and 6.0 for those with elevated depressive symptoms. Sociodemographic factors, cognitive status, and time from stroke were not found to be factors that alter the effectiveness of VR therapy. **Conclusions:** While VR therapy as an adjunctive treatment for post-stroke rehabilitation seems especially effective for women with elevated depressive symptoms, the results should be interpreted with caution due to the study's small experimental group size. Traditional methods showed reduced effectiveness in women compared to men; thus, developing technologically advanced and gender-specific approaches can lead to more tailored therapy.





Kaonga NN, Morgan J. Common themes and emerging trends for the use of technology to support mental health and psychosocial well-being in limited resource settings: A review of the literature. <i>Psychiatry Research</i> . 2019;281:112594. doi:10.1016/j.psychres.2019 .112594	There are significant disparities in access to mental health care. With the burgeoning of technologies for health, digital tools have been leveraged within mental health and psychosocial support programming (eMental health). A review of the literature was conducted to understand and identify how eMental health has been used in resource-limited settings in general. PubMed, Ovid Medline and Web of Science were searched. Six-hundred and thirty full-text articles were identified and assessed for eligibility; of those, 67 articles met the inclusion criteria and were analyzed. The most common mental health use cases were for depression (n = 25) and general mental health and well-being (n = 21). Roughly one-third used a website or Internet-enabled intervention (n = 23) and nearly one-third used an SMS intervention (n = 22). Technology was applied to enhance service delivery (n = 32), behavior change communication (n = 26) and data collection (n = 8), and specifically dealt with adherence (n = 7), ecological momentary assessments (n = 7), well-being promotion (n = 5), education (n = 8), telemedicine (n = 28), machine learning (n = 5) and games (n = 2). Emerging trends identified wearables, predictive analytics, robots and virtual reality as promising areas. eMental health interventions that leverage low-tech tools can introduce, strengthen and expand mental health and psychosocial support services and can be a starting point for future, advanced tools.
Keefe RSE, Davis VG, Atkins AS, et al. Validation of a Computerized test of Functional Capacity. <i>Schizophrenia Research</i> . 2016;175(1-3):90-96. doi:10.1016/j.schres.2016.0 3.038	Regulatory guidance for schizophrenia cognition clinical trials requires that the assessment of cognitive change is accompanied by a functionally meaningful endpoint. However, currently available measures are challenged by resistance to change, psychometric weaknesses, and for interview-based assessments, dependence upon the presence of an informant. The aims of the current study were to: 1) assess the validity, sensitivity, and reliability of the Virtual Reality Functional Capacity Assessment Tool (VRFCAT) as a measure of functional capacity; 2) determine the association between performance on the VRFCAT and performance on the MATRICS Consensus Cognitive Battery (MCCB); and 3) compare the metrics of the VRFCAT with the UCSD Performance-based Skills Assessment (UPSA). 167 patients with schizophrenia and 166 healthy controls completed the VRFCAT, UPSA, and the MCCB at baseline. The VRFCAT and UPSA were very sensitive to impairment in schizophrenia (d=1.16 to 1.22). High test-retest reliability was demonstrated for VRFCAT total completion time and the UPSA demonstrated significant practice effects in patients (d=0.35), while the VRFCAT did not (d=-0.04). VRFCAT total completion time was correlated with both UPSA (r=-0.56, p<0.0001 for patients and -0.58, p<0.0001 for controls) and MCCB Composite (r=-0.57, p<0.0001 for patients and -0.68, p<0.0001 for controls). The VRFCAT is a highly reliable and sensitive measure of functional capacity with associations to the UPSA and MCCB. These results provide encouraging support for accompleted for upper factors and for accompleted encouraging support





Khirallah Abd El Fatah N. Abdelwahab Khedr M. Alshammari M, Mabrouk Abdelaziz Elgarhy S. Effect of Immersive Virtual Reality Reminiscence versus Traditional Reminiscence Therapy on Cognitive Function and Psychological Well-being among Older Adults in Assisted Living Facilities: A randomized controlled trial. Geriatr Nurs. 2024;55:191-203. doi:10.1016/j.gerinurse.2023 .11.010

**Background:** Virtual reality (VR) reminiscence is an innovative strategy that integrates technology into the care of older adults. Limited research was conducted to compare the role of VR reminiscence and traditional RT in improving older adults' cognitive and psychological well-being. **Aim:** Investigate the effect of virtual reality reminiscence versus traditional reminiscence therapy on cognitive function and psychological well-being among older adults in assisted living facilities. **Methods:** A randomized controlled trial research design was followed. Sixty older adults for each group). **Results:** Post interventions, a significant increase in the mean scores of cognitive function and psychological well-being with statistically significant differences (P <0.05) compared with pre-intervention and the control group. **Conclusion:** Application of VR reminiscence or traditional RT is efficacious in improving cognitive function and psychological well-being among institutionalized older adults.





Kirkham R, Kooijman L, Albertella L, Myles D, Yücel M, Rotaru K. Immersive Virtual Reality-Based Methods for Assessing Executive Functioning: Systematic Review. *JMIR Serious Games*. 2024;12:e50282. Published 2024 Feb 26. doi:10.2196/50282 Background: Neuropsychological assessments traditionally include tests of executive functioning (EF) because of its critical role in daily activities and link to mental disorders. Established traditional EF assessments, although robust, lack ecological validity and are limited to single cognitive processes. These methods, which are suitable for clinical populations, are less informative regarding EF in healthy individuals. With these limitations in mind, immersive virtual reality (VR)based assessments of EF have garnered interest because of their potential to increase test sensitivity, ecological validity, and neuropsychological assessment accessibility. Objective: This systematic review aims to explore the literature on immersive VR assessments of EF focusing on (1) EF components being assessed, (2) how these assessments are validated, and (3) strategies for monitoring potential adverse (cybersickness) and beneficial (immersion) effects. Methods: EBSCOhost, Scopus, and Web of Science were searched in July 2022 using keywords that reflected the main themes of VR, neuropsychological tests, and EF. Articles had to be peer-reviewed manuscripts written in English and published after 2013 that detailed empirical, clinical, or proof-of-concept studies in which a virtual environment using a head-mounted display was used to assess EF in an adult population. A tabular synthesis method was used in which validation details from each study, including comparative assessments and scores, were systematically organized in a table. The results were summed and qualitatively analyzed to provide a comprehensive overview of the findings. **Results:** The search retrieved 555 unique articles, of which 19 (3.4%) met the inclusion criteria. The reviewed studies encompassed EF and associated higherorder cognitive functions such as inhibitory control, cognitive flexibility, working memory, planning, and attention. VR assessments commonly underwent validation against gold-standard traditional tasks. However, discrepancies were observed, with some studies lacking reported a priori planned correlations, omitting detailed descriptions of the EF constructs evaluated using the VR paradigms, and frequently reporting incomplete results. Notably, only 4 of the 19 (21%) studies evaluated cybersickness, and 5 of the 19 (26%) studies included user experience assessments. **Conclusions:** Although it acknowledges the potential of VR paradigms for assessing EF, the evidence has limitations. The methodological and psychometric properties of the included studies were inconsistently addressed, raising concerns about their validity and reliability. Infrequent monitoring of adverse effects such as cybersickness and considerable variability in sample sizes may limit interpretation and hinder psychometric evaluation. Several recommendations are proposed to improve the theory and practice of immersive VR assessments of EF. Future studies should explore the integration of biosensors with VR systems and the capabilities of VR in the context of spatial navigation assessments. Despite considerable promise, the systematic and validated implementation of VR assessments is essential for ensuring their practical utility in real-world applications.





Koskina A, Campbell IC,	Exposure therapy is a widely used and effective form of treatment in anxiety
Schmidt U. Exposure therapy	disorders and addictions but evidence for its usefulness in eating disorders (ED)
in eating disorders revisited.	is inconsistent. This paper systematically reviews the literature on the use of
Neuroscience &	exposure therapy in ED, the theory underpinning its use, and the deficits in
Biobehavioral Reviews.	current knowledge. Databases were searched to 2012. In addition, potential
2013;37(2):193-208.	improvements in the use of exposure techniques in ED are considered by
doi:10.1016/j.neubiorev.201	drawing upon theory and research involving neuropharmacology, basic and
2.11.010	clinical neuroscience, contemporary behavioural and neurobiological research,
	and technologies such as virtual reality (VR).
Kupczik L, Farrelly W, Wilson	Aging populations across the world are facing a number of challenges in the
S. Appraising Virtual	context of health and healthcare. These challenges are driven by the aging
Technologies' Impact on	process and the illnesses associated with aging. Healthcare for older people has
Older Citizens' Mental	become a point of concern with most health organizations, and this is
Health-A Comparative	particularly the case with palliative care. In this instance, the movement of the
between 360° Video and	patient may be restricted to a room with no or limited access to the outdoors.
Virtual Reality. Int J Environ	This research focuses on the active integration of immersive technologies with
Res Public Health.	healthcare. By addressing the problem of providing patients with the experience
2022;19(18):11250.	of being present in an outdoors space, the associated psychological and
Published 2022 Sep 7.	physiological benefits can be identified. In this mixed methods research paper,
doi:10.3390/ijerph19181125	the impact of a crossover study to discern technology preferences in relation to
0	immersive technologies among a sample of older people is reported. In addition,
	the study highlights factors that contribute to a meaningful immersive
	experience that can improve psychological and physiological wellbeing. The
	study identifies that there are two significant categorical aspects that contribute
	to such immersive experiences, technological aspects (including, for example,
	the weight of headsets, visual impairment, pixelation, and gamification) and
	emotive aspects (for example, joy, anger, and fear). The study suggests that
	older people prefer immersive Virtual Reality (VR) environments rather than 360
	video experiences. This can be attributed to the greater flexibility in the provision
	of interactivity in virtual reality systems.





Lake J. The integrative management of PTSD: A review of conventional and CAM approaches used to prevent and treat PTSD with emphasis on military personnel. *Advances in Integrative Medicine*. 2015;2(1):13-23. doi:10.1016/j.aimed.2014.10 .002 Post-traumatic stress disorder (PTSD) may be the most urgent problem the U.S. military is facing today. Pharmacological and psychological interventions reduce the severity of some PTSD symptoms however these conventional approaches have limited efficacy. This issue is compounded by the high rate of co-morbid traumatic brain injury (TBI) and other medical and psychiatric disorders in veterans diagnosed with PTSD and unresolved system-level problems within the Veterans Administration and Department of Defense healthcare services that interfere with adequate and prompt care for veterans and active duty military personnel. This paper is offered as a framework for interdisciplinary dialogue and collaboration between experts in biomedicine and CAM addressing three primary areas of need: resiliency training in high risk military populations, prevention of PTSD following exposure to combat-related trauma, and treatment of established cases of PTSD. The evidence for widely used conventional pharmacological and psychological interventions used in the VA/DOD healthcare systems to treat PTSD is reviewed. Challenges and barriers to adequate assessment and treatment of PTSD in military personnel are discussed. A narrative review of promising CAM modalities used to prevent or treat PTSD emphasizes interventions that are not widely used in VA/DOD clinics and programmes. Interventions reviewed include virtual reality graded exposure therapy (VRGET), brain-computer interface (BCI), EEG biofeedback, cardiac coherence training, EMDR, acupuncture, omega-3 fatty acids and other natural products, lucid dreaming training, and energy therapies. As meditation and mind-body practices are widely offered within VA/DOD programmes and services addressing PTSD the evidence for these modalities is only briefly reviewed. Sources included mainstream medical databases and journals not currently indexed in the mainstream medical databases. Although most interventions discussed are applicable to both civilian and military populations the emphasis is on military personnel. Provisional integrative guidelines are offered with the goal of providing a flexible and open framework when planning interventions aimed at preventing or treating PTSD based on the best available evidence for both conventional and CAM approaches. The paper concludes with recommendations on research and policy within the VA and DOD healthcare systems addressing urgent unmet needs associated with PTSD.





Lan L, Sikov J, Lejeune J, et al. A Systematic Review of using Virtual and Augmented Reality for the Diagnosis and Treatment of Psychotic Disorders. *Curr Treat Options Psychiatry*. Published online June 14, 2023. doi:10.1007/s40501-023-00287-5 Objective: Immersive virtual reality (VR) and augmented reality (AR) have the potential to improve the treatment and diagnosis of individuals experiencing psychosis. Although commonly used in creative industries, emerging evidence reveals that VR is a valuable tool to potentially improve clinical outcomes, including medication adherence, motivation, and rehabilitation. However, the efficacy and future directions of this novel intervention require further study. The aim of this review is to search for evidence of efficacy in enhancing existing psychosis treatment and diagnosis with AR/VR. Methods: 2069 studies involving AR/VR as a diagnostic and treatment option were reviewed via PRISMA guidelines in five databases: PubMed, PsychInfo, Embase, and CINAHL. **Results:** Of the initial 2069 articles, 23 original articles were eligible for inclusion. One study applied VR to the diagnosis of schizophrenia. Most studies demonstrated that the addition of VR therapies and rehabilitation methods to treatment-as-usual (medication, psychotherapy, social skills training) was more effective than traditional methods alone in treating psychosis disorders. Studies also support the feasibility, safety, and acceptability of VR to patients. No articles using AR as a diagnostic or treatment option were found. **Conclusions:** VR is efficacious in diagnosing and treating individuals experiencing psychosis and is a valuable augmentation of evidence-based treatments.





Langener S, Klaassen R, VanDerNagel J, Heylen D. Immersive Virtual Reality Avatars for Embodiment Illusions in People With Mild to Borderline Intellectual Disability: User-Centered Development and Feasibility Study. *JMIR Serious Games*. 2022;10(4):e39966. Published 2022 Dec 7. doi:10.2196/39966 Background: Immersive virtual reality (IVR) has been investigated as a tool for treating psychiatric conditions. In particular, the practical nature of IVR, by offering a doing instead of talking approach, could support people who do not benefit from existing treatments. Hence, people with mild to borderline intellectual disability (MBID; IQ=50-85) might profit particularly from IVR therapies, for instance, to circumvent issues in understanding relevant concepts and interrelations. In this context, immersing the user into a virtual body (ie, avatar) appears promising for enhancing learning (eg, by changing perspectives) and usability (eg, natural interactions). However, design requirements, immersion procedures, and proof of concept of such embodiment illusion (ie, substituting the real body with a virtual one) have not been explored in this group. Objective: Our study aimed to establish design guidelines for IVR embodiment illusions in people with MBID. We explored 3 factors to induce the illusion, by testing the avatar's appearance, locomotion using IVR controllers, and virtual object manipulation. Furthermore, we report on the feasibility to induce the embodiment illusion and provide procedural guidance. Methods: We conducted a user-centered study with 29 end users in care facilities, to investigate the avatar's appearance, controller-based locomotion (ie, teleport, joystick, or hybrid), and object manipulation. Overall, 3 iterations were conducted using semistructured interviews to explore design factors to induce embodiment illusions in our group. To further understand the influence of interactions on the illusion, we measured the sense of embodiment (SoE) during 5 interaction tasks. **Results:** IVR embodiment illusions can be induced in adults with MBID. To induce the illusion, having a high degree of control over the body outweighed avatar customization, despite the participants' desire to replicate their own body image. Similarly, the highest SoE was measured during object manipulation tasks, which required a combination of (virtual) locomotion and object manipulation behavior. Notably, interactions that are implausible (eg, teleport and occlusions when grabbing) showed a negative influence on SoE. In contrast, implementing artificial interaction aids into the IVR avatar's hands (ie, for user interfaces) did not diminish the illusion, presuming that the control was unimpaired. Nonetheless, embodiment illusions showed a tedious and complex need for (control) habituation (eg, motion sickness), possibly hindering uptake in practice. Conclusions: Balancing the embodiment immersion by focusing on interaction habituation (eg, controller-based locomotion) and lowering customization effort seems crucial to achieve both high SoE and usability for people with MBID. Hence, future studies should investigate the requirements for natural IVR avatar interactions by using multisensory integrations for the virtual body (eg, animations, physics-based collision, and touch) and other interaction techniques (eg, hand tracking and redirected walking). In addition, procedures and use for learning should be explored for tailored mental health therapies in people with MBID.





Lee Y, Kim SK, Eom MR. Usability of mental illness simulation involving scenarios with patients with schizophrenia via immersive virtual reality: A mixed methods study. <i>PLoS One</i> . 2020;15(9):e0238437. Published 2020 Sep 16. doi:10.1371/journal.pone.02 38437	<b>Objectives:</b> Schizophrenia is one of the most prevalent mental illnesses contributing to national burden worldwide. It is well known that mental health nursing education, including clinical placement, is still insufficient to reach the optimal level of competency in nursing students. This study suggests a new form of mental health virtual reality (VR) simulation that is user-friendly and engaging to improve education about schizophrenia, thereby improving its treatment. <b>Method:</b> A mixed-methods study was conducted with a total of 60 nursing students, using 360-degree videos of five different scenarios reflecting clinical symptoms of schizophrenia patients and related treatment tasks delivered via head-mounted displays (HMDs). We used a 17-item quantitative questionnaire and a 7-item open-ended qualitative questionnaire to evaluate the ease of use and usefulness of the VR simulation program and to identify areas where further improvement is required. <b>Results:</b> The VR simulation program was perceived as useful and exciting. Participants stressed that the high realism of the simulation increased their engagement in and motivation to learn about mental health nursing. Some participants made suggestions, such as further refining the picture and sound quality in order to achieve satisfactory educational outcomes. <b>Conclusion:</b> VR simulation using 360-degree videos and HMDs could serve as an effective alternative form of clinical training in mental health nursing. Education could be enhanced by its benefits of being engaging and exciting, as reported by this study's participants.
Lem WG, Kawata KHDS, Oyama H. Exploring the impact of immersive virtual reality on depression knowledge and stigma reduction: a cross-over RCT fMRI study. <i>Sci Rep</i> . 2024;14(1):5193. Published 2024 Mar 2. doi:10.1038/s41598-024- 55797-w	The stigma of mental illness is a form of negative judgmental knowledge and is a barrier to individual seeking treatment. Contact-based educational interventions with first-person perspective (1PP) combined with immersive virtual reality (IVR) is promising as an anti-stigma intervention. This study aims to investigate the effectiveness of 1PP anti-stigma IVR intervention compared to video in enhancing depression knowledge and reducing stigma, as well as to examine the corresponding depression knowledge brain activity change using functional magnetic resonance imaging (fMRI). Participants engaged in a 1PP anti-stigma intervention using both IVR and conventional video, focusing on the daily life and recovery of a patient with mild depression. The change in depression knowledge, stigma-related behavioral, and brain activity using fMRI were measured at preand post-interventions. Depression knowledge improved for both interventions; however, only the IVR intervention reduced stigma. In the IVR intervention, depression knowledge score was positively associated with neural response in the right superior frontal gyrus activation, indicative of empathic concern. Conversely, the video intervention. This effectiveness is underpinned by the change in depression knowledge on neural activity, with IVR fostering empathy-related behavioral responses. The results highlight the potential of IVR in enhancing empathic understanding and reducing stigma towards mental illness, emphasizing the need for further exploration into immersive technologies for mental health education.





Liu Q, Wang Y, Yao MZ, Tang Q, Yang Y. The Effects of Viewing an Uplifting 360- Degree Video on Emotional Well-Being Among Elderly Adults and College Students Under Immersive Virtual Reality and Smartphone Conditions. <i>Cyberpsychol Behav Soc Netw</i> . 2020;23(3):157-164. doi:10.1089/cyber.2019.027 3	Positive emotions are important for the physical and mental health of elderly adults. Previous research has suggested that the emotion processing mechanisms of elderly adults differ from those of young people. The current study used a mixed-methods approach to explore the emotional impacts of viewing an uplifting 360° videos under immersive (using a virtual reality [VR] headset) and nonimmersive (using a smartphone) conditions on elderly populations and young people. In Study 1, we conducted a pre-post treatment between-subject field experiment (smartphone vs. VR) among 58 seniors (aged 60 years and above) in a community center in Beijing, China. One-on-one semistructured interviews of each participant were conducted after the experiment. In Study 2, we conducted a between-subject laboratory experiment with the same design among college students. The results show that while both VR and smartphone viewing conditions led to a significant positive effect on the self-reported emotions of the college students, only the smartphone viewing condition had a significant impact on the emotional well-being of the elderly participants. For college students, immersive VR had a stronger effect on inducing positive emotions than smartphone, but for elderly people, the smartphone viewing condition was more effective in improving emotional wellbeing than immersive VR. An analysis of the qualitative data from interviewing the elderly participants also revealed a divergence in the acceptance of VR technologies among elderly adults, and the sense of telepresence had both positive and negative effects on the elderly participants' emotions and experiences.
Loucks L, Yasinski C, Norrholm SD, et al. You can do that?!: Feasibility of virtual reality exposure therapy in the treatment of PTSD due to military sexual trauma. <i>Journal of Anxiety</i> <i>Disorders</i> . 2019;61:55-63. doi:10.1016/j.janxdis.2018.0 6.004	This initial feasibility study examined the use of virtual reality exposure therapy (VRE) in the treatment of MST-related PTSD, with newly developed content tailored to MST. Participants included 15 veterans (26% male) with MST-related PTSD. Assessment of PTSD, depression, and psychophysiological indicators of distress occurred at pre-treatment, post-treatment, and 3-month follow-up. Treatment included 6–12 VRE sessions. There were significant reductions in pre-to post-treatment PTSD (CAPS severity: $t(10) = 3.69$ , p = .004; PCL-5: $t(10) = 3.79$ , p = .004) and depressive symptoms, (PHQ-9: $t(8) = 2.83$ , p = .022), which were maintained at follow-up. There also was a significant pre- to post-treatment reduction in heart rate response to a trauma cue. Cohen's d effect sizes were large (CAPS: d = 1.11; PCL-5: d = 1.14, PHQ-9: d = .94), and the percentage of participants meeting PTSD criteria continued to decline from post-treatment (53%) to follow-up (33%). Findings indicate VRE can be safely delivered and is a promising treatment for MST-related PTSD.





Lu Z, Wang W, Yan W, Kew CL, Seo JH, Ory M. The Application of Fully Immersive Virtual Reality on Reminiscence Interventions for Older Adults: Scoping Review. *JMIR Serious Games*. 2023;11:e45539. Published 2023 Oct 6. doi:10.2196/45539 **Background:** The increasing number of older adults with mental, behavioral, and memory challenges presents significant public health concerns. Reminiscence is one type of nonpharmacological intervention that can effectively evoke memories, stimulate mental activities, and improve psychological well-being in older adults through a series of discussions on previous experiences. Fully immersive virtual reality (FIVR) may be a useful tool for reminiscence interventions because it uses realistic virtual environments connected to a person's significant past stories. **Objective:** This review aims to examine empirical evidence regarding the application of FIVR in reminiscence interventions, its usability and acceptability, and its effectiveness in assisting the intervention to achieve optimal outcomes. Methods: We followed the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) approach for scoping reviews. The PubMed, PsycINFO, Embase, CINAHL, Web of Science, ACM, and IEEE Xplore electronic databases were used for the search. We included peer-reviewed studies that used FIVR as an assistive tool for reminiscence interventions; were published between January 1, 2000, and August 1, 2022; reported empirical research; involved older adults as participants; and addressed health- and behavior-related outcomes or the feasibility and usability of FIVR. We used Endnote X9 to organize the search results and Microsoft Excel for data extraction and synthesis. **Results:** Of the 806 articles collected from the databases and other resources, 11 were identified. Most of the studies involved participants aged between 70 and 90 years. Only 1 study did not involve those with cognitive impairments, whereas 3 specifically targeted people living with dementia. The results indicated that FIVR reminiscence interventions enhanced engagement and reduced fatigue. Although some studies have observed positive effects on anxiety, apathy, depression, cognitive functions, and caregiver burden reduction, these findings were inconsistent across other research. In addition, FIVR showed overall usability and acceptability with manageable side effects among older adults across various health conditions during reminiscence sessions. However, 1 study reported adverse feelings among participants, triggered by unpleasant memories evoked by the virtual reality content. Conclusions: The role of FIVR in reminiscence interventions remains nascent, with limited studies evaluating its impacts on older adults. Many of the reviewed studies had notable limitations: small sample sizes, absence of rigorous research design, limited assessment of long-term effects, lack of measures for health and behavior outcomes, and quality of life. Beyond these limitations, this review identified a list of future research directions in 6 categories. On the basis of the review findings, we provide practical recommendations to enhance FIVR reminiscence interventions, covering topics such as virtual reality content, device choice, intervention types, and the role and responsibility of facilitators.




Lucifora C, Grasso GM, Nitsche MA, et al. Enhanced fear acquisition in individuals with evening chronotype. A virtual reality fear conditioning/extinction study. <i>Journal of Affective Disorders</i> . 2022;311:344- 352. doi:10.1016/j.jad.2022.05.03 3	Circadian rhythms have received increasing attention within the context of mental disorders. Evening chronotype has been associated with enhanced risk to develop anxiety and post-traumatic stress disorder (PTSD). The classical fear conditioning paradigm is a powerful tool to reveal key mechanisms of anxiety and PTSD. We used this paradigm to study the neurocognitive basis of the association between chronotype and fear responses in healthy humans. 20 participants with evening chronotype and 20 controls (i.e., intermediate chronotype) completed a 2-day Pavlovian fear learning and extinction virtual reality task. Participants received fear conditioning, and extinction learning on day 1. Extinction memory recall was tested on day 2. To address interactions between chronotype and time of day of the fear conditioning, and extinction performance, half of the participants were tested in the morning, and the other half in the evening. Skin conductance response (SCR) and subjective fear ratings were measured as primary outcomes. Chronotype was established via the morningness–eveningness questionnaire (MEQ). We found an overall higher SCR for fear acquisition in participants with the evening chronotype profile, compared to controls. Moreover, the higher the MEQ scores –indicative of less eveningness – the lower the SCR was. No effects of chronotype were found for extinction and extinction recall. The higher vulnerability of the evening chronotype for anxiety and related disorders may thus be explained by enhanced fear acquisition of this group.
Ma J, Zhao D, Xu N, Yang J. The effectiveness of immersive virtual reality (VR) based mindfulness training on improvement mental- health in adults: A narrative systematic review. <i>Explore</i> <i>(NY)</i> . 2023;19(3):310-318. doi:10.1016/j.explore.2022.0 8.001	<b>Objective:</b> In recent years, digital techniques, such as virtual reality (VR) has been employed in tandem with more traditional psychological interventions. The aim of this study is to investigate whether VR-based mindfulness training can improve mental health outcomes, and notably mindfulness levels amongst adults. In addition, this review seeks to summarise the various designed VR scenarios, as well as those elements around VR that may assist people in practising mindfulness and meditation. <b>Methods:</b> The search for eligible studies for inclusion was conducted via the following databases: the Applied Social Science Index & Abstract (ASSIA), PsychINFO, Medline, EMBASE, and the Webof-Science Core Collection. Only experimental studies were eligible for inclusion, and specifically, those that compared the effectiveness of mindfulness training using immersive VR (on the one hand) with a control condition. <b>Results:</b> This search generated 2523 articles published between 2016 and 2022, and of these, 106 were assessed for eligibility. This review included seven studies, with a collective total of 798 participants. VR-based mindfulness - it improves levels of mindfulness and meditation experience; but also shown to reduce anxiety, depression, improve sleep quality, emotion regulation, and generate mood improvement. VR-based mindfulness training frequently contains natural 'environmentally relevant' elements, such as forest, grassland, caves, sea, etc. <b>Conclusions:</b> This review suggests that using VR to assist mindfulness training is an effective and innovative way to improve mental health conditions within the adult population. Further directions and limitations are discussed.





	Maples-Keller JL, Jovanovic T, Dunlop BW, et al. When translational neuroscience fails in the clinic: Dexamethasone prior to virtual reality exposure therapy increases drop-out rates. <i>Journal of Anxiety</i> <i>Disorders</i> . 2019;61:89-97. doi:10.1016/j.janxdis.2018.1 0.006	Posttraumatic stress disorder (PTSD) is characterized by exaggerated expression of fear responses to danger and safety cues. Translational research suggests that dexamethasone facilitates fear extinction in animal and human fear conditioning models. For this randomized, placebo-controlled trial (N = 27), we aimed to translate these findings to the clinic by using virtual reality exposure (VRE) therapy for OEF/OIF/OND veterans with PTSD to determine whether dexamethasone will increase the efficacy of exposure therapy for VRE relative to placebo. VRE sessions involved imaginal exposure to the most traumatic war memories while viewing a computer-generated view of virtual Iraq or Afghanistan with multisensory stimulus options used to match patient's description of the trauma. VRE was effective in reducing PTSD symptoms but there was no interaction with dexamethasone. Drop-out rate was significantly higher in the dexamethasone group, with 10 of 13 (76.9%) participants in this group discontinuing, compared to only 4 of 14 (28.5%) in the placebo group, $\chi 2 = 6.31$ , p = 0.02. Results indicate that the dexamethasone group may have experienced an increase in PTSD symptoms, particularly re-experiencing, at session 2 following first drug administration. Contrary to study hypotheses, dexamethasone did not enhance exposure therapy outcomes and was associated with increased drop-out. This demonstrates potential pitfalls in translating neuroscience models to the clinic; future research carefully examining glucocorticoid mechanisms involved in therapy augmentation is warranted.
ľ	Maples-Keller JL, Price M,	Several cognitive behavioral therapeutic approaches have been demonstrated
	Rauch S, Gerardi M,	to be effective in reducing post-traumatic stress disorder (PISD) symptoms
	Rothbaum BO. Investigating	(Foa, Keane, Friedman, & Conen, 2008). The bulk of PTSD treatment research
	Relationships Between PISD	has relied on pre-post designs, which are limited in their ability to investigate the
	Symptom Clusters Within	therapeutic process over time. The present study investigated the relations
		between PISD symptom clusters using symptom assessment at pretreatment,
	Veterapy IOI OEF/OIF	midtreatment, and positreatment using cross-tagged panel design over the
		and/or Afghanistan votorang who mot DSM IV criteria for PTSD due to military
	2017,40(2).147-133.	trauma Using structural equation modeling the final reconcision model
	011	demonstrated good fit $x^2(34)=39.95$ n= 22: RMSEA= 034.90% CI: [0.00.0.07]
	011	CEL= 993 and results suggested that recoveriencing at pretreatment
		demonstrated a significant effect on numbing avoidance, hyperarousal at
		a demonstrated a significant effect of numbing, avoluance, hyperarousal al
		midtreatment, and reexperiencing symptoms at midtreatment demonstrate a
		midtreatment, and reexperiencing symptoms at midtreatment demonstrate a
		midtreatment, and reexperiencing symptoms at midtreatment demonstrate a significant effect on each of the three symptom clusters at posttreatment. These findings suggest that reexperiencing symptoms are indeed a key aspect of the
		midtreatment, and reexperiencing symptoms at midtreatment demonstrate a significant effect on each of the three symptom clusters at posttreatment. These findings suggest that reexperiencing symptoms are indeed a key aspect of the therapeutic process within exposure therapy for PTSD. Additional research
		midtreatment, and reexperiencing symptoms at midtreatment demonstrate a significant effect on each of the three symptom clusters at posttreatment. These findings suggest that reexperiencing symptoms are indeed a key aspect of the therapeutic process within exposure therapy for PTSD. Additional research examining the impact of reexperiencing focused intervention strategies on
		midtreatment, and reexperiencing symptoms at midtreatment demonstrate a significant effect on each of the three symptom clusters at posttreatment. These findings suggest that reexperiencing symptoms are indeed a key aspect of the therapeutic process within exposure therapy for PTSD. Additional research examining the impact of reexperiencing-focused intervention strategies on treatment outcomes is warranted.





Maples-Keller JL, Rauch SAM, Jovanovic T, et al. Changes in traumapotentiated startle, skin conductance, and heart rate within prolonged exposure therapy for PTSD in high and low treatment responders. *Journal of Anxiety Disorders*. 2019;68:102147. doi:10.1016/j.janxdis.2019.1 02147 While exposure-based psychotherapy is recommended as a first-line treatment for posttraumatic stress disorder (PTSD) given strong evidence for its effectiveness, some patients fail to receive full benefit. Psychophysiological data may be important complementary indices for investigating variability in treatment response and changes over the course of treatment. The focus of the present investigation was to examine change in psychophysiological indices preto post-treatment and to investigate if changes differed for high versus low PTSD treatment responders. Participants included veterans with primary PTSD diagnoses who received a two-week intensive prolonged exposure (PE) treatment. Psychophysiological assessment included trauma-potentiated startle, heart rate, and skin conductance recordings during presentation of three standard virtual reality (VR)-based, trauma-relevant scenes presented through a head mounted display. Results indicate that 48.6% were classified as high treatment responders (≥50% reduction in PCL-5 from baseline). Traumapotentiated startle was observed in all patients at pre-treatment, F = 13.58, p < .001, in that startle magnitude was increased during VR stimuli relative to baseline regardless of responder status. However, in high treatment responders, there was an interaction of VR with time, F = 14.10, p = .001; VR scenes did not potentiate startle post-treatment. Specifically, high treatment responders were less reactive to trauma stimuli following PE treatment. There was no effect of time in the low responder group. Heart rate reactivity data revealed a significant main effect of treatment, F = 45.7, p = .035, but no significant interaction with responder status. Skin conductance reactivity did not significantly change from pre to post-treatment. These results suggest that trauma-potentiated startle may represent an objective marker of fear- and anxiety-related symptom reduction that is sensitive to both traditional outpatient as well as intensive treatment approaches.





McLay RN, Baird A, Webb- Murph J, et al. AVirtual reality exposure therapy (VRET) is one of the few interventions supported by randomized controlled trials for the treatment of combat-related posttraumatic stress disorder (PTSD) in active duty service members. ARandomized, Head-to-Head Romonized Study of Virtual Reality Exposure Therapy for Posttraumatic Stresscomparative effectiveness study was conducted to determine if virtual reality technology itself improved outcomes, or if similar results could be achieved with a control exposure therapy (CET) condition. Service members with combat- related PTSD were randomly selected to receive nine weeks of VRET or CET. Assessors, but not therapists, were blinded. PTSD symptom improvement was assessed one week and 3 months after the conclusion of treatment using the clinician-administered PTSD scale (CAPS). A small crossover component was included. Results demonstrated that PTSD symptoms improved with both treatments, but there were no statistically significant differences between groups. Dropout rates were higher in VRET. Of those who received VRET, 13/42 (31%) showed >30% improvement on the CAPS, versus 16/43 (37%) who received CET. Three months after treatment, >30% improvement was seen in 10/33 (30%) of VRET participants and 12/33 (36%) in CET. Participants who crossed over (n = 11) showed no statistically significant improvement si na second round of treatment, regardless of condition. This study supported the utility of exposure therapy for PTSD, but did not support additional benefit by the inclusion of virtual reality. (WR) technologies in the treatment of PTSD. Indeed, we exploit full capabilities of VR technologies in the treatment of PTSD. Indeed, we exploit full capabilities of VR technologies in the treatment of PTSD. Indeed, we exploit full capabilities of VR technologies in the treatment of PTSD. Indee		
Murphy J, et al. Aby randomized controlled trials for the treatment of combat-relatedRandomized, Head-to-Headposttraumatic stress disorder (PTSD) in active duty service members. AStudy of Virtual Realitycomparative effectiveness study was conducted to determine if virtual realityExposure Therapy fora control exposure therapy (CET) condition. Service members with combat-Disorder. CyberpsycholBehav Soc Netw.2017;20(4):218-224.doi:10.1089/cyber.2016.0554doi:10.1089/cyber.2016.0554clinician-administered PTSD scale (CAPS). A small crossover component was included. Results demonstrated that PTSD symptoms improved with both treatments, but there were no statistically significant differences between groups. Dropout rates were higher in VRET. Of those who received VRET, 13/42 (31%) showed >30% improvement on the CAPS, versus 16/43 (37%) who received CET. Three months after treatment, >30% improvement was seen in 10/33 (30%) of VRET participants and 12/33 (36%) in CET. Participants who crossed over (n = 11) showed no statistically significant improvements in a second round of treatment, regardless of condition. This study supported the utility of exposure therapy for PTSD, but did not support additional benefit by the inclusion of virtual reality (VR) technologies in the treatment of PTSD. Indeed, we exploit full capabilities of VR technologies on to only expose the user to the frightening stimuli but also to allow him to be active in this environment that may contain anxiety-provoking stimuli. These two aspects are supported throughout a gamification process where the game mechanics are mapped to the expected learning mechanics. Moreover, the developed simulator is fully customizable. Two truck drivers suffering from PTSD have experimented it. The	McLay RN, Baird A, Webb-	Virtual reality exposure therapy (VRET) is one of the few interventions supported
Randomized, Head-to-Head Study of Virtual Reality Exposure Therapy for Posttraumatic Stressposttraumatic stress disorder (PTSD) in active duty service members. A comparative effectiveness study was conducted to determine if virtual reality technology itself improved outcomes, or if similar results could be achieved with a control exposure therapy (CET) condition. Service members with combat- related PTSD were randomly selected to receive nine weeks of VRET or CET. Assessors, but not therapists, were blinded. PTSD symptom improvement was assessed one week and 3 months after the conclusion of treatment using the clinician-administered PTSD scale (CAPS). A small crossover component was included. Results demonstrated that PTSD symptoms improved with both treatments, but there were no statistically significant differences between groups. Dropout rates were higher in VRET. Of those who received VRET, 13/42 (31%) showed >30% improvement on the CAPS, versus 16/43 (37%) who received CET. Three months after treatment, >30% improvement was seen in 10/33 (30%) of VRET participants and 12/33 (36%) in CET. Participants who crossed over (n = 11) showed no statistically significant improvements in a second round of treatment, regardless of condition. This study supported the utility of exposure therapy for PTSD, but did not support additional benefit by the inclusion of virtual reality.Menelas BAJ, Haidon C, Ecrepont A, Girard B. Use of virtual reality technologies as an Action-Cue Exposure therapy for truck drivers suffering from Post- Traumatic Stress Disorder.This work describes a truck-driving simulator designed for the care of truckers suffering from Post- therapy for truck drivers suffering from Post- therapy for truck drivers suffering from Post- theraping from Post- therapy for truck drivers suffering from Post- thexepted learning	Murphy J, et al. A	by randomized controlled trials for the treatment of combat-related
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Miskowiak KW, Jespersen AE, Kessing LV, et al. Cognition Assessment in Virtual Reality: Validity and feasibility of a novel virtual reality test for real-life cognitive functions in mood disorders and psychosis spectrum disorders. *J Psychiatr Res*. Published online December 12, 2021. doi:10.1016/j.jpsychires.202 1.12.002

There is a pressing need for measures of real-life cognitive functioning in patients with mood or psychotic disorders in clinical settings and treatment trials targeting cognition. We developed the first immersive virtual reality cognition assessment tool, the Cognition Assessment in Virtual Reality (CAVIR), which assesses verbal memory, processing speed, attention, working memory and planning skills in an interactive virtual reality kitchen scenario. This study investigates the sensitivity and validity of the CAVIR for cognitive impairments in mood and psychotic disorders and its association with functioning and neuropsychological performance. Symptomatically stable patients with mood disorders (MD; n = 40) or psychosis spectrum disorders (PSD; n = 41) and healthy control participants (HC; n = 40) completed the CAVIR and standard neuropsychological tests and were rated for clinical symptoms and daily functioning. We found that the CAVIR was sensitive to cognitive impairments across MD and PSD with large effect sizes (MD: F(73) = 11.61, p < .01,  $\eta p^2 = 0.14$ ; PSD: F(72) = 18.24, p < .001, np<sup>2</sup> = 0.19). There was a moderate to strong positive correlation between performance on the CAVIR and on neuropsychological tests (r(121) = 0.58, p < .001), which prevailed after adjustment for age, years of education and verbal IQ (B = 0.67, p < .001). Lower CAVIR scores correlated moderately with more observer-rated and performance-based functional disability (r(121) = -0.30, p < .01 and r(68) = 0.44, p < .001, respectively), alsoafter adjustment for age, years of education and verbal IQ (B = 0.03, p < .001). In conclusion, the CAVIR is a sensitive and valid instrument for measuring real-life cognitive impairments in mood and psychotic disorders. After further psychometric assessments, the CAVIR can be implemented in clinical settings and trials targeting cognition.





Mocco A, Valmaggia L, Bernardi L, Alfieri M, Tarricone I. Enhancing Physical Activity with Immersive Virtual Reality: A Systematic Review. <i>Cyberpsychol Behav</i> <i>Soc Netw.</i> Published online March 20, 2024. doi:10.1089/cyber.2023.039 4	The aim of this article is to review how immersive virtual reality-enhanced physical activity (IVR-PA) can be used to improve psychological, physiological, and performance outcomes linked to exercising and to compare it with non-immersive virtual reality-enhanced physical activity (nIVR-PA) and with traditional physical activity (TR-PA). We also aimed to explore the effectiveness of IVR-PA in promoting psychological well-being and engagement in physical activity. A systematic literature review (Prospero CRD42022330572) was conducted following Preferred Reporting Items for Systematic Reviews and Meta-Analysis guidelines. OVID (including Medline, Embase, GlobalHealth, and APA PsychInfo), Web of Science, and Sport Discuss were searched. The quality of the studies was assessed using the Effective Public Health Practice Project Quality Assessment. The search identified 26,548 titles. After screening, 20 studies (the total number of participants was 798) published between 2009 and 2023 were included in this systematic review. The quality of the studies was rated as weak ( $n = 9$ ), moderate ( $n = 10$ ), or strong ( $n = 1$ ). Overall, the reviewed studies indicated that, compared with TR-PA and nIVR-PA, IVR-PA was associated with an increase in enjoyment of physical activity, a reduction in perceived exertion, and increased rates of self-efficacy, intrinsic motivation, and exercise intention. Furthermore, some studies showed higher muscular strength and aerobic increase after an IVR-PA intervention compared with TR-PA. The findings suggest that IVR-PA can improve psychological, physiological, and performance outcomes linked to exercising, as well as improving psychological well-being and engagement in physical activity. However, owing to the methodological limitations of the reviewed studies, further research is
Mohr DC, Burns MN,	<b>Objective:</b> A technical expert panel convened by the Agency for Healthcare
Schueller SM, Clarke G,	Research and Quality and the National Institute of Mental Health was charged
Klinkman M. Behavioral	with reviewing the state of research on behavioral intervention technologies
Intervention lechnologies: Evidence review and	(BITS) in mental health and identifying the top research priorities. Bits refers to
recommendations for future	communication technology features to address behavioral and mental health
research in mental health.	outcomes. <b>Method:</b> This study on the findings of the technical expert panel.
General Hospital Psychiatry.	<b>Results:</b> Videoconferencing and standard telephone technologies to deliver
doi:10.1016/j.genhosppsych	efficacy across a broad range of mental health outcomes. Social media such as
.2013.03.008	online support groups have produced disappointing outcomes when used alone.
	Mobile technologies have received limited attention for mental health
	outcomes. Virtual reality has shown good efficacy for anxiety and pediatric disorders. Serious gaming has received little work in mental health.
	Research focused on understanding reach, adherence, barriers and cost is
	recommended. Improvements in the collection, storage, analysis and
	visualization of big data will be required. New theoretical models and evaluation
	strategies will be required. Finally, for BITs to have a public health impact,
	research on implementation and application to prevention is required.





Moreno-Fernández RD, García-León D, Peñas G, Martín-Romero R, Buades-Sitjar F, Sampedro-Piquero P. Immersive virtual plus-maze to examine behavior and psychophysiological-related variables in young people with problematic alcohol and cannabis consumption. *Neurobiology of Stress*. 2023;26:100564. doi:10.1016/j.ynstr.2023.100 564 Stressful events appear to be risky situations that can precipitate the consumption of drugs. One way to recreate stressful contexts, in an ecological and controlled method, is through immersive virtual reality (VR). In our study, we designed the scenario of an elevated plus-maze (EPM) using VR, which is widely used in animal models to assess unconditioned anxiety. This task allowed us to analyze the behavioral, psychophysiological (heart rate and electrodermal activity), and hormonal response (salivary cortisol and Alpha-amylase) to this stressful situation in different moments (before VR task (anticipation), at the end of the task and 10 minutes later) in young people with problematic alcohol use (AU, n = 27), alcohol combined with cannabis consumption (AU + C, n = 10), as well as in a control group (CO, n = 33). Behavioral analysis revealed that the AU group displayed fewer entries into open arms than the CO group, whereas both experimental groups spent less time at the end of the open arms, as well as lower time by look down index compared to the CO group. Moreover, our VR EPM induced different psychophysiological responses in the different moments measured. In general, electrodermal activity seemed to be a good biomarker of recovery from a stressful situation, as once the exposure to the stressful situation ended, the AU + C group took longer to recover compared to the CO group. Regarding hormonal analyses, we observed a similar response pattern in all groups suggesting that our VR task was able to activate both stress systems. The alpha-amylase to cortisol ratio, proposed as a biomarker of stress systems dysregulation, was higher in the group of young participants with alcohol abuse. Interestingly, our VR EPM was able to induce a slight alcohol craving in both experimental groups. In conclusion, our results suggest certain subtle behavioral and physiological differences that could be used to detect young individuals at risk of future severe addictions or other stress-related comorbidities. Moreover, it could help us to develop prevention strategies focused on emotional, cognitive, and psychophysiological aspects.





Norrholm SD, Jovanovic T,	Baseline cue-dependent physiological reactivity may serve as an objective
Gerardi M, et al. Baseline	measure of posttraumatic stress disorder (PTSD) symptoms. Additionally, prior
psychophysiological and	animal model and psychological studies would suggest that subjects with
cortisol reactivity as a	greatest symptoms at baseline may have the greatest violation of expectancy to
predictor of PTSD treatment	danger when undergoing exposure based psychotherapy: thus treatment
outcome in virtual reality	approaches which enhanced the learning under these conditions would be
exposure therapy <i>Behav</i> Res	optimal for those with maximal baseline cue-dependent reactivity. However
Ther 2016:82:28-37	methods to study this hypothesis objectively are lacking. Virtual reality (VB)
doi:10.1016/i brat 2016.05.0	methodologies have been successfully employed as an enhanced form of
02	imaginal prolonged exposure therapy for the treatment of PTSD. Our goal was to
02	examine the predictive nature of initial psychophysiological (e.g. startle, skin
	examine the predictive nature of initial psychophysiological (e.g., startle, skin
	conductance, near rate) and stress normone responses (e.g., contisol) during
	presentation of VR-based combat-related stimution PTSD treatment outcome.
	Compativeterans with PTSD underwent 6 weeks of VR exposure therapy
	combined with either d-cycloserine (DCS), alprazolam (ALP), or placebo (PBO).
	In the DCS group, startle response to VR scenes prior to initiation of treatment
	accounted for 76% of the variance in CAPS change scores, p < 0.001, in that
	higher responses predicted greater changes in symptom severity over time.
	Additionally, baseline cortisol reactivity was inversely associated with treatment
	response in the ALP group, p = 0.04. We propose that baseline cue-activated
	physiological measures will be sensitive to predicting patients' level of response
	to exposure therapy, in particular in the presence of enhancement (e.g., DCS).
O'Connor S, Mayne A, Hood	<b>Objectives:</b> To identify and synthesize the scientific literature on virtual reality
B. Virtual Reality-Based	(VR)-based mindfulness applications for the management of chronic pain in
Mindfulness for Chronic Pain	adults. Design: A scoping review methodology was followed and conducted
Management: A Scoping	according to Preferred Reporting Items for Systematic Review and Meta-
Review. Pain Management	Analyses extension for Scoping Reviews guideline. Data sources: Combinations
Nursing. 2022;23(3):359-	of key words related to "virtual reality", "mindfulness", and "chronic pain" were
369.	searched for in PubMed, CINAHL, EMBASE, Scopus, and the Cochrane library
doi:10.1016/j.pmn.2022.03.	databases. Title, abstracts, and full-text articles were screened against inclusion
013	criteria. Review/Analysis methods: Braun and Clarke's thematic analysis
	approach was used. Results: Seven studies were included in the review and
	their findings synthesized into three overarching themes: (1) physical and mental
	health benefits; (2) treatment engagement and satisfaction; and (3) intervention
	usability. The last theme had four subthemes which were cybersickness,
	physical limitations, technical support, and personalized design. <b>Conclusions:</b>
	While studies suggested VR could improve chronic pain management by
	enhancing the practice of mindfulness, weak study designs and small sample
	sizes limited the utility of the review results. Future research should rigorously
	co-design and test VR-based mindfulness applications with people with chronic
	pain to assess if they improve health and other outcomes.





Painter DR, Norwood MF, Marsh CH, et al. Immersive virtual reality gameplay detects visuospatial atypicality, including unilateral spatial neglect, following brain injury: a pilot study. <i>J Neuroeng Rehabil</i> . 2023;20(1):161. Published 2023 Nov 23. doi:10.1186/s12984-023- 01283-9	<b>Background:</b> In neurorehabilitation, problems with visuospatial attention, including unilateral spatial neglect, are prevalent and routinely assessed by pen- and-paper tests, which are limited in accuracy and sensitivity. Immersive virtual reality (VR), which motivates a much wider (more intuitive) spatial behaviour, promises new futures for identifying visuospatial atypicality in multiple measures, which reflects cognitive and motor diversity across individuals with brain injuries. <b>Methods:</b> In this pilot study, we had 9 clinician controls (mean age 43 years; 4 males) and 13 neurorehabilitation inpatients (mean age 59 years; 9 males) recruited a mean of 41 days post-injury play a VR visual search game. Primary injuries included 7 stroke, 4 traumatic brain injury, 2 other acquired brain injury. Three patients were identified as having left sided neglect prior to taking part in the VR. Response accuracy, reaction time, and headset and controller raycast orientation quantified gameplay. Normative modelling identified the typical gameplay bounds, and visuospatial atypicality was defined as gameplay beyond these bounds. <b>Results:</b> The study found VR to be feasible, with only minor instances of motion sickness, positive user experiences, and satisfactory system usability. Crucially, the analytical method, which emphasized identifying 'visuospatial atypicality,' proved effective. Visuospatial atypicality was more commonly observed in patients compared to controls and was prevalent in both groups of patients-those with and without neglect. <b>Conclusion:</b> Our research indicates that normative modelling of VR gameplay is a promising tool for identifying visuospatial atypicality are acute brain injury.
Borra A. Galatti A	Packground: Cognitive impairment is a frequent consequence of hipelar
Zaccheddu R, et al. A Recovery-Oriented Program for People with Bipolar Disorder through Virtual Reality-Based Cognitive Remediation: Results of a Feasibility Randomized Clinical Trial. <i>J Clin Med</i> . 2023;12(6):2142. Published 2023 Mar 9. doi:10.3390/jcm12062142	<b>Background:</b> Cognitive impainment is a nequence consequence of hipotan disorder (BD) that is difficult to prevent and treat. In addition, the quality of the preliminary evidence on the treatment of BD through Cognitive Remediation (CR) with traditional methods is poor. This study aims to evaluate the feasibility of a CR intervention with fully immersive Virtual Reality (VR) as an additional treatment for BD and offers preliminary data on its efficacy. <b>Methods:</b> Feasibility randomized controlled cross-over clinical study, with experimental condition lasting three months, crossed between two groups. Experimental condition: CR fully immersive VR recovery-oriented program plus conventional care; Control condition: conventional care. The control group began the experimental condition after a three months period of conventional care (waiting list). After the randomization of 50 people with BD diagnosis, the final sample consists of 39 participants in the experimental condition and 25 in the control condition because of dropouts. <b>Results:</b> Acceptability and tolerability of the intervention were good. Compared to the waitlist group, the experimental group reported a significant improvement regarding cognitive functions (memory: $p = 0.003$ ; attention: $p = 0.002$ , verbal fluency: $p = 0.010$ , executive function: $p = 0.003$ ), depressive symptoms ( $p = 0.029$ ). <b>Conclusions:</b> The results are preliminary and cannot be considered exhaustive due to the small sample size. However, the evidence of efficacy, together with the good acceptability of the intervention, is of interest. These results suggest the need to conduct studies with larger





Perra A, Riccardo CL, De	Background: Cognitive Remediation (CR) programs are effective for the
Lorenzo V, et al. Fully	treatment of mental diseases; in recent years, Virtual Reality (VR) rehabilitation
Immersive Virtual Reality-	tools are increasingly used. This study aimed to systematically review and meta-
Based Cognitive	analyze the published randomized controlled trials that used fully immersive VR
Remediation for Adults with	tools for CR programs in psychiatric rehabilitation. We also wanted to map
Psychosocial Disabilities: A	currently published CR/VR interventions, their methods components, and their
Systematic Scoping Review	evidence base, including the framework of the development intervention of CR in
of Methods Intervention	fully immersive VR. Methods: Level 1 of evidence. This study followed the
Gaps and Meta-Analysis of	PRISMA extension for Scoping Reviews and Systematic Review. Three electronic
Published Effectiveness	databases (Pubmed, Cochrane Library, Embase) were systematically searched,
Studies. Int J Environ Res	and studies were included if they met the eligibility criteria: only randomized
Public Health.	clinical trials, only studies with fully immersive VR, and only CR for the adult
2023;20(2):1527. Published	population with mental disorders. <b>Results:</b> We found 4905 (database) plus 7
2023 Jan 14.	(manual/citation searching articles) eligible studies. According to inclusion
doi:10.3390/ijerph20021527	criteria, 11 studies were finally reviewed. Of these, nine included patients with
	mild cognitive impairment, one with schizophrenia, and one with mild dementia.
	Most studies used an ecological scenario, with improvement across all cognitive
	domains. Although eight studies showed significant efficacy of CR/VR, the
	interventions' development was poorly described, and few details were given on
	the interventions' components. <b>Conclusions:</b> Although CR/VR seems to be
	effective in clinical and feasibility outcomes, the interventions and their
	components are not clearly described. This limits the understanding of the
	effectiveness and undermines their real-world implementation and the
	establishment of a gold standard for fully immersive VR/CR.
Plechatá A, Nekovářová T,	Background: A growing interest in non-pharmacological approaches aimed at
Fajnerová I. What is the	cognitive rehabilitation and cognitive enhancement pointed towards the
future for immersive virtual	application of new technologies. The complex virtual reality (VR) presented using
reality in memory	immersive devices has been considered a promising approach. <b>Objective:</b> The
rehabilitation? A systematic	article provides a systematic review of studies aimed at the efficacy of VR-based
review. NeuroRehabilitation.	rehabilitation. First, we shortly summarize literature relevant to the role of
2021;48(4):389-412.	immersion in memory assessment and rehabilitation. Methods: We searched
doi:10.3233/NRE-201534	Web of Science, ScienceDirect, and PubMed with the search terms "memory
	rehabilitation", "virtual reality", "memory deficit". Only original studies
	investigating the efficacy of complex three-dimensional VR in rehabilitation and
	reporting specific memory output measures were included. <b>Results:</b> We
	identified 412 citations, of which 21 met our inclusion criteria. We calculated
	appropriate effect sizes for 10 studies including control groups and providing
	descriptive data. The effect sizes range from large to small, or no effect of
	memory rehabilitation was present, depending on the control condition applied.
	Summarized studies with missing control groups point out to potential positive
	effects of VR but do not allow any generalization. Conclusions: Even though
	there are some theoretical advantages of immersive VE over non-immersive
	technology, there is not enough evidence yet to draw any conclusions.





Plechatá A, Sahula V, Fayette D, Fajnerová I. Age-Related Differences With Immersive and Non-immersive Virtual Reality in Memory Assessment. <i>Front Psychol</i> . 2019;10:1330. Published 2019 Jun 11. doi:10.3389/fpsyg.2019.013 30	Memory decline associated with physiological aging and age-related neurological disorders has a direct impact on quality of life for seniors. With demographic aging, the assessment of cognitive functions is gaining importance, as early diagnosis can lead to more effective cognitive interventions. In comparison to classic paper-and-pencil approaches, virtual reality (VR) could offer an ecologically valid environment for assessment and remediation of cognitive deficits. Despite the rapid development and application of new technologies, the results of studies aimed at the role of VR immersion in assessing cognitive performance and the use of VR in aging populations are often ambiguous. VR can be presented in a less immersive form, with a desktop platform, or with more advanced technologies like head-mounted displays (HMDs). Both these VR platforms are associated with certain advantages and disadvantages. In this study, we investigated age-related differences related to the use of desktop and HMD platforms during memory assessment using an intra-subject design. Groups of seniors ( <i>N</i> = 36) and young adults ( <i>N</i> = 25) completed a virtual Supermarket Shopping task using desktop and HMD platforms. The ability to recall a shopping list in the young adult group remained stable regardless of the platform used. With the HMD platform, the performance of the subjects of both groups seemed to be more influenced by fatigue. The evaluated user experiences did not differ between the two platforms, and only minimal and rare side effects were reported by seniors. This implies that highly immersive technology has good acceptance among aging adults. These findings might have implications for the further use of HMD in cognitive assessment and remediation.
Poetar CR, Bradley N, Voinescu A. Immersive virtual reality or computerised mindfulness meditation for improving mood? Preliminary efficacy from a pilot randomised trial. <i>Front Psychol</i> . 2023;14:1157469. Published 2023 Oct 25. doi:10.3389/fpsyg.2023.115 7469	<b>Introduction:</b> Mindfulness interventions are effective in improving mood, reducing stress, and increasing quality of life. New developments in technology bring important channels to deliver mindfulness interventions that can increase accessibility, such as the Internet, computerised interventions, mobile apps and recently, virtual reality (VR). The aim of the present study is to enhance our current understanding of the use of VR in mindfulness, namely we examined in a pilot randomised trial the efficacy of an immersive VR-based mindfulness approach compared to an active control (computerised-based mindfulness meditation) on improving mood. A secondary objective was to examine whether VR use resulted in simulator sickness which could affect user engagement. <b>Methods:</b> Forty-seven ( $M_{age} = 29.22 \text{ years}$ ) healthy participants were randomly assigned to the experimental or control group. <b>Results:</b> A mixed 2X3 ANOVA showed a significant Time effect. Namely, negative emotions were reduced in both groups, with non-significant differences between groups. For positive emotions, on the other hand, our results showed no significant impact. Simulator sickness in VR was not present, according to <i>t</i> -test, making VR a safe delivery method. <b>Discussion:</b> Future research should investigate VR dosage and combine VR with other interventions (e.g., blended with face-to-face mindfulness interventions, with Internet-delivered interventions).





Pogoda TK, Levy CE, Helmick	<b>Objective:</b> We review health services and reintegration practices that contribute
K, Pugh MJ. Health services	to the rehabilitation of US active duty service members (ADSMs) and Veterans
and renabilitation for active	who experienced traumatic brain injury (IBI), especially mild IBI (mIBI), as
duty service members and	discussed at the 2015 Department of veterans Affairs (VA) IBI State-of-the-Art
veterans with mild IBI. Brain	(SOTA) Conference. <b>Methodology:</b> We reviewed the state-of-the-art at the time
<i>Inj</i> . 2017;31(9):1220-1234.	of the previous 2008 TBI SOTA Conference, advances in the field since then, and
doi:10.1080/02699052.2016.	future directions to address gaps in knowledge. Main results: we reviewed: (1)
12/4///	m I BI and its comorbid conditions documented in ADSMs and Veterans, and
	recognized the need for additional healthcare utilization, health cost and quality
	of care studies; (2) VA vocational renabilitation programs and the effectiveness
	of supported employment for helping those with workplace difficulties; (3) the
	application of technology to assist in TBI rehabilitation, including mobile device
	applications for self-management, videoconferencing with providers, and virtual
	reality to help with behavioral and cognitive challenges, and (4) Department of
	Defense (DoD)-VA partnerships on identification, evaluation and dissemination
	of IBI best practices. <b>Conclusions:</b> There have been significant advances in IBI
	rehabilitation, but multiple areas across the DoD and VA care continuum need
	further exploration and development to meet the needs of ADSMs and Veterans.
Price M, Maples JL,	<b>Background:</b> Outcome expectancy, or the degree to which a client believes that
Jovanovic I, Norrholm SD,	therapy will result in improvement, is related to improved treatment outcomes
Heekin M, Rothbaum BO. An	for multiple disorders. There is a paucity of research investigating this relation in
investigation of outcome	regards to posttraumatic stress disorder (PISD). Additionally, the bulk of the
expectancies as a predictor	research on outcome expectancy and treatment outcomes has relied mostly on
of treatment response for	self-report outcome measures. <b>Methods:</b> The relation between outcome
combat veterans with PISD:	expectancy on self-report measures, clinician-rated measures, and two
comparison of clinician, self-	biological indices (fear-potentiated startle and cortisol reactivity) of PISD
report, and biological	symptoms was explored. The sample included combat veterans (N = 116)
measures. <i>Depress Anxiety</i> .	treated with virtual reality exposure therapy for PISD. <b>Results:</b> Results
2015;32(6):392-399.	supported a negative association between outcome expectancy and both self-
doi:10.1002/da.22354	report and clinician-rated symptoms at the conclusion of treatment, but
	outcome expectancy was related to the magnitude of change during treatment
	for self-report measures only. Outcome expectancy was unrelated to biological
	measures of treatment response. Conclusions: These findings suggest that
	outcome expectancy may be related to patient and clinician perceptions of
	outcomes, but not biological indices of outcome for PISD.
Pugnetti L, Mendozzi L,	Immersive virtual reality (IVR) is a technology already developed to assist
Motta A, Cattaneo A,	cognitive psychologists and therapists in their clinical work with brain-damaged
Barbieri E, Brancotti A.	patients. The rationale, the software and the hardware of the first application
Evaluation and retraining of	(ARCANA 1) based on affordable technology are discussed here, in order to
adults' cognitive	provide a concrete example of what the authors think may be the role of IVR as a
impairments: Which role for	clinical tool. Although prospects are exciting, extensive research is needed to
virtual reality technology?	validate this new approach and reveal its limitations and advantages.
Computers in Biology and	
Medicine. 1995;25(2):213-	
227. doi:10.1016/0010-	
4825(94)00040-W	





Pyne JM, Constans JI, Wiederhold BK, et al. Predicting Post-Traumatic Stress Disorder Treatment Response Using Heart Rate Variability to Virtual Reality Environment and Modified Stroop Task: An Exploratory Study. <i>Cyberpsychol Behav</i> <i>Soc Netw.</i> 2023;26(12):896- 903. doi:10.1089/cyber.2023.016 4	Predicting treatment response can inform treatment decisions, expectations, and optimize use of mental health treatment resources. This study examined heart rate (HR), heart rate variability (HRV), and a modified Stroop task (mStroop) to predict post-traumatic stress disorder (PTSD) treatment response. We report on an observational, longitudinal study with 45 U.S. veterans in outpatient PTSD care, who had deployed to Iraq or Afghanistan. HR and HRV were collected before, during, and after virtual reality (VR) combat and civilian scenes. HRV recovery was defined as HRV after a 3-minute VR simulation minus HRV during a VR scene. mStroop threat variables included index scores for combat and general threat. Self-report data were collected at baseline and 6 months later. The outcome variable was the 17-item Clinician Administered PTSD Scale (CAPS). Controlling for baseline CAPS and number of combat experiences, the following baseline HRV recovery variables were significant predictors of 6-month CAPS: standard deviation of normal beat to beat interval (SDNN) after combat scene minus SDNN during combat scene. HRV at rest, HR reactivity, HR recovery, and mStroop scores did not predict treatment response. In conclusion, HRV recovery variables in the context of a standardized VR stressor were significant predictors of PTSD treatment response after controlling for baseline CAPS and number of combat experiences. The direction of this relationship indicates that greater baseline HRV recovery predicts lower 6- month PTSD symptom severity. This was an exploratory study in need of realisetion.
Qu J, Zhang Y, Bu L. Functional near-infrared spectroscopy in the assessment of rehabilitation efficacy of virtual reality products for people with cognitive disorders. <i>International Journal of</i> <i>Industrial Ergonomics</i> . 2023;97:103500. doi:10.1016/j.ergon.2023.10 3500	Rehabilitation products for people with cognitive disorders (CDs) have gained increasing attention due to the aging population. However, existing approaches to rehabilitation product design do not adequately consider the importance of feedback information. To address this issue, two VR products with different roaming environments were developed, and 30 elderly participants completed an ergonomic experiment while objective user physiological data were continuously collected using functional near-infrared spectroscopy (fNIRS). The shifts in the subjects' brain function were analyzed from brain activation and effective connectivity perspectives. Results indicated that VR stimulates various brain areas, with an immersive interactive environment the main influencing factor. There were notable variations in how different virtual settings stimulated individual brain functions. Environmental variables should be included in selecting rehabilitation product design theories. This study provides a quantitative assessment of product ergonomic design for the CDs population and offers guidance in the design of rehabilitation products. <b>Relevance to</b> <b>industry:</b> This study developed VR rehabilitation products for cognitive disorders based on data-driven product design. Brain function data were introduced to propose a quantitative assessment method for the rehabilitation efficacy of VR products. VR product design is a hot issue in the industry. Evaluating the efficiency of VR products is an urgent challenge for the industry.





Hoarding disorder is common and debilitating, especially in older adults, and novel treatment approaches are needed. Many current treatments emphasize skills related to discarding and decision-making about possessions, which can be practiced in the patient's home. However in many cases, in-home visits are unfeasible, or real-life discarding is too difficult. Virtual reality (VR) offers the ability to create a virtual "home" including 3D scans of the patient's actual possessions that can be moved or discarded. VR discarding is an alternative to in-home visits and an approach that provides a stepping stone to real-life discarding. VR has been successfully utilized to treat many disorders but tested minimally in hoarding disorder. In nine older adults with hoarding disorder, we tested an 8-week VR intervention administered to augment a 16-week Buried in Treasures group treatment. Individualized VR rooms were uniquely modeled after each patient's home. During clinician-administered VR sessions, patients practiced sorting and discarding their virtual possessions. The intervention was feasible to administer. Open-ended participant responses, examined by two independent evaluators, indicated that VR sessions were well-tolerated and that participants found them useful, with nearly all participants noting that VR helped them increase real-life discarding. Self-reported hoarding symptoms decreased from baseline to close, with seven of the nine participants showing reliable improvement in this timeframe and none showing deterioration. Results from this exploratory pilot study suggest that VR is a feasible way to simulate an at- home sorting and discarding experience in a manner that may augment skills acquisition. It remains an open question whether VR discarding practice yields greater improvement than existing treatments. VR for this population merits further elinical invectivation.
Improving the mental health of urban residents is a global public health priority. This study builds on existing work that demonstrates the ability of virtual exposure to restorative environments to improve population mental health. It compares the restorative effects of green, blue and historic environments delivered by both flat screen and immersive virtual reality technology, and triangulates data from psychological, physiological and qualitative sources. Results from the subjective measure analyses showed that exposures to all the experimental videos were associated with self-reported reduced anxiety and improved mood, although the historic environment was associated with a smaller reduction of anxiety ( $p < 0.01$ ). These results were supported by the qualitative accounts. For two of the electroencephalography (EEG) frequency bands, higher levels of activity were observed for historic environments. In relation to the mode of delivery, the subjective measures did not suggest any effect, while for the EEG analyses there was evidence of a significant effect of technology across three out of four frequency bands. In conclusion, this study adds to the evidence that the benefits of restorative environments can be delivered through virtual exposure and suggests that virtual reality may provide





Reger GM, Smolenski D, Edwards-Stewart A, Skopp NA, Rizzo AS, Norr A. Does Virtual Reality Increase Simulator Sickness During Exposure Therapy for Post-Traumatic Stress Disorder?. *Telemed J E Health*. 2019;25(9):859-861. doi:10.1089/tmj.2018.0175 Purpose: Measurement of simulator-related side effects (SSEs) is an integral component of competent and ethical use of virtual reality exposure (VRE), but common SSEs may overlap with symptoms of anxiety. Limited research exists about the frequency of SSEs during VRE treatment for post-traumatic stress disorder (PTSD) and no research compares self-reported SSEs for those undergoing VRE with those participating in exposure therapy without virtual reality. This study compared the SSEs of active duty soldiers with PTSD randomly assigned to exposure therapy through traditional prolonged exposure or VRE. Methodology: A total of 108 soldiers participated in up to 10 sessions of exposure therapy. Of those, 93 provided data on simulator sickness both before and after initiation of imaginal exposure. Approximately half (n = 49) used the Virtual Iraq/Afghanistan system to support engagement with their trauma memory. Soldiers completed a 4-item, self-reported measure of SSE after each session. **Results:** Controlling for age, gender, baseline anxiety symptoms, and SSE symptom counts at the first two sessions of therapy (before initiating imaginal exposure), there was no statistically significant difference between the treatment groups in SSEs at the beginning of imaginal exposure or over the course of treatment. **Conclusions:** This finding suggests that caution should be exercised in the interpretation of SSE measurements during the use of VRE for PTSD. Virtual reality did not account for any increase in self-reported SSE. It is possible that anxiety accounts for a meaningful proportion of SSE reports during VRE.





Restout J, Bernache-Assollant I, Morizio C, et al. Fully Immersive Virtual Reality Using 360° Videos to Manage Well-Being in Older Adults: A Scoping Review. J Am Med Dir Assoc. 2023;24(4):564-572. doi:10.1016/j.jamda.2022.12 .026 Objective: The development of negative behavioral and psychosocial factors (depression, anxiety, apathy, etc) is associated with poor well-being, which can contribute to health issues in ageing, especially in the context of COVID-19. Despite its relative novelty, fully immersive virtual reality (VR) interventions through 360° immersive videos are becoming more accessible and flexible and constitute an emerging method to potentially enhance well-being. The aim of this scoping review is to assess the effectiveness of 360° interventions on wellbeing in older adults with or without cognitive impairment, as well as cybersickness and attitudes toward this technology. **Design:** Scoping review. Setting and participants: Older adults with or without cognitive impairment. Methods: The PRISMA-SR guideline was followed. Four databases were used, and we selected articles published until April 2022. We have analyzed the effect of 360° videos on the well-being of older adults with respect to the study design, the population, the contents, the duration of intervention, and the outcomes. Results: A total of 2262 articles were screened, of which 10 articles were finally included in this review. Most of them are pilot studies and used mixed methods including scales and interviews. The material and content of VR are diversified. Many behavioral and psychological outcomes were assessed, including anxiety, apathy, loneliness, depression, social engagement, quality of life, and emotions. The results were positive or mixed, according to the outcomes. We recorded few adverse events, and the interviews show contrasting results concerning the participants' feelings (ie, degree of immersion, familiarity with technology, and VR content). Conclusions and implications: The use of VR 360° videos seems feasible in community-dwelling older adults or residential aged care facilities, as they are safe and provide enjoyment. It constitutes an emerging and promising therapeutic tool to manage psychosocial disorders. This review provides key considerations for the design and implementation of interventions using VR 360° video in clinical practice.





Ribeiro JD, Linthicum KP, Harris LM, Bryen CP, Broshek CE. Raising doubt about the anticipated consequences of suicidal behavior: Evidence for a new approach from laboratory and real- world experiments. <i>Behaviour Research and</i> <i>Therapy</i> . 2021;147:103971. doi:10.1016/j.brat.2021.103 971	<b>Objective:</b> Converging evidence from basic science and experimental suicide research suggest that the anticipated consequences of suicide may have direct causal effects on suicidal behavior and accordingly represent a promising intervention target. Raising doubt about individuals' desirable anticipated consequences of suicide may be one means of disrupting this target. We tested this possibility across two complementary experimental studies. <b>Method:</b> Study 1 tested the effects of raising doubt about desirable anticipated consequences on virtual reality (VR) suicide in the lab, randomizing 413 participants across four conditions. In Study 2, 226 suicidal adults were randomized to an anticipated consequence manipulation or control condition then re-assessed at 2- and 8-weeks post-baseline. <b>Results:</b> In Study 1, anticipating that engaging in VR suicide rate; conversely, raising doubt about the desirable anticipated consequences significantly reduced the VR suicide rate. In Study 2, raising doubt about the desirable anticipated consequences significantly reduced the VR suicide rate. In Study 2, raising doubt about the anticipated consequences of attempting suicide by firearm significantly reduced the perceived lethality of firearms as well as self-predicted likelihood of future suicide attempts, with effects sustained at 2-week follow-up. <b>Conclusions:</b> Findings suggest that raising doubt about desirable anticipated consequences of suicide merits further research as one potential approach to inhibit suicidal behavior.
Riem MME, Kunst LE, Steenbakkers FDF, et al. Oxytocin reduces interpersonal distance: Examining moderating effects of childrearing experiences and interpersonal context in virtual reality. <i>Psychoneuroendocri</i> <i>nology</i> . 2019;108:102-109. doi:10.1016/j.psyneuen.201 9.06.012	Oxytocin has been shown to stimulate social approach behaviors, although effects may depend on contextual and individual difference factors. Here, we examined intranasal oxytocin effects on interpersonal distance using an immersive Virtual Reality paradigm, taking into account early caregiving experiences and interpersonal context as potential moderators. Participants were 180 women who received 24 IU oxytocin or a placebo and had reported how often their mother used love withdrawal as a disciplinary strategy, involving withholding love and affection after a failure or misbehavior. We used a virtual stop-distance paradigm, instructing participants to approach a virtual person or to stop an approaching virtual person at a preferred distance (passive approach). In order to examine the role of interpersonal context in shaping oxytocin effects, facial expressions and bodily gestures of the virtual person were manipulated. The person showed a dynamical expression of sadness, happiness, anger, fear, disgust, or no emotional expression in six different emotion conditions. We found that oxytocin reduced interpersonal distance across the different emotion conditions, but only in individuals with lower levels of love withdrawal. In addition, oxytocin reduced anxiety levels during passive approach, in particular in the disgust condition, but only in individuals with lower levels of maternal disciplinary love withdrawal. Individuals with more love withdrawal experienced more anxiety while being approached by a virtual person displaying disgust or fear, but benefitted less from anxiety-reducing oxytocin effects. These results are consistent with previous research showing a dysregulated oxytocinergic system after childhood adversity and indicate that oxytocin may be less effective for individuals who are most in need of an intervention because of a problematic family background.





Bodríguez-Rivas MF Cangas	<b>Background:</b> Stigma toward people with serious mental illnesses (SMI) like
AJ. Martin A. et al. Reducing	schizophrenia, is a serious global public health challenge that limits the quality
Stigma Toward People with	of life of those affected and poses a major barrier that keeps people from
Serious Mental Illness	seeking professional help. There is an urgent need for novel, effective, and
Through a Virtual Reality	scalable interventions to decrease stigmatized perceptions of chronic psychotic
Intervention: A Bandomized	disorders and to reduce the health burden imposed by them. <b>Method:</b> We
Controlled Trial Games	conducted a randomized controlled trial to assess the impact of a new
Health I 2024:13(1):57-64	immersive virtual reality game ( $I_{DC}$ / $i_{V}$ etc./ $VR$ ) on the level of stigma toward
doi:10.1089/g/b.2023.0118	neonle with SML measured by the Attribution questionnaire ( $\Delta \Omega_{-}27$ )
doi.10.1003/g41.2020.0110	Participants in the experimental group were exposed in an immersive way to
	hallucipations common in schizonbrenia, then shown different psychosocial
	resources available for their recovery and social inclusion: those in the control
	droup used VB software unrelated to mental health. VB sessions were delivered
	through Oculus boodgoor and losted 25 minutes. <b>Posults:</b> We randomly
	assigned 124 university students (55% female) to experimental or control
	assigned 124 driversity students (35% remate) to experimental or control conditions ( $n = 62$ each). We used mixed ANOVA to compare outcomes before
	and after the intervention between the two groups. We found a significant
	and after the intervention between the two groups. We found a significant intervention by time interaction ( $P < 0.001$ ) with a reduction in the experimental
	$\alpha$ aroun of overall stigma lovels on the AO 27 scale and its three subscales:
	group of overall slight levels of the AQ-27 scale and its three subscales.
	ally <b>Conclusions:</b> The $Incluster VP$ software proved effective in the short term
	in reducing stigma toward people with sovere mental illness. The program's
	longer term officaev, seelability, and discomination remain to be studied
Bothbourn BO, Hodgoo I E	This is the first appearance to test the office ov of computer generated virtual
Kooper P. Opdyke D	reality (VP) for the treatment of acrophobic (fear of heights). The subject was a
Williford IS North M Virtual	10 year old undergraduate student with a fear of heights, norticularly of
reality graded exposure in	alouators. Twice weekly, sessions were conducted for 2 weeks, for a total of 5
the treatment of acrophobia:	elevators. Twice weekly, sessions were conducted for 5 weeks, for a total of 5
A case study <i>Behavior</i>	distress, and included a behavioral avoidance test. VR graded exposure was
therapy 1995:26(3):547-554	successful in reducing fears of heights. VP graded exposure is proposed as a
doi: 10.1016/S0005-	new medium for exposure therapy
7894(05)80100-5	
Rudschies C. Schneider I	Virtual agents (VAs) and immersive virtual reality (VP) applications broaden the
Ethical legal and social	opportunities for accessing healthcare by transposing certain processes from
implications (ELSI) of virtual	the analogue world into a virtual realm. While these innovations offer a number
agonts and virtual reality in	of advantages including improved access for individuals in diverse geographic
boolthooro Social Science &	locations and novel therapoutic entions, their implementation reises significant
Modicino 2024-240-116492	othical social and logal implications. Kay considerations partain to the doctor
doi:10.1016/i.socscimed 20	nations relationship, privacy and data protection, justice, fairness, and equal
23 116/83	access as well as to issues of accountability liability and safety. This paper
20.110400	conducts a comprehensive review of the existing literature to analyze the
	ethical social and legal ramifications of employing VAs and VR applications in
	healthcare. It examines the recommended strategies to mitigate notontial
	advoree offects and addresses current research gaps in this domain
	auverse enects and addresses current research gaps in this domain.





Ruívo M, Frontini R,	The worldwide prevalence of mental health diseases is alarming. $79^2$ million
Pernencar C. Virtual Reality	individuals have a mental disorder such as anxiety or depression. Treatment
in Depressive and Anxiety	varies among the types of illness. They can be expensive and, in order to be
Symptomatology –	effective, must address a combination of psychotherapy and medications. The
Contributions to REVIDA	drugs used for treating symptoms present a risk of negative side effects. Studies
project from a mobile app	have shown the benefits of other co-therapies such as physical exercise. In this
mapping. Procedia	case, the ability to simulate reality can strongly increase the introduction of
Computer Science.	other psychological therapies and treatment results can be improved through
2023;219:1185-1192.	new immersive experiences. Virtual Reality Exposure Therapy has demonstrated
doi:10.1016/j.procs.2023.01.	its effectiveness by allowing patients to gradually face fearful stimuli or stressful
400	situations. Recent studies showed that the use of Virtual Reality is effective and
	safe for mental health. Particularly, in the scenario of how Virtual Reality
	simulation could increase empathy and behaviour change. This article presents
	a preliminary study of the REVIDA project: It aims to investigate through
	Benchmarking and SWOT Analysis the possible integration of Virtual Reality in
	mental illness monitoring in Portugal. Results show that there exist several new
	opportunities for using Virtual Reality technology in mental health and wellbeing.
Ruse SA, Harvey PD, Davis	Introduction: Assessment of functional capacity is an intrinsic part of
VG, Atkins AS, Fox KH, Keefe	determining the functional relevance of response to treatment of cognitive
RSE. Virtual reality functional	impairment in schizophrenia. Existing methods are highly and consistently
capacity assessment in	correlated with performance on neuropsychological tests, but most current
schizophrenia: Preliminary	assessments of functional capacity are still paper and pencil simulations. We
data regarding feasibility and	developed a computerized virtual reality assessment that contains all of the
correlations with cognitive	components of a shopping trip. <b>Methods:</b> We administered the Virtual Reality
and functional capacity	Functional Capacity Assessment Tool (VRFCAT) to 54 healthy controls and to 51
performance. Schizophrenia	people with schizophrenia to test its feasibility. Dependent variables for the
Research: Cognition.	VRFCAT included time to completion and errors on 12 objectives and the
2014;1(1):e21-e26.	number of times that an individual failed to complete an objective. The MATRICS
doi:10.1016/j.scog.2014.01.	Consensus Cognitive Battery (MCCB) and a standard functional capacity
004	measure, the UCSD Performance-Based Skills Assessment-Brief (UPSA-B), were
	administered to the patients with schizophrenia. Results: Patients with
	schizophrenia performed more poorly than healthy controls on 10/11 of the time
	variables, as well as 2/12 error scores and 2/12 failed objectives. Pearson
	correlations for 7 of 15 VRFCAT variables with MCCB composite scores were
	statistically significant. Conclusion: These results provide support for the
	possibility of computerized functional capacity assessment, but more
	substantial studies are required.
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Sabé M, Chen C, El-Hage W, et al. Half a Century of Research on Posttraumatic Stress Disorder: A Scientometric Analysis. *Curr Neuropharmacol*. 2024;22(4):736-748. doi:10.2174/1570159X22666 230927143106 We conducted a scientometric analysis to outline clinical research on posttraumatic stress disorder (PTSD). Our primary objective was to perform a broad-ranging scientometric analysis to evaluate key themes and trends over the past decades. Our secondary objective was to measure research network performance. We conducted a systematic search in the Web of Science Core Collection up to 15 August 2022 for publications on PTSD. We identified 42,170 publications published between 1945 and 2022. We used CiteSpace to retrieve the co-cited reference network (1978-2022) that presented significant modularity and mean silhouette scores, indicating highly credible clusters (Q = 0.915, S = 0.795). Four major trends of research were identified: 'war veterans and refugees', 'treatment of PTSD/neuroimaging', 'evidence syntheses', and 'somatic symptoms of PTSD'. The largest cluster of research concerned evidence synthesis for genetic predisposition and environmental exposures leading to PTSD occurrence. Research on war-related trauma has shifted from battlefield-related in-person exposure trauma to drone operator trauma and is being out published by civilian-related trauma research, such as the 'COVID-19' pandemic impact, 'postpartum', and 'grief disorder'. The focus on the most recent trends in the research revealed a burst in the 'treatment of PTSD' with the development of Mhealth, virtual reality, and psychedelic drugs. The collaboration networks reveal a central place for the USA research network, and although relatively isolated, a recent surge of publications from China was found. Compared to other psychiatric disorders, we found a lack of high-quality randomized controlled trials for pharmacological and nonpharmacological treatments. These results can inform funding agencies and future research.





Sauchelli S, Brunstrom JM. Virtual reality exergaming improves affect during physical activity and reduces subsequent food consumption in inactive adults. *Appetite*. 2022;175:106058. doi:10.1016/j.appet.2022.10 6058 An individual's affective (i.e. emotional) response to exercise may play an important role in post-exercise eating behaviour for some individuals. Taking advantage of advances in fully immersive virtual reality (VR) technology, this study aimed to: a) examine whether VR exergaming can improve the psychological response to exercise in inactive adults, and b) assess the extent to which this improvement reduces post-exercise appetite and eating behaviour. In a cross-over study, 34 adults not meeting the World Health Organisation's physical activity recommendations completed two exercise sessions on a stationary bike; one while engaging in a VR exergame and one without VR. Monitoring enabled heart rate, energy expenditure, and duration across conditions to be closely matched. The Physical Activity Enjoyment Scale, Feeling Scale, Felt Arousal Scale and Borg's Ratings of Perceived Exertion were measured to capture the affective responses to exercise. Appetite and eating behaviour were evaluated using visual-analogue scales, a computerised food preference task, and intake at a post-exercise buffet meal. Cycling in VR elicited greater exercise enjoyment (p < 0.001,  $\eta 2p = 0.62$ ), pleasure (p < 0.001,  $\eta_{2p} = 0.47$ ), and activation (p < 0.001,  $\eta_{2p} = 0.55$ ). VR exergaming did not alter perceived physical exertion (p = 0.64), perceived appetite (p = 0.68), and preference for energy dense (p = 0.78) or sweet/savoury foods (p = 0.90) compared to standard exercise. However, it did result in a mean 12% reduction in post-exercise food intake (mean difference: 105.9 kcal; p < 0.01;  $\eta 2p = 0.20$ ) and a decrease in relative food intake (p < 0.01; n2p = 0.20), although interindividual differences in response to VR exergaming were observed. The integration of VR in a cycling workout improves the affective experience of physical activity for inactive adults and reduces subsequent food intake. Virtual reality technology shows potential as an adjunct tool to support adults in weight management programmes become more active, especially for those individuals who are prone to eat in excess after physical activity.





Seo K, Kim JK, Oh DH, Ryu H, Choi H. Virtual daily living test to screen for mild cognitive impairment using kinematic movement analysis. <i>PLoS One</i> . 2017;12(7):e0181883. Published 2017 Jul 24. doi:10.1371/journal.pone.01 81883	Questionnaires or computer-based tests for assessing activities of daily living are well-known approaches to screen for mild cognitive impairment (MCI). However, questionnaires are subjective and computerized tests only collect simple performance data with conventional input devices such as a mouse and keyboard. This study explored the validity and discriminative power of a virtual daily living test as a new diagnostic approach to assess MCI. Twenty-two healthy controls and 20 patients with MCI were recruited. The virtual daily living test presents two complex daily living tasks in an immersive virtual reality environment. The tasks were conducted based on subject body movements and detailed behavioral data (i.e., kinematic measures) were collected. Performance in both the proposed virtual daily living test and conventional neuropsychological tests for patients with MCI was compared to healthy controls. Kinematic measures considered in this study, such as body movement trajectory, time to completion, and speed, classified patients with MCI from healthy controls, F(8, 33) = 5.648, p < 0.001, $\eta$ 2 = 0.578. When both hand and head speed were employed in conjunction with the immediate free-recall test, a conventional neuropsychological test, the discrimination power for screening MCI was significantly improved to 90% sensitivity and 95.5% specificity (cf. the immediate free-recall test alone has 80% sensitivity and 77.3% specificity). Inclusion of the kinematic measures in screening for MCI significantly improved
	the classification of patients with MCI compared to the healthy control group,
	Wilks' Lambda = 0.451, p < 0.001.
Shah LBI, Klainin-Yobas P, Torres S, Kannusamy P. Efficacy of Psychoeducation and Relaxation Interventions on Stress-Related Variables in People With Mental Disorders: A Literature Review. Archives of Psychiatric Nursing. 2014;28(2):94-101. doi:10.1016/j.apnu.2013.11. 004	This paper aimed to critically review and summarize empirical evidence concerning the efficacy of psychoeducation or relaxation-based stress management interventions on stress-related variables in people with mental disorders. Electronic databases were used during the literature search. Thirteen articles that fulfilled the preset eligible criteria were included in the review. Findings indicated that psychoeducation and relaxation-based interventions mitigated stress and depression; and enhanced relaxation intensity and knowledge on stress management. However, mixed results were obtained on anxiety. In addition, interventions using virtual reality technology revealed positive effects on depression, relaxation intensity and anxiety. Limitations and recommendations for future research are discussed.





Shen YI, Nelson AJ, Oberlin BG. Virtual reality intervention effects on future self-continuity and delayed reward preference in substance use disorder recovery: pilot study results. *Discov Ment Health*. 2022;2(1):19. doi:10.1007/s44192-022-00022-1 Sustained remission from substance use disorder (SUD) is challenged by high relapse rates, which provides opportunities for novel clinical interventions. Immersive virtual reality (VR) permits delivering synthetic experiences that feel real and actualizes otherwise impossible scenarios for therapeutic benefit. We report on the feasibility of an immersive VR intervention designed to increase valuation of the future by enhancing future self-continuity and leveraging future self-discrepancy with personalized future selves as SUD recovery support. Twenty-one adults in early SUD recovery (< 1 year) interacted with versions of themselves age-progressed fifteen years from two different behavioral trajectories: an SUD Future Self and a Recovery Future Self. The future selves' interactive monologs include personalized details and voice for a lifelike interaction within a time travel vignette. Before and following the intervention, participants rated future self-continuity and performed delay discounting. Following the intervention, daily images of the Recovery Future Self were sent to participants' smartphones for thirty days. The VR intervention generated no adverse events, was well tolerated (presence, liking, and comfort), and significantly increased future self-continuity and delayed reward preference (doubling delay tolerance). The intervention also reduced craving, ps < 0.05. Thirty days later, n = 18 remained abstinent; importantly, increased future selfsimilarity persisted. Abstainers' future self-similarity increased following VR. All individual participants showing increased future self-similarity post-VR remained abstinent, and all participants who relapsed showed either reduced or zero effect on future self-similarity. Post-intervention semi-structured interviews revealed emotional engagement with the experience. VR simulation of imagined realities reifies novel clinical interventions that are practicable and personalized. The current study demonstrates an implementation readily applied in the clinic and shows promise for facilitating SUD recovery. Creative collaboration between researchers, clinicians, and VR developers has great potential to revolutionize mental health interventions and expand the range of tools for clinicians targeting SUD and other disorders.





Smith LC, Mateos AC, Due	Background: A large group of psychiatric patients suffer from auditory
AS, et al. Immersive virtual	hallucinations (AH) despite relevant treatment regimens. In mental health
reality in the treatment of	populations, AH tend to be verbal (AVH) and the content critical or abusive.
auditory hallucinations: A	Trials employing immersive virtual reality (VR) to treat mental health disorders
PRISMA scoping	are emerging. <b>Objective:</b> The aim of this scoping review is to provide an overview
review. Psychiatry Res.	of clinical trials utilizing VR in the treatment of AH and to document knowledge
2024;334:115834.	gaps in the literature. <b>Methods:</b> PubMed, Cochrane Library, and Embase were
doi:10.1016/j.psychres.2024	searched for studies reporting on the use of VR to target AH. <b>Results:</b> 16 papers
.115834	were included in this PRISMA scoping review (ScR). In most studies VR therapy
	(VRT) was employed to ameliorate treatment resistant AVH in schizophrenia
	spectrum disorders. Only two studies included patients with a diagnosis of
	affective disorders. The VRT was carried out with the use of an avatar to
	represent the patient's most dominant voice. <b>Discussion:</b> The research field
	employing VR to treat AH is promising but still in its infancy. Results from larger
	randomized clinical trials are needed to establish substantial evidence of
	therapy effectiveness. Additionally, the knowledge base would benefit from
	more profound qualitative data exploring views of patients and therapists.
Smith-MacDonald L, Jones	Background: Exposure to trauma and potentially morally injurious events may
C, Brown MRG, et al. Moving	lead to moral injury (MI). The link between MI and posttraumatic stress disorder
Forward from Moral Injury: A	(PTSD) may have particularly relevant implications for treatment-resistant PTSD
Mixed Methods Study	(TR-PTSD). Multi-modal Motion-Assisted Memory Desensitization and
Investigating the Use of	Reconsolidation (3MDR), a technology-assisted exposure-based trauma therapy
3MDR for Treatment-	that has been used in the treatment of PTSD, may also be an acceptable
Resistant PTSD. Int J Environ	modality for patients in the treatment of TR-PTSD and MI. This proof-of-concept
Res Public Health.	study aimed to investigate (1) whether MI co-occurs in military members (MMs)
2023;20(7):5415. Published	and veterans with TR-PTSD, and (2) the perspectives of MMs and veterans with
2023 Apr 6.	TR-PTSD utilizing 3MDR for MI. <b>Methods:</b> This study employed a mixed-methods
doi:10.3390/ijerph20075415	clinical trial. Military Members and veterans participated in this study (N = 11)
	through self-reported questionnaires, video recordings of treatment sessions,
	and semi-structured interviews post-session and post-intervention, with
	longitudinal follow-up to 6 months. <b>Results:</b> MI scores correlated with self-
	reported measures of mental health symptoms related to PTSD. The thematic
	analysis revealed three emergent themes: (1) Realities of War, (2) Wrestling
	Scruples, and (3) Moral Sensemaking. Conclusion: MI was highly correlated with
	TR-PTSD and themes regarding MI. This result, while preliminary, allows for the
	postulation that MI may be contributing to the continuation of PTSD symptoms in
	TR-PTSD, and that 3MDR may be an acceptable modality for addressing these
	symptoms in MMs and veterans.





Tang E, Jones C, Smith- MacDonald L, Brown MRG, Vermetten EHGJM, Brémault-Phillips S. Decreased Emotional Dysregulation Following Multi-Modal Motion-Assisted Memory Desensitization and Reconsolidation Therapy (3MDR): Identifying Possible Driving Factors in Remediation of Treatment- Resistant PTSD. <i>Int J Environ</i> <i>Res Public Health</i> . 2021;18(22):12243. Published 2021 Nov 22. doi:10.3390/ijerph18221224 3	Multi-modal motion-assisted memory desensitization and reconsolidation therapy (3MDR), an interactive, virtual reality-assisted, exposure-based intervention for PTSD, has shown promising results for treatment-resistant posttraumatic stress disorder (TR-PTSD) among military members (MMs) and veterans in randomized controlled trials (RCT). Previous research has suggested that emotional regulation (ER) and emotional dysregulation (ED) may be factors which are correlated with symptom severity and maintenance of TR-PTSD. This embedded mixed-methods pilot study ( <i>n</i> = 9) sought to explore the impact of 3MDR on ER and ED of MMs and veterans. Difficulties in Emotional Regulation Scale (DERS-18) data were collected at baseline, prior to each session, and at one week, one month, and three months postintervention and analyzed. Qualitative data collected from sessions, debriefs, and follow-up interviews were transcribed and descriptively analyzed. Results demonstrated statistically significant decreases in DERS-18 scores from preintervention to postintervention at each timepoint. Qualitatively, participants perceived improvements in ER within specified DERS-18 domains. We describe how 3MDR's unique and novel approach addresses ED through cognitive-motor stimulation, narration, divergent thinking, reappraisal of aversive stimuli, dual- task processing, and reconsolidation of traumatic memories. More studies are needed to better understand the underlying neurobiological mechanisms by
	which 3MDR addresses ER and PTSD.
Thunström AO, Sarajlic Vukovic I, Ali L, Larson T, Steingrimsson S. Prevalence of virtual reality (VR) games found through mental health categories on STEAM: a first look at VR on commercial platforms as tools for therapy. <i>Nord J Psychiatry</i> . 2022;76(6):474-485. doi:10.1080/08039488.2021. 2003859	<b>Background:</b> Immersive virtual reality (VR) games are increasingly becoming part of everyday life. Several studies support immersive VR technology as a treatment method for mental health problems. There is however little insight into the prevalence of commercially available VR games for treatment of mental health problems on commercial platforms such as STEAM, and to what extent they can be used as tools for treatment or add-on treatment of mental health problems. <b>Objective:</b> The aim of this study was to take a first look at the prevalence and overview of content of commercially available games. The games were found using search words related to psychiatric diagnosis or care. <b>Methods:</b> We performed a search for keywords related to symptoms, diagnosis, and treatment strategies of mental health problems. The search was performed November 2020 on STEAM. A scheme was created for elimination and inclusion of games, eliminating those games which were irrelevant to mental health or had triggering elements such as violence, excessive movement which could trigger nausea, horror and pornographic imagery. <b>Results:</b> In total, 735 hits were found, 565 unique games. After the games were reviewed for content <i>via</i> trailers, descriptions and screenshots, 32%, i.e. 182 games passed the inclusion criteria. Majority of the games which were excluded were either not connected to mental health, contained violence, adult content or were in other ways irrelevant or inappropriate. <b>Conclusions:</b> Commercial platforms are only at the beginning of the development towards therapeutic content. Currently the quality and usability for therapeutic use is scarce but holds great potential.





Tsai J. Use and Interest in	Virtual reality (VR) represents a new way to deliver health interventions, but
Virtual Reality for Mental and	research is needed on experience and interest in using VR for health among
Physical Health in a U.S.	important subgroups in the United States. This descriptive study examined these
Population-Based Sample of	issues among low-income veterans in the United States. Data were analyzed
Low-Income	from a nationally representative sample of 1,028 low-income veterans surveyed
Veterans. Cyberpsychol	in late 2022-early 2023. The results showed that while only 10 percent of the
Behav Soc Netw. Published	sample had ever used a VR headset, 35 percent of veterans reported they would
online February 15, 2024.	be "somewhat/very willing" to use VR for mental health or substance use
doi:10.1089/cyber.2023.009	problems. Veterans with higher levels of education (adjusted odds ratio [aOR] =
1	1.25, 95% confidence interval [CI] = 1.07-1.47), lower mental health functioning
	(aOR = 0.96, 95% CI = 0.94-0.98), and previous VR experience (aOR = 5.30, 95%
	CI = 2.96-9.48) were significantly more willing to use VR to treat their mental
	health or substance use problems. These findings suggest many veterans are
	willing to use VR to improve their mental health, and they could benefit from
	greater exposure and education about VR-based interventions.
Valmaggia LR, Latif L,	The aim of this paper is to provide a review of controlled studies of the use of
Kempton MJ, Rus-Calafell M.	Virtual Reality in psychological treatment (VRT). Medline, PsychInfo, Embase
Virtual reality in the	and Web of Science were searched. Only studies comparing immersive virtual
psychological treatment for	reality to a control condition were included. The search resulted in 1180 articles
mental health problems: An	published between 2012 and 2015, of these, 24 were controlled studies. The
systematic review of recent	reviewed studies confirm the effectiveness of VRT compared to treatment as
evidence. Psychiatry Res.	usual, and show similar effectiveness when VRT is compared to conventional
2016;236:189-195.	treatments. Current developments and future research are discussed.
doi:10.1016/j.psychres.2016	
.01.015	





Van Doren N, Ng H, Rawat E, McKenna KR, Blonigen DM. Virtual reality mindfulness training for veterans in residential substance use treatment: Pilot study of feasibility and acceptability. *Journal of Substance Use and Addiction Treatment*. 2024;161:209315. doi:10.1016/j.josat.2024.209 315 Background: Mindfulness training is effective in recovery from substance use disorders; however, adoption can be difficult due to environmental and personal distractions. Virtual reality (VR) may help overcome these challenges by providing an immersive environment for practicing mindfulness, but there is currently limited knowledge regarding patient and provider perceptions of VRbased tools. Objective: The present study investigated the feasibility and acceptability of VR mindfulness training for veterans in residential substance use treatment as well as potential benefits of VR mindfulness interventions in this population. We conducted a pilot feasibility/acceptability study as a first step toward conducting a larger randomized controlled trial (RCT). Methods: The study recruited participants (N = 32) from a 30-day residential substance use program and collected both qualitative and quantitative feedback on the VR mindfulness intervention using a mixed-methods approach. Patients (n = 20) and providers (n = 12) rated the acceptability, usability, and satisfaction of the intervention. Using a within-subjects design, patients provided pre-post emotion ratings and reported on state mindfulness and VR presence after completing a single-session self-guided VR mindfulness intervention. Patients provided qualitative interview data on their overall impressions, while providers gave the same information via survey. **Results:** Both patients and providers reported high satisfaction and confidence in the intervention. Moreover, within subjects t-tests showed that patients experienced significant reductions in negative affect and significant increases in positive affect from pre-post, along with high levels of state mindfulness and presence. Results of thematic analysis revealed that the intervention facilitated focused attention on the present moment, induced a state of calm and relaxation, and reduced negative thoughts and emotions. Participants requested improvements such as better integration of audiovisual elements, a more personalized and longer intervention, and more comfortable fitting headset. Finally, the intervention presented with several advantages compared to other mindfulness experiences including reduced distractions and a sense of safety and privacy. Conclusions: Self-guided VR mindfulness intervention is feasible and acceptable to patients and providers. VR mindfulness training provides an immersive experience that uplifts mood and reduces distractions. VR may provide a scaffolding tool to set the stage for deepening mindfulness skills. Results of the present study could inform further development and tailoring for future interventions.





van Gelderen MJ, Nijdam MJ, de Vries F, Meijer OC, Vermetten E. Exposurerelated cortisol predicts outcome of psychotherapy in veterans with treatmentresistant posttraumatic stress disorder. *J Psychiatr Res.* 2020;130:387-393. doi:10.1016/j.jpsychires.202 0.08.011 Background: Hypothalamic-pituitary-adrenal axis functioning has been related to treatment outcome in posttraumatic stress disorder (PTSD). Previous studies have primarily focused on cortisol levels before and after a course of therapy and findings have not been fully consistent. This study investigated sessionrelated cortisol levels in veterans with treatment-resistant PTSD over the course of a novel motion-assisted virtual reality exposure therapy and aimed to determine whether cortisol levels were related to changes in PTSD symptom severity. Methods: Veterans (N = 22) received six exposure sessions during which salivary cortisol samples were collected pre-session, post-session and in the late afternoon following sessions. PTSD symptom severity was assessed by structured clinical interviews at pre- and post-treatment. Average cortisol levels were compared between responders and non-responders. Linear regression analyses were conducted with PTSD symptom change as criterion variable, average cortisol levels as predictor, and timing of sampling and baseline PTSD symptoms as covariates. Results: Responders to treatment tended to have higher average cortisol levels at pre-session (p = 0.064) and post-session (p = 0.050) compared to non-responders. Higher average pre-session and postsession cortisol levels predicted greater PTSD symptom improvement (pre: b = -1.83, p = 0.009; post: b = -3.57, p = 0.004). **Conclusion:** This study provides preliminary evidence for session-related cortisol as biomarker of response to exposure-based therapies for PTSD. Higher cortisol levels may have facilitated fear extinction and reconsolidation, and may indicate increased physiological stress activation necessary for appropriate treatment engagement. Further work involving comparable methodology is encouraged to establish session-related cortisol as biomarker and to determine the mechanisms through which it interacts with treatment outcome.





van Gelderen MJ, Nijdam MJ, Dubbink GE, Sleijpen M, Vermetten E. Perceived treatment processes and effects of interactive motionassisted exposure therapy for veterans with treatmentresistant posttraumatic stress disorder: a mixed methods study. *Eur J Psychotraumatol*. 2020;11(1):1829400. Published 2020 Oct 30. doi:10.1080/20008198.2020. 1829400 **Background:** A novel intervention, Multi-modular motion-assisted memory desensitization and reconsolidation (3MDR), aims to reduce avoidance and improve engagement for patients with posttraumatic stress disorder (PTSD) who did not sufficiently respond to previous treatments. It has been found to effectively reduce PTSD symptoms for veterans with treatment-resistant PTSD. Symptomatic measures alone might not capture all treatment effects, and addition of qualitative outcomes may provide deeper understanding of treatment processes and treatment-induced changes. **Objective:** To study the perspectives of veterans with treatment-resistant PTSD on 3MDR treatment processes and effects and explore the relation of their experiences to PTSD symptom improvement. Method: A convergent parallel mixed methods design was applied. For the qualitative part, open-ended question interviews were conducted until data saturation was reached (N = 10). Thematic analysis, rooted in grounded theory, was performed. Quantitative data included pre- to posttreatment responder status based on a structured clinical interview for PTSD. Results: Treatment processes endorsed by the veterans were engaging, regulating distress, feeling supported, facing traumatic memories, allowing emotions, associating, and disengaging from trauma. In terms of effects, veterans reported positive changes following 3MDR, including openness, new learning, self-understanding, closure, and reintegration. High comparability across themes was observed for responders and non-responders, except for the themes closure and reintegration, which were reported more often or more in depth by responders. Conclusions: Veterans indicated 3MDR treatment processes that complied with its aims of breaking through avoidance and increasing engagement, thereby facilitating traumatic memory retrieval and processing. However, this did not necessarily translate into PTSD symptom improvement for all veterans. Walking towards trauma-related pictures was highlighted as unique component of 3MDR and connected to specific treatment processes and effects. Positive changes following 3MDR were experienced outside the domain of PTSD symptom improvement, implicating that 3MDR may beneficially impact veterans beyond symptom changes alone.





van Gelderen MJ, Nijdam MJ, Haagen JFG, Vermetten E. Interactive Motion-Assisted Exposure Therapy for Veterans with Treatment-Resistant Posttraumatic Stress Disorder: A Randomized Controlled Trial. *Psychother Psychosom*. 2020;89(4):215-227. doi:10.1159/000505977 Background: Veterans with posttraumatic stress disorder (PTSD) tend to benefit less from evidence-based treatments than other PTSD populations. A novel virtual reality and motion-assisted exposure therapy, called 3MDR, provides treatment in an immersive, personalized and activating context. **Objective:** To study the efficacy of 3MDR for veterans with treatment-resistant PTSD. Method: In a randomized controlled trial (n = 43) 3MDR was compared to a nonspecific treatment component control group. Primary outcome was clinicianrated PTSD symptoms at baseline, after 3MDR, and at the 12-week and 16-week follow-up (primary end point). Intention-to-treat analyses of covariance and mixed models were applied to study differences between groups at the end point and over the course of intervention, controlling for baseline scores. Results: The decrease in PTSD symptom severity from baseline to end point was significantly greater for 3MDR as compared to the control group, with a large effect size (F[1, 37] = 6.43, p = 0.016, d = 0.83). No significant between-group difference was detected in the course of PTSD symptoms during treatment when including all time points. The dropout rate was low (7%), and 45% of the patients in the 3MDR group improved clinically. The number needed to treat was 2.86. **Conclusions:** In this trial, 3MDR significantly decreased PTSD symptoms in veterans with, on average, a history of 4 unsuccessful treatments. The low dropout rate may be indicative of high engagement. However, a lack of significant differences on secondary outcomes limits conclusions that can be drawn on its efficacy and underlines the need for larger phase III trials. These data show emerging evidence for 3MDR and its potential to progress PTSD treatment for veterans.





van Gelderen MJ, Nijdam MJ,	Despite an array of evidence-based psychological treatments for patients with a
Vermetten E. An Innovative	posttraumatic stress disorder (PTSD), a majority of patients do not fully benefit
Framework for Delivering	from the potential of these therapies. In veterans with PTSD, up to two-thirds
Psychotherapy to Patients	retain their diagnosis after psychotherapy and often their disorder is treatment-
With Treatment-Resistant	resistant, which calls for improvement of therapeutic approaches for this
Posttraumatic Stress	population. One of the factors hypothesized to underlie low response in PTSD
Disorder: Rationale for	treatment is high behavioral and cognitive avoidance to traumatic reminders. In
Interactive Motion-Assisted	the current paper we explore if a combination of personalized virtual reality,
Therapy. Front Psychiatry.	multi-sensory input, and walking during exposure can enhance treatment
2018;9:176. Published 2018	engagement, overcome avoidance, and thereby optimize treatment
May 4.	effectiveness. Virtual reality holds potential to increase presence and in-session
doi:10.3389/fpsyt.2018.0017	attention and to facilitate memory retrieval. Multi-sensory input such as pictures
6	and music can personalize this experience. Evidence for the positive effect of
	physical activity on fear extinction and associative thinking, as well as embodied
	cognition theories, provide a rationale for decreased avoidance by literally
	approaching cues of the traumatic memories. A dual-attention task further
	facilitates new learning and reconsolidation. These strategies have been
	combined in an innovative framework for trauma-focused psychotherapy,
	named Multi-modular Motion-assisted Memory Desensitization and
	Reconsolidation (3MDR). In this innovative treatment the therapeutic setting is
	changed from the face-to-face sedentary position to a side-by-side activating
	context in which patients walk toward trauma-related images in a virtual
	environment. The framework of 3MDR has been designed as a boost for patients
	with treatment-resistant PTSD, which is illustrated by three case examples. The
	intervention is discussed in context of other advancements in treatment for
	treatment-resistant PTSD. Novel elements of this approach are activation,
	personalization and empowerment. While developed for veterans with PTSD
	who do not optimally respond to standardized treatments, this innovative
	framework holds potential to also be used for other patient populations and
	earlier stages of treatment for patients with PTSD.





van Meggelen M, M	Iorina N, Alt	nough well-established therapies exist for post-traumatic stress disorder
van der Heiden C,	et al. A (PT	SD), barriers to seek mental health care are high. Technology-based
randomized contro	olled trial inte	erventions may play a role in improving the reach of efforts to treat, especially
to pilot the efficacy	/ofa wh	en therapist availability is low. The goal of the current randomized controlled
computer-based	tria	l was to pilot the efficacy of a computer-based trauma intervention with
intervention with e	lements ele	ments of virtual reality (VR: 3MR system) and limited therapist involvement for
of virtual reality an	d limited the	treatment of PTSD in a childhood sexual abuse (CSA) and war veteran
therapist assistance	e for the sar	nple and to compare this to "treatment as usual" (TAU). TAU consisted of
treatment of post-t	traumatic evi	dence-based approaches such as imaginal exposure. EMDR, or narrative
stress disorder. Fro	ont Digit ext	posure therapy. A total of 44 patients with PTSD were included and randomly
Health, 2022:4:974	1668. ass	signed to 12 sessions of $3MR$ intervention or TAU (completer <i>n</i> $3MR = 12$ . TAU
Published 2022 Oc	t 18 = 1	8) Several measures (PCI -5 BDI-II $\Omega\Omega$ -45-2 and the MINI 500 ) were
doi:10 3389/fdgth	2022 97/ adu	ministered to measure symptoms of PTSD and depression and scores of
668		and a three-month follow-up measurement
000	Δη	alvses suggest that symptoms of PTSD and depression in the 3MR condition
	de	pressed and overall well-being increased between hre and host
	me	asurements. Results did not indicate any clear differences between the
	tro	astrements. Results and normalizate any clear differences between the
	the	2MP intervention seem no less than those of TALL Finally, both treatment
		aditions produced similar remission rates of DTSD and depression. Therefore
	C01	2MD intervention could possibly constitute on appropriate treatment
		size as well as well as a wident drop out rates in
	the	2MP condition (45%) do warrant further research
Wohh AK Vincent		akaround: Doot troumotic atroop diporder (DTSD) autrontly is diagnoood via
	AL, JIII AD, <b>D</b> a	bioslintention in which subjective self reports of traumatic events and
		incal interview in which subjective set reports of traumatic events and
reactivity to nonide	eographic ass	sociated experiences are discussed with a mental nearth professional. The
virtual reality stime	uuin reu	ability and validity of diagnoses can be improved with the use of objective
veterans with and V	without phy	/siological measures. <b>Methods:</b> In this study, physiological activity was
PISD. Brain Benav.	. rec	orded from 58 male veterans (PISD Diagnosis n = 16; Trauma Exposed/No
2015;5(2):e00304.		SD Diagnosis: n = 23; No Trauma/No PTSD Diagnosis: n = 19) with and without
doi:10.1002/brb3.3	304 PIS	SD and combat trauma exposure in response to emotionally evocative non-
	Idio	ographic virtual reality stimuli. <b>Results:</b> Statistically significant differences
	am	ong the Control, Irauma, and PISD groups were present during the viewing of
	two	o virtual reality videos. Skin conductance and interbeat interval features were
	ext	racted for each of ten video events (five events of increasing severity per
	vid	eo). These features were submitted to three stepwise discriminant function
	ana	alyses to assess classification accuracy for Control versus Trauma, Control
	ver	sus PTSD, and Trauma versus PTSD pairings of participant groups. Leave-
	one	e-out cross-validation classification accuracy was between 71 and 94%.
	Co	nclusions: These results are promising and suggest the utility of objective
	phy	/siological measures in assisting with PTSD diagnosis.





Wiebe A, Kannen K,	Background: Virtual reality (VR) technologies are playing an increasingly
Selaskowski B, et al. Virtual	important role in the diagnostics and treatment of mental disorders. Objective:
reality in the diagnostic and	To systematically review the current evidence regarding the use of VR in the
therapy for mental disorders:	diagnostics and treatment of mental disorders. Data source: Systematic
A systematic review. <i>Clinical</i>	literature searches via PubMed (last literature update: 9th of May 2022) were
Psychology Review.	conducted for the following areas of psychopathology: Specific phobias, panic
2022:98:102213.	disorder and agoraphobia, social anxiety disorder, generalized anxiety disorder.
doi:10.1016/j.cpr.2022.1022	posttraumatic stress disorder (PTSD), obsessive-compulsive disorder, eating
13	disorders dementia disorders attention-deficit/hyperactivity disorder
	depression autism spectrum disorder, schizophrenia spectrum disorders, and
	addiction disorders. <b>Fligibility criteria:</b> To be eligible, studies had to be
	nublished in English to be peer-reviewed to report original research data to be
	VP related and to deal with one of the above mentioned areas of
	vn-related, and to deal with one of the above-mentioned areas of
	psychopathology. Study evaluation: For each study included, various study
	characteristics (including interventions and conditions, comparators, major
	outcomes and study designs) were retrieved and a risk of blas score was
	calculated based on predefined study quality criteria. <b>Results:</b> Across all areas
	of psychopathology, $k = 9315$ studies were inspected, of which $k = 721$ studies
	met the eligibility criteria. From these studies, 43.97% were considered
	assessment-related, 55.48% therapy-related, and 0.55% were mixed. The
	highest research activity was found for VR exposure therapy in anxiety disorders,
	PTSD and addiction disorders, where the most convincing evidence was found,
	as well as for cognitive trainings in dementia and social skill trainings in autism
	spectrum disorder. Conclusion: While VR exposure therapy will likely find its
	way successively into regular patient care, there are also many other promising
	approaches, but most are not yet mature enough for clinical application.
Williams LM, Pines A,	Precision medicine models for personalizing achieving sustained behavior
Goldstein-Piekarski AN, et	change are largely outside of current clinical practice. Yet, changing self-
al. The ENGAGE study:	regulatory behaviors is fundamental to the self-management of complex
Integrating neuroimaging,	lifestyle-related chronic conditions such as depression and obesity - two top
virtual reality and	contributors to the global burden of disease and disability. To optimize
smartphone sensing to	treatments and address these burdens, behavior change and self-regulation
understand self-regulation	must be better understood in relation to their neurobiological underpinnings.
for managing depression and	Here, we present the conceptual framework and protocol for a novel study.
obesity in a precision	"Engaging self-regulation targets to understand the mechanisms of behavior
medicine model <i>Behav</i> Res	change and improve mood and weight outcomes (ENGAGE)" The ENGAGE study
Ther 2018:101:58-70	integrates neuroscience with behavioral science to better understand the self-
doi:10 1016/i brat 2017 09 0	regulation related mechanisms of behavior change for improving mood and
12	weight outcomes among adults with comorbid depression and obesity. We
12	collect assays of three solf regulation targets (amotion, cognition, and solf
	reflection in multiple settings, neuroimaging and behavioral lab based
	meneous on multiple settings, neuroimaging and penavioral lap-based
	human neuropeienee and behavioral acience in this rearrant within the ENOACE
	numan neuroscience anu penavioral science in this manner within the ENGAGE
	study, we develop a prototype for elucidating the underlying self-regulation
	mechanisms of behavior change outcomes and their application in optimizing
	intervention strategies for multiple chronic diseases.ma





Wrzesien M, Burkhardt JM, Botella C, Alcañiz M. Evaluation of the quality of collaboration between the client and the therapist in phobia treatments. *Interacting with Computers*. 2012;24(6):461-471. doi:10.1016/j.intcom.2012.0 9.001 A growing number of empirical studies evaluate the influence of Mental Health (MH) technology on the clinical effectiveness, the therapeutic relationship (i.e., therapeutic alliance), and usability issues. However, to the authors' knowledge, no studies have yet been performed regarding the influence of technology on the therapeutic process in terms of collaboration. This study evaluates the quality of collaboration between the client and therapist in Augmented Reality Exposure Therapy (ARET) context and the traditional, In Vivo Exposure Therapy (IVET) context with the Therapeutic Collaborative Scale (TCS). Twenty participants received an intensive session of cognitive behavioral therapy in either a technology-mediated therapeutic context or in a traditional therapeutic context. The results indicate that both therapeutic conditions show high collaboration scores. However, the asymmetry of roles between the therapist and the client under both conditions were detected. Also, a greater level of distraction was observed for therapists in ARET, which affected the quality of the therapists' involvement in the therapeutic session. The implications of these results are discussed.





Yuen ASY, Mak WWS. The Effects of Immersive Virtual Reality in Reducing Public Stigma of Mental Illness in the University Population of Hong Kong: Randomized Controlled Trial. *J Med Internet Res*. 2021;23(7):e23683. Published 2021 Jul 14. doi:10.2196/23683 **Background:** Public stigma in mental health often brings various adverse effects on people with mental illness. Researchers have been developing different interventions in combating public stigma. **Objective:** This study investigates the effects of immersive virtual reality (IVR) in reducing the public stigma of mental illness using a single-blinded randomized control trial. Methods: A pre-post experimental design with a 1-week follow-up was conducted. Participants (N=206) were recruited through the mass mail system of The Chinese University of Hong Kong and randomized into 3 conditions: immersive animation, text, and control. In the immersive animation condition (n=72), participants experienced the simulation of daily life and the stigma experienced as an animated story protagonist with mixed anxiety and depressive disorder with IVR. In the text condition (n=65), participants experienced an identical story to the immersive animation condition with first-person audio narration using the same virtual reality headset. In the control condition (n=69), participants watched a video about planets with IVR. All participants received interventions with a researcherassisted Oculus Go virtual reality headset. Participants' public stigma was measured through self-administered online questionnaires and compared across conditions and at different time points using repeated measures analysis of variance. Simple and sequential mediation analyses on the relationship of condition (immersive animation vs text) and follow-up public stigma with possible mediators, including sense of embodiment and story transportation, were conducted using PROCESS. Results: Public stigma did not differ significantly across conditions at pre-experiment (P>.99). In the immersive animation and text conditions, public stigma was significantly reduced at postexperiment and at the 1-week follow-up compared to pre-experiment (all with P<.001). Public stigma in the control condition at postexperiment and follow-up remained unchanged compared with pre-experiment (P=.69). Immersive animation had significantly lower public stigma than the control at postexperiment (P=.003) and follow-up (P=.02). Text also had lower public stigma than the control at postexperiment (P=.007) and follow-up (P=.03). However, immersive animation did not significantly differ from text in public stigma at postexperiment and follow-up (both P>.99). In simple mediation models, both sense of embodiment (95% CI -0.22 to 0.46) and story transportation (95% CI -0.18 to 0.00) were not significant mediators. In the sequential mediation model, both sense of embodiment and story transportation were significant sequential mediators. Sense of embodiment was positively associated with story transportation (P<.001), while story transportation was negatively associated with public stigma (P<.001). The indirect effect of the sequential mediation model was significant (95% CI -0.38 to -0.11). **Conclusions:** This study provides novel findings and a rigorous comparison in understanding the effects of IVR on public stigma. The findings showed that IVR and text with audio narration performed similarly and significantly in stigma reduction. Sense of embodiment and story transportation were found to be sequentially associated with public stigma reduction.





Zinzow HM, Brooks JO, Rosopa PJ, et al. Virtual Reality and Cognitive-Behavioral Therapy for Driving Anxiety and Aggression in Veterans: A Pilot Study. *Cognitive and Behavioral Practice*. 2018;25(2):296-309. doi:10.1016/j.cbpra.2017.09 .002 Within the U.S. military, motor vehicle accidents (MVAs) are the leading cause of preventable morbidity and mortality. Prior combat exposure and anxiety symptoms are associated with risky and aggressive driving, which is responsible for over half of MVA fatalities. Therefore, interventions are needed to reduce driving anxiety and aggression in veterans in order to mitigate the public health impact of MVAs. Virtual reality exposure therapy (VRET) offers safe, controlled exposure to distressing stimuli. The current study piloted a novel virtual reality and cognitive behavioral intervention (VRET + CBT) for veterans that integrated both anxiety and anger management components. Virtual reality driving scenarios were delivered in a driving simulator and tailored for the military population. Six previously deployed veterans completed eight intervention sessions, as well as pre/post, one month follow-up and six to nine month followup assessments. Repeated measures ANOVAs demonstrated significant decline and large effect sizes for PTSD symptoms, driving phobia, hyperarousal in driving situations, anxiety/anger-related thoughts and behaviors, and risky driving. Hyperarousal in driving situations declined by 69%, aggressive driving declined by 29%, and risky driving declined by 21%. Treatment gains were maintained at follow-up. Recruitment, retention, immersion, simulator sickness scores, and qualitative feedback demonstrated feasibility of the intervention. Implications for future research and adaptation are discussed.




## Table 4: Peer Support

Citation	Abstract
Ali K, Farrer L, Gulliver A,	Background: Adolescence and early adulthood are critical periods for the
Griffiths KM. Online Peer-to-	development of mental disorders. Online peer-to-peer communication is
Peer Support for Young	popular among young people and may improve mental health by providing social
People With Mental Health	support. Previous systematic reviews have targeted Internet support groups for
Problems: A Systematic	adults with mental health problems, including depression. However, there have
Review. JMIR Ment Health.	been no systematic reviews examining the effectiveness of online peer-to-peer
2015;2(2):e19. Published	support in improving the mental health of adolescents and young adults.
2015 May 19.	<b>Objective:</b> The aim of this review was to systematically identify available
doi:10.2196/mental.4418	evidence for the effectiveness of online peer-to peer support for young people
	with mental health problems. <b>Methods:</b> The PubMed, PsycInfo, and Cochrane
	databases were searched using keywords and Medical Subject Headings (MeSH)
	terms. Retrieved abstracts (n=3934) were double screened and coded. Studies
	were included if they (1) investigated an online peer-to-peer interaction, (2) the
	interaction discussed topics related to mental health, (3) the age range of the
	sample was between 12 to 25 years, and (4) the study evaluated the
	effectiveness of the peer-to-peer interaction. <b>Results:</b> Six studies satisfied the
	inclusion criteria for the current review. The studies targeted a range of mental
	health problems including depression and anxiety (n=2), general psychological
	problems (n=1), eating disorders (n=1), and substance use (tobacco) (n=2). The
	majority of studies investigated Internet support groups (n=4), and the remaining
	studies focused on virtual reality chat sessions (n=2). In almost all studies (n=5),
	the peer support intervention was moderated by health professionals,
	researchers or consumers. Studies employed a range of study designs including
	randomized controlled trials (n=3), pre-post studies (n=2) and one randomized
	trial. Overall, two of the randomized controlled trials were associated with a
	significant positive outcome in comparison to the control group at post-
	intervention. In the remaining four studies, peer-to-peer support was not found
	to be effective. <b>Conclusions:</b> This systematic review identified an overall lack of
	high-quality studies examining online peer-to-peer support for young people.
	Given that peer support is frequently used as an adjunct to Internet interventions
	for a variety of mental health conditions, there is an urgent need to determine
	the effectiveness of peer support alone as an active intervention.





Beauchamp JES, Wang M, Leon Novelo LG, et al. Feasibility and userexperience of a virtual environment for social connection and education after stroke: A pilot study. *Journal of Stroke and Cerebrovascular Diseases*. 2024;33(2):107515. doi:10.1016/j.jstrokecerebro vasdis.2023.107515 Objectives: To evaluate the feasibility and usability of stroke survivor participation in an 8-week virtual environment intervention that provides opportunities for social support exchanges, social network interactions, and recovery education. Materials and methods: A single-group, pre- and post-test measure design was used. Descriptive statistics were used to examine enrollment and retention rates, proportion of questionnaires completed, and virtual environment process data (e.g., number of log-ins) and usability scores. Changes in pre- and post-intervention questionnaire (e.g., usability, social support, depression, anxiety, loneliness, and self-efficacy) scores were explored using Wilcoxon signed-rank tests and paired t-test. Results: Fifteen (65 %) of the eligible stroke survivors enrolled (60 % white, 27 % black), 12 (80 %) had an ischemic stroke, ages ranged from 33 to 74 years (mean 44 years), and mean months since stroke was 33 ± 23. Retention and questionnaire completion rates were both 93 % (n = 14). Survivors logged into the virtual environment a total of 122 times, logged an average of 49 min/log-in, and 12 (80 %) attended support groups and social activities. Median usability score indicated lower than average usability. Improvement trends in social support, loneliness, and depressive symptoms were found, but significant changes in mean questionnaire scores were not found. **Conclusions:** Overall, the results suggest that using a virtual environment to foster social support exchanges, social network interactions, and recovery education after stroke is feasible. Similar to other chronic disease populations, stroke survivor adoption of a virtual environment likely requires ongoing technical assistance, repetition of instructions, and opportunities for practice to reinforce engagement.





Bond J, Kenny A, Pinfold V, et al. A Safe Place to Learn: Peer Research Qualitative Investigation of gameChange Virtual Reality Therapy. *JMIR Serious Games*. 2023;11:e38065. Published 2023 Jan 16. doi:10.2196/38065 **Background:** Automated virtual reality (VR) therapy has the potential to substantially increase access to evidence-based psychological treatments. The results of a multicenter randomized controlled trial showed that gameChange VR cognitive therapy reduces the agoraphobic avoidance of people diagnosed with psychosis, especially for those with severe avoidance. Objective: We set out to use a peer research approach to explore participants' experiences with gameChange VR therapy. This in-depth experiential exploration of user experience may inform the implementation in clinical services and future VR therapy development. Methods: Peer-led semistructured remote interviews were conducted with 20 people with a diagnosis of psychosis who had received gameChange as part of the clinical trial (ISRCTN17308399). Data were analyzed using interpretative phenomenological analysis and template analyses. A multiperspectival approach was taken to explore subgroups. Credibility checks were conducted with the study Lived Experience Advisory Panel. **Results:** Participants reported the substantial impact of anxious avoidance on their lives before the VR intervention, leaving some of them housebound and isolated. Those who were struggling the most with agoraphobic avoidance expressed the most appreciation for, and gains from, the gameChange therapy. The VR scenarios provided "a place to practise." Immersion within the VR scenarios triggered anxiety, yet participants were able to observe this and respond in different ways than usual. The "security of knowing the VR scenarios are not real" created a safe place to learn about fears. The "balance of safety and anxiety" could be calibrated to the individual. The new learning made in VR was "taken into the real world" through practice and distilling key messages with support from the delivery staff member. Conclusions: Automated VR can provide a therapeutic simulation that allows people diagnosed with psychosis to learn and embed new ways of responding to the situations that challenge them. An important process in anxiety reduction is enabling the presentation of stimuli that induce the original anxious fears yet allow for learning of safety. In gameChange, the interaction of anxiety and safety could be calibrated to provide a safe place to learn about fears and build confidence. This navigation of therapeutic learning can be successfully managed by patients themselves in an automated therapy, with staff support, that provides users with personalized control. The clinical improvements for people with severe anxious avoidance, the positive experience of VR, and the maintenance of a sense of control are likely to facilitate implementation.





Bridge P, Mehta J, Keane P, et al. A virtual reality environment for supporting mental wellbeing of students on remote clinical placement: A multi-methods evaluation. *Nurse Education Today*. 2024;138:106184. doi:10.1016/j.nedt.2024.106 184

Background: Nursing and Allied Health Profession (NAHP) students undertake clinical placements as part of their pre-registration training. The remote nature of some placement sites, shiftwork and the emotionally challenging nature of the workload has led to mental wellbeing issues in many students. Aim: This project aimed to evaluate a novel 3D immersive virtual reality environment that supports mental wellbeing for NAHP students on clinical placement. It comprises a calming 3D tropical beach environment where students and tutors can meet for reflection and mutual support. Design: A multi-methods design gathered quantitative impact data with validated measurement tools and qualitative output related to the lived experience of students. Settings and participants: All 600 pre-registration NAHP students within the institution undertaking clinical placements were invited to participate, irrespective of mental wellbeing status. Students were randomly assigned to either a VR or Conventional cohort; all participants received the control support mechanism in a subsequent placement. Methods: All participants completed an initial demographic and Readiness for Therapy survey followed by weekly Beck Anxiety and Depression Inventories during placement. All participants were invited to a semi-structured interview. Results: Overall, 32 participants engaged with the application; although the VR cohort demonstrated improved scores on both Beck inventories, these were not statistically significant. This is probably due to the low response rate for the control cohort. A total of 15 interviews were conducted and several themes emerged from the data in relation. to both experiential outcomes (escapism, anonymity and sense of community) and instrumental outcomes (calming, mindfulness and combatting loneliness). Conclusions: User feedback indicates that a VR environment can provide a calming escape from the pressures and anxiety arising from clinical placement for healthcare students. The relaxing beach environment facilitated mindfulness meditation and the additional opportunities for pseudo-anonymous interactions with peers and tutors were well received by students.





Casarez RL, Johnson CM, Purpose: Self-management and lifestyle interventions are a key factor in Soares JC, Meyer TD. Use of treatment outcomes for persons with bipolar disorder (BD). A virtual a virtual environment to environment (VE), due to it's ability to provide flexibility of involvement in its promote self-management platform, may be an alternative to face-to-face treatment to provide support for self-management. The purpose of this study is to explore how a VE, developed and lifestyle changes in persons with bipolar for chronic illness self-management, may be modified to promote selfmanagement and lifestyle changes in those with BD. Method: This study used a disorder. Archives of Psychiatric Nursing. qualitative description design with focus groups. Data were collected via 2024;49:73-82. minimally structured interviews and analyzed using thematic content analysis. A doi:10.1016/j.apnu.2024.02. total of seven focus groups were conducted, and the sample consisted of 30 003 adults with BD. Age range was 21–77 years with 21 females, seven males, and two non-binary individuals. **Results:** Five themes emerged from the findings: Self-management and lifestyle interventions with regards to (1) mental health; (2) holistic health; (3) role of peers; (4) involvement of the family; (5) technological aspects of the VE. **Conclusions:** Focus group participants suggested that the VE may be an efficacious way to enhance self-management and promote lifestyle interventions in those with BD. Research is needed to adapt such platforms to the need of the patients and examine its' effect on health outcomes.





Fortuna K, Hill J, Chalker S, Ferron J. Certified Peer Support Specialists Training in Technology and Delivery of Digital Peer Support Services: Cross-sectional Study. *JMIR Form Res*. 2022;6(12):e40065. Published 2022 Dec 7. doi:10.2196/40065

Background: When the COVID-19 pandemic lockdown measures were instituted, the wide-scale necessity for remote mental health care increased among professional clinicians, such as psychiatrists, psychologists, social workers, and certified peer support (CPS) specialists. Factors contributing to increased demand include concern for the safety of loved ones, the safety of oneself, overall well-being, unemployment, and loneliness for older individuals. While demand continues to increase and a shortage of mental health professionals persists, understanding the training, technology, media, and delivery of digital peer support services can facilitate community-based support services to assist patients in coping with mental health symptoms between clinical encounters with licensed professionals. Digital peer support consists of asynchronous and synchronous, live or automated, peer support services such as applications, social media, and phone calls. **Objective:** The purpose of this cross-sectional study is to determine how digital peer support is delivered, by which technologies it is delivered, and how certified digital peer supporters are trained within the United States to inform future delivery of digital peer support. Methods: We used an online cross-sectional self-report survey developed alongside certified peer specialists. The study included questions regarding the types of peer support training and the delivery methods used within their practices. We advertised the survey through a certified peer support specialist listserve, Facebook, and Twitter. Results: Certified peer specialists provide mutual social emotional support to those with a similar mental health condition. Of certified peer specialists trained in CPS, the majority of CPS specialists were trained in peer support (418/426, 98.1%). Peer support specialists deliver services via telephone calls (182/293, 62.1%), via videoconference-based services (160/293, 54.6%), via SMS text messages (123/293, 42%), via smartphone apps (68/293, 23.2%), and via social media (65/293, 22.2%). Certified peer specialists deliver services through virtual reality (11/293, 3.8%) and through video games (6/293, 2%). Virtual reality and video games may represent emerging technologies to develop and deliver community-based support. **Conclusions:** This study examined the modes of digital peer support intervention as well as the training and demographic background of peer supporters. Given the demand for mental health care, digital peer support emerges as one option to increase access. These results suggest that CPS specialists commonly use SMS text messaging, phone calls, and videoconferences to engage in peer support. Less frequently, they may use diverse modes such as apps, social media, and video games. It is important to consider the backgrounds of peer supporters and the mediums of communication to best accommodate areas where access to peer support is emerging. Larger longitudinal studies and a variety of experimental designs may be considered to understand the efficacy of digital interventions and digital peer support training to direct optimal care.





Goldenhersch E, Thrul J, Ungaretti J, Rosencovich N, Waitman C, Ceberio MR. Virtual Reality Smartphone-Based Intervention for Smoking Cessation: Pilot Randomized Controlled Trial on Initial Clinical Efficacy and Adherence. *J Med Internet Res.* 2020;22(7):e17571. Published 2020 Jul 29. doi:10.2196/17571 **Background:** Obstacles to current tobacco cessation programs include limited access and adherence to effective interventions. Digital interventions offer a great opportunity to overcome these difficulties, yet virtual reality has not been used as a remote and self-administered tool to help increase adherence and effectiveness of digital interventions for tobacco cessation. Objective: This study aimed to evaluate participant adherence and smoking cessation outcomes in a pilot randomized controlled trial of the digital intervention Mindcotine (MindCotine Inc) using a self-administered treatment of virtual reality combined with mindfulness. Methods: A sample of 120 participants was recruited in the city of Buenos Aires, Argentina (mean age 43.20 years, SD 9.50; 57/120, 47.5% female). Participants were randomly assigned to a treatment group (TG), which received a self-assisted 21-day program based on virtual reality mindful exposure therapy (VR-MET) sessions, daily surveys, and online peer-to-peer support moderated by psychologists, or a control group (CG), which received the online version of the smoking cessation manual from the Argentine Ministry of Health. Follow-up assessments were conducted by online surveys at postintervention and 90-day follow-up. The primary outcome was self-reported abstinence at postintervention, with missing data assumed as still smoking. Secondary outcomes included sustained abstinence at 90-day followup, adherence to the program, and readiness to quit. Results: Follow-up rates at day 1 were 93% (56/60) for the TG and 100% (60/60) for the CG. At postintervention, the TG reported 23% (14/60) abstinence on that day compared with 5% (3/60) in the CG. This difference was statistically significant ( $\chi^2_1$ =8.3; P=.004). The TG reported sustained abstinence of 33% (20/60) at 90 days. Since only 20% (12/60) of participants in the CG completed the 90-day follow-up, we did not conduct a statistical comparison between groups at this follow-up time point. Among participants still smoking at postintervention, the TG was significantly more ready to quit compared to the CG (TG: mean 7.71, SD 0.13; CG: mean 7.16, SD 0.13; P=.005). A total of 41% (23/56) of participants completed the treatment in the time frame recommended by the program. **Conclusions:** Results provide initial support for participant adherence to and efficacy of Mindcotine and warrant testing the intervention in a fully powered randomized trial. However, feasibility of trial follow-up assessment procedures for control group participants needs to be improved. Further research is needed on the impact of VR-MET on long-term outcomes.





Horan WP, Depp CA, Hurst S, et al. Qualitative Analysis of the Content Validity of the Virtual Reality Functional Capacity Assessment Tool (VRFCAT) in Schizophrenia: A Multi-Stakeholder Perspective. *Schizophr Bull Open.* 2023;4(1):sgad012. Published 2023 May 6. doi:10.1093/schizbullopen/s gad012 The US Food and Drug Agency (FDA) requires clinical trials targeting cognitive impairment associated with schizophrenia (CIAS) to demonstrate the functional relevance of cognitive improvements by employing a functional co-primary measure. Although quantitative evidence supports the suitability of the Virtual Reality Functional Capacity Assessment Tool (VRFCAT) for this purpose, FDA guidelines for qualification of clinical outcome assessments require evidence of content validity, defined as qualitative evidence that key stakeholders view the measure as relevant and important. To collect this important qualitative data, semi-structured interviews were conducted with outpatients with schizophrenia (n = 24), caregivers (n = 12), and professional peer support specialists (n = 12) to elicit their views about the definition and importance of functional independence, the importance of the functional domains assessed by the VRFCAT (meal planning, using transportation, handling money, shopping), and the relevance of the VRFCAT tasks to these domains. Qualitative thematic analyses revealed consistent themes across groups in defining functional independence, including performing instrumental self-care, financial, and social tasks; making decisions autonomously; and not depending on others to carry out daily activities. There were, however, notable differences in their views regarding the importance of and barriers to functional independence. All groups viewed the VRFCAT as assessing skill domains that are central to independent functioning and, with some minor differences, the VRFCAT tasks were viewed as relevant and meaningful examples of the domains. These qualitative results provide converging evidence that key stakeholders view the VRFCAT as a content-valid measure.





Jain SR, Sui Y, Ng CH, Chen ZX, Goh LH, Shorey S. Patients' and healthcare professionals' perspectives towards technology-assisted diabetes self-management education. A qualitative systematic review. <i>PLoS</i> <i>One</i> . 2020;15(8):e0237647. Published 2020 Aug 17. doi:10.1371/journal.pone.02 37647	<b>Introduction:</b> Diabetes self-management education is a key aspect in the long- term management of type 2 diabetes. The patient and healthcare professional (HCP) perspective on the use of technology-assisted DSME has yet to be studied. Hence, the objective of this study was to better understand the factors that facilitate or hinder the adoptions of such education by adults with type 2 diabetes and their HCPs. <b>Methods:</b> We systematically searched five databases (Medline, Embase, CINAHL, Web of Science Core Collection, and PsycINFO) until August 2019. The search included qualitative and mixed-method studies that reported the views of patients and HCPs regarding features, uses, and implementations of technology-assisted DSME. Data were synthesized through an inductive thematic analysis. <b>Results:</b> A total of 13 articles were included, involving 242 patients, ranging from 18 to 81 years and included web-based, mobile application, digital versatile disc (DVD), virtual reality or telehealth interventions. Patients and HCPs had mixed views towards features of the technology-assisted interventions, with patients' personal qualities and HCPs' concerns affecting uses of the interventions. Patients generally preferred technologies that were easy to access, use, and apply and that had reliable information. Patients' ambitions motivated them, and personal attributes such as poor competence with technology, poor literacy, and language barriers acted as barriers. Patients especially liked the peer support that they received but did not like it when there was no regulation of advice on these platforms. HCPs believed that while the interventions were useful to patients, they faced difficulties with integration into their clinical workflows. <b>Conclusion:</b> This review explored the features of technology-assisted diabetes self-management education interventions that enhanced positive patient engagements and the negative aspects of both the platforms and the target groups. Technical support and training will be effective in managi
Knowles LM, Stelzer EM,	Social support and grief education can ameliorate mental and physical health
Jovel KS, O'Connor MF. A	risks in widow(er)s. However, barriers often prevent older individuals from
pilot study of virtual support	attending support groups. This controlled pilot study examined the feasibility
for grief: Feasibility,	and acceptability of an online, real-time, interactive virtual reality (VR) support
acceptability, and	group for widow(er)s, and assessed the preliminary efficacy of the VR support
preliminary outcomes.	group for improving psychosocial outcomes and sleep quality compared to an
Computers in Human	active control grief education website. Thirty widow(er)s (Mage = 67.0, SD = 11.0)
Behavior. 2017;73:650-658.	participated in an 8-week VR support group or accessed a grief education
doi:10.1016/j.chb.2017.04.0	website. Participants completed self-report measures of depression, grief
05	intensity, grief cognitions, yearning, loneliness, perceived stress and sleep
	quality at three time points. Participant attrition and self-report indicated that
	both interventions were reasible and acceptable. Both groups showed
	significant improvements in grief sevency, grief cognitions, yearning, tonellness,
	only widow(er)s in the VR support group showed a significant improvement in
	depression across time. This study demonstrates the feasibility, acceptability
	and preliminary efficacy of an accessible and low-cost online support format for
	widow(er)s.





Marks A, Garbatini A, Hieftje K, Puthenpura V, Weser V, Fernandes CSF. Use of Immersive Virtual Reality Spaces to Engage Adolescent and Young Adult Patients With Cancer in Therapist-Guided Support Groups: Protocol for a Pre-Post Study. *JMIR Res Protoc*. 2023;12:e48761. doi:10.2196/48761 **Background:** For adolescents and young adults, a cancer diagnoses can magnify feelings of social isolation at an inherently vulnerable developmental stage. Prior studies have highlighted the importance of peer groups during cancer treatment. Support groups help foster connection and resilience, but patients find in-person participation difficult due to a variety of factors. Additionally, physical changes brought on by cancer makes these patients hesitant to meet in person. The COVID-19 pandemic magnified these difficulties. Virtual reality (VR) allows for the creation of a therapist-curated, computer-generated social space that potentially enables support groups for this population. **Objective:** This protocol describes a pilot study examining the efficacy, feasibility, and acceptability of a social VR support group intervention for adolescent and young adult patients with cancer. Methods: We approached 20 participants aged 17-20 years, and 16 agreed to participate. Moreover, 1 participant dropped out due to hospitalization. Participants attended virtual, professionally facilitated support groups using Meta Quest VR headsets. The groups consisted of 4 participants and 1 facilitator, amounting to a total of 22 individual sessions. Each session lasted 45-60 minutes and took place weekly for 4-6 weeks. The primary aim of this study was to collect quantitative and qualitative data on the feasibility and acceptability of the intervention. Feasibility was measured through session participation rates and overall retention rates. The acceptability of the intervention was explored through brief in-person interviews with participants at the end of the final intervention session. The secondary aim of this study was to collect data on the preliminary efficacy of the intervention in decreasing symptoms of participant depression and anxiety and increasing positive affect and resiliency. **Results:** In total, 15 patients aged 17-20 years participated in 22 sessions between November 5, 2019, and July 8, 2021. The median age was 19 (IQR 17-20) years. Overall, 10 (62%) participants identified as male, 5 (31%) as female, and 1 (6%) as transgender female. Furthermore, 5 (31%) participants identified as Hispanic, 1 (6%) identified as non-Hispanic Asian, 3 (19%) identified as non-Hispanic Black, 6 (38%) identified as non-Hispanic White, and 1 (6%) identified as other race or ethnicity. Hematologic malignancies or bone marrow failure was the most common diagnosis (8/16, 50%). The mean attendance rate was 72.8% (SD 25.7%) and retention was 86.7% (SD 0.35%). Moreover, 45% (10/22) of sessions had to be postponed by a week or more due to unexpected participant scheduling issues. **Conclusions:** The use of VR to deliver psychosocial support for adolescents and young adults with cancer may reduce common barriers associated with attending in-person peer support groups while improving quality-of-life measures. The data from this study will inform future studies focused on conducting VR support groups in other rare disease populations, including older adults with cancer.





McKelvin R, McKelvin G.	Background: Simulated practice using high fidelity has been shown to have
Immersive simulation	significant benefits in the medical and nursing field. However, the benefits
training: Comparing the	amongst paramedical and midwifery students are not well known. Aim: The aim
impact on midwifery and	of this study was to explore and compare the impact of Immersive Simulation
paramedic students'	Training (IST) on midwifery and paramedic students' confidence to perform a
confidence to perform basic	skill (basic life support) in real-life stressful and life-threatening scenarios.
life support skills. Midwifery.	<b>Design:</b> A mixed-method approach with an explanatory sequential design was
2020;87:102717.	used. Setting and participants: Seventeen first year student midwives and
doi:10.1016/j.midw.2020.10	paramedics were recruited from one Higher Education Institution.
2717	Measurements: A validated confidence questionnaire and focus groups were
	used to collect data. Findings: Students' confidence following IST was
	significantly improved when compared to confidence following conventional
	simulation training (CST); a statistically significant increase of 6.71 (95% CI, 3.57
	to 9.84), p < 0.001. Additionally, five themes were identified; 'Needing a solid
	foundation', 'The role of peer support' and 'It is just not real' following CST and 'A
	steep learning curve' and 'A whole new world' following IST. <b>Conclusion:</b> The
	study identified the important role of CST to establish a foundation but the need
	for escalation to IST to ensure deeper learning and preparedness for real life
	scenarios and should both be integrated in curricula.
Rehm IC, Foenander E,	In the burgeoning field of e-mental health interventions, avatars are increasingly
Wallace K, Abbott JM, Kyrios	being utilized to facilitate online communication between clients and therapists,
M, Thomas N. What Role	and among peers. Avatars are digital self-representations, which enable
Can Avatars Play in e-Mental	individuals to interact with each other in computer-based virtual environments.
Health Interventions?	In this narrative review, we examine the psychotherapeutic applications of
Exploring New Models of	avatars that have been investigated and trialed to date. Five key applications
Client-Therapist	were identified (1) in the formation of online peer support communities: (2)
Interaction. Front Psychiatry.	replicating traditional modes of psychotherapy by using avatars as a vehicle to
2016:7:186. Published 2016	communicate within a wholly virtual environment: (3) using avatar technology to
Nov 18.	facilitate or augment face-to-face treatment: (4) as part of serious games: and (5)
doi:10.3389/fpsvt.2016.0018	communication with an autonomous virtual therapist. Across these
6	applications, avatars appeared to serve several functions conducive to
	treatment engagement by (1) facilitating the development of a virtual therapeutic
	alliance: (2) reducing communication barriers: (3) promoting treatment-seeking
	through anonymity: (4) promoting expression and exploration of client identity:
	and (5) enabling therapists to control and manipulate treatment stimuli. Further
	research into the feasibility and ethical implementation of avatar-based
	psychotherapies is required.





Robinson N, Mahapatra A,	Introduction: Cognitive Behavioral Immersion (CBI) is a novel cognitive-
Jean-Baptiste B, et al.	behavioral skills program delivered by lay coaches in the metaverse through
Cognitive Behavioral	immersive virtual reality technology. <b>Objectives:</b> The objective for this study was
Immersion for Substance	to run a feasibility and pilot study of CBI for individuals in recovery from a
Use Disorders: A Feasibility	substance use disorder. <b>Methods:</b> Data from 48 participants were used and
and Pilot Study of a Peer-	program usage was assessed. Participants were asked to complete
Based Coaching Program in	questionnaires assessing affect, perceived online social support, and group
the Metaverse. Games	therapy alliance throughout their participation in the program. Structured
Health J. 2023;12(5):397-	qualitative interviews were also conducted with a subset of participants ( $n = 11$ )
404.	to understand the feasibility of the novel program. <b>Results:</b> Participants
doi:10.1089/g4h.2022.0214	experienced a significant increase in their positive affect and non-significant
	decrease in their negative affect during their most recently attended session.
	Participants also experienced a nonsignificant increase in online social support
	across their participation in the program. Structured qualitative interviews
	revealed eight primary themes including both advantages (community
	nsvchoeducational impact immersion comparability with other interventions
	coping in the pandemic, and aponymity) and areas of improvement (challenges
	and technological usability) of the program <b>Conclusion:</b> This study provides
	and technological usability of the program. <b>Conclusion.</b> This study provides
	pretininary support for the reasibility and potential effects of CBI and its
	metoporation of tay coaches to tead cognitive-benavioral skills groups in the
	of this program for a broader array of aligical procentations
	of this program for a broader array of cunical presentations.
	Objectives blows can used and the subscription first line can supply the
Sung HC, Su HF, Lee WL,	<b>Objectives:</b> Home care workers who are the first-line care workers for
Sung HC, Su HF, Lee WL, Yamakawa M, Wang HM.	<b>Objectives:</b> Home care workers who are the first-line care workers for community-dwelling dementia patients often have limited dementia knowledge,
Sung HC, Su HF, Lee WL, Yamakawa M, Wang HM. Effects of a dementia virtual	<b>Objectives:</b> Home care workers who are the first-line care workers for community-dwelling dementia patients often have limited dementia knowledge, skills, and empathy towards those with dementia. Research is sparse on
Sung HC, Su HF, Lee WL, Yamakawa M, Wang HM. Effects of a dementia virtual reality-based training with	<b>Objectives:</b> Home care workers who are the first-line care workers for community-dwelling dementia patients often have limited dementia knowledge, skills, and empathy towards those with dementia. Research is sparse on dementia care training using virtual reality (VR) technology and support network
Sung HC, Su HF, Lee WL, Yamakawa M, Wang HM. Effects of a dementia virtual reality-based training with peer support for home care	<b>Objectives:</b> Home care workers who are the first-line care workers for community-dwelling dementia patients often have limited dementia knowledge, skills, and empathy towards those with dementia. Research is sparse on dementia care training using virtual reality (VR) technology and support network for home care workers. <b>Methods:</b> This cluster randomized controlled trial
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Sung HC, Su HF, Lee WL, Yamakawa M, Wang HM. Effects of a dementia virtual reality-based training with peer support for home care workers: A cluster randomized controlled trial. <i>Int J Geriatr Psychiatry</i> . 2022;37(9):10.1002/gps.579	<b>Objectives:</b> Home care workers who are the first-line care workers for community-dwelling dementia patients often have limited dementia knowledge, skills, and empathy towards those with dementia. Research is sparse on dementia care training using virtual reality (VR) technology and support network for home care workers. <b>Methods:</b> This cluster randomized controlled trial evaluated the effects of a dementia VR-based training with peer support on dementia knowledge, attitude, competence, and empathy of home care workers. Each home care worker team was used as the unit for randomization. Sixteen teams were randomly assigned to either VR group or non-VR control
Sung HC, Su HF, Lee WL, Yamakawa M, Wang HM. Effects of a dementia virtual reality-based training with peer support for home care workers: A cluster randomized controlled trial. <i>Int J Geriatr Psychiatry</i> . 2022;37(9):10.1002/gps.579 9. doi:10.1002/gps.5799	<b>Objectives:</b> Home care workers who are the first-line care workers for community-dwelling dementia patients often have limited dementia knowledge, skills, and empathy towards those with dementia. Research is sparse on dementia care training using virtual reality (VR) technology and support network for home care workers. <b>Methods:</b> This cluster randomized controlled trial evaluated the effects of a dementia VR-based training with peer support on dementia knowledge, attitude, competence, and empathy of home care workers. Each home care worker team was used as the unit for randomization. Sixteen teams were randomly assigned to either VR group or non-VR control group There was a total of 124 participants completed the study, the VR group (n
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Sung HC, Su HF, Lee WL, Yamakawa M, Wang HM. Effects of a dementia virtual reality-based training with peer support for home care workers: A cluster randomized controlled trial. <i>Int J Geriatr Psychiatry</i> . 2022;37(9):10.1002/gps.579 9. doi:10.1002/gps.5799	<b>Objectives:</b> Home care workers who are the first-line care workers for community-dwelling dementia patients often have limited dementia knowledge, skills, and empathy towards those with dementia. Research is sparse on dementia care training using virtual reality (VR) technology and support network for home care workers. <b>Methods:</b> This cluster randomized controlled trial evaluated the effects of a dementia VR-based training with peer support on dementia knowledge, attitude, competence, and empathy of home care workers. Each home care worker team was used as the unit for randomization. Sixteen teams were randomly assigned to either VR group or non-VR control group There was a total of 124 participants completed the study, the VR group (n = 61) received a dementia VR-based training consisted of 3-month dementia care e-book modules, dementia VR-based activity and 1-h monthly face-to-face peer support group meetings. The non-VR control group (n = 63) only receive the 3-month dementia care e-book modules and 1-h monthly regular staff meetings with no VR activity. Outcome measures were assessed at three time points:
Sung HC, Su HF, Lee WL, Yamakawa M, Wang HM. Effects of a dementia virtual reality-based training with peer support for home care workers: A cluster randomized controlled trial. <i>Int J Geriatr Psychiatry</i> . 2022;37(9):10.1002/gps.579 9. doi:10.1002/gps.5799	<b>Objectives:</b> Home care workers who are the first-line care workers for community-dwelling dementia patients often have limited dementia knowledge, skills, and empathy towards those with dementia. Research is sparse on dementia care training using virtual reality (VR) technology and support network for home care workers. <b>Methods:</b> This cluster randomized controlled trial evaluated the effects of a dementia VR-based training with peer support on dementia knowledge, attitude, competence, and empathy of home care workers. Each home care worker team was used as the unit for randomization. Sixteen teams were randomly assigned to either VR group or non-VR control group There was a total of 124 participants completed the study, the VR group (n = 61) received a dementia VR-based training consisted of 3-month dementia care e-book modules, dementia VR-based activity and 1-h monthly face-to-face peer support group meetings. The non-VR control group (n = 63) only receive the 3-month dementia care e-book modules and 1-h monthly regular staff meetings with no VR activity. Outcome measures were assessed at three time points: baseline, the end of the 3-month intervention, and 1-month post intervention.
Sung HC, Su HF, Lee WL, Yamakawa M, Wang HM. Effects of a dementia virtual reality-based training with peer support for home care workers: A cluster randomized controlled trial. <i>Int J Geriatr Psychiatry</i> . 2022;37(9):10.1002/gps.579 9. doi:10.1002/gps.5799	<b>Objectives:</b> Home care workers who are the first-line care workers for community-dwelling dementia patients often have limited dementia knowledge, skills, and empathy towards those with dementia. Research is sparse on dementia care training using virtual reality (VR) technology and support network for home care workers. <b>Methods:</b> This cluster randomized controlled trial evaluated the effects of a dementia VR-based training with peer support on dementia knowledge, attitude, competence, and empathy of home care workers. Each home care worker team was used as the unit for randomization. Sixteen teams were randomly assigned to either VR group or non-VR control group There was a total of 124 participants completed the study, the VR group (n = 61) received a dementia VR-based training consisted of 3-month dementia care e-book modules, dementia VR-based activity and 1-h monthly face-to-face peer support group meetings. The non-VR control group (n = 63) only receive the 3-month dementia care e-book modules and 1-h monthly regular staff meetings with no VR activity. Outcome measures were assessed at three time points: baseline, the end of the 3-month intervention, and 1-month post intervention. <b>Results:</b> Generalized estimating equations results indicate that the
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Sung HC, Su HF, Lee WL, Yamakawa M, Wang HM. Effects of a dementia virtual reality-based training with peer support for home care workers: A cluster randomized controlled trial. <i>Int J Geriatr Psychiatry</i> . 2022;37(9):10.1002/gps.579 9. doi:10.1002/gps.5799	<b>Objectives:</b> Home care workers who are the first-line care workers for community-dwelling dementia patients often have limited dementia knowledge, skills, and empathy towards those with dementia. Research is sparse on dementia care training using virtual reality (VR) technology and support network for home care workers. <b>Methods:</b> This cluster randomized controlled trial evaluated the effects of a dementia VR-based training with peer support on dementia knowledge, attitude, competence, and empathy of home care workers. Each home care worker team was used as the unit for randomization. Sixteen teams were randomly assigned to either VR group or non-VR control group There was a total of 124 participants completed the study, the VR group (n = 61) received a dementia VR-based training consisted of 3-month dementia care e-book modules, dementia VR-based activity and 1-h monthly face-to-face peer support group meetings. The non-VR control group (n = 63) only receive the 3-month dementia care e-book modules and 1-h monthly regular staff meetings with no VR activity. Outcome measures were assessed at three time points: baseline, the end of the 3-month intervention, and 1-month post intervention. <b>Results:</b> Generalized estimating equations results indicate that the improvement in dementia knowledge, attitudes, competence, and empathy over time is significant in the VR group compared to the non-VR control group. The
Sung HC, Su HF, Lee WL, Yamakawa M, Wang HM. Effects of a dementia virtual reality-based training with peer support for home care workers: A cluster randomized controlled trial. <i>Int J Geriatr Psychiatry</i> . 2022;37(9):10.1002/gps.579 9. doi:10.1002/gps.5799	<b>Objectives:</b> Home care workers who are the first-line care workers for community-dwelling dementia patients often have limited dementia knowledge, skills, and empathy towards those with dementia. Research is sparse on dementia care training using virtual reality (VR) technology and support network for home care workers. <b>Methods:</b> This cluster randomized controlled trial evaluated the effects of a dementia VR-based training with peer support on dementia knowledge, attitude, competence, and empathy of home care workers. Each home care worker team was used as the unit for randomization. Sixteen teams were randomly assigned to either VR group or non-VR control group There was a total of 124 participants completed the study, the VR group (n = 61) received a dementia VR-based training consisted of 3-month dementia care e-book modules, dementia VR-based activity and 1-h monthly face-to-face peer support group meetings. The non-VR control group (n = 63) only receive the 3-month dementia care e-book modules and 1-h monthly regular staff meetings with no VR activity. Outcome measures were assessed at three time points: baseline, the end of the 3-month intervention, and 1-month post intervention. <b>Results:</b> Generalized estimating equations results indicate that the improvement in dementia knowledge, attitudes, competence, and empathy over time is significant in the VR group compared to the non-VR control group. The effects remained significant 1 month after the end of the 3-month intervention.
Sung HC, Su HF, Lee WL, Yamakawa M, Wang HM. Effects of a dementia virtual reality-based training with peer support for home care workers: A cluster randomized controlled trial. <i>Int J Geriatr Psychiatry</i> . 2022;37(9):10.1002/gps.579 9. doi:10.1002/gps.5799	<b>Objectives:</b> Home care workers who are the first-line care workers for community-dwelling dementia patients often have limited dementia knowledge, skills, and empathy towards those with dementia. Research is sparse on dementia care training using virtual reality (VR) technology and support network for home care workers. <b>Methods:</b> This cluster randomized controlled trial evaluated the effects of a dementia VR-based training with peer support on dementia knowledge, attitude, competence, and empathy of home care workers. Each home care worker team was used as the unit for randomization. Sixteen teams were randomly assigned to either VR group or non-VR control group There was a total of 124 participants completed the study, the VR group (n = 61) received a dementia VR-based training consisted of 3-month dementia care e-book modules, dementia VR-based activity and 1-h monthly face-to-face peer support group meetings. The non-VR control group (n = 63) only receive the 3-month dementia care e-book modules and 1-h monthly regular staff meetings with no VR activity. Outcome measures were assessed at three time points: baseline, the end of the 3-month intervention, and 1-month post intervention. <b>Results:</b> Generalized estimating equations results indicate that the improvement in dementia knowledge, attitudes, competence, and empathy over time is significant 1 month after the end of the 3-month intervention.
Sung HC, Su HF, Lee WL, Yamakawa M, Wang HM. Effects of a dementia virtual reality-based training with peer support for home care workers: A cluster randomized controlled trial. <i>Int J Geriatr Psychiatry</i> . 2022;37(9):10.1002/gps.579 9. doi:10.1002/gps.5799	<b>Objectives:</b> Home care workers who are the first-line care workers for community-dwelling dementia patients often have limited dementia knowledge, skills, and empathy towards those with dementia. Research is sparse on dementia care training using virtual reality (VR) technology and support network for home care workers. <b>Methods:</b> This cluster randomized controlled trial evaluated the effects of a dementia VR-based training with peer support on dementia knowledge, attitude, competence, and empathy of home care workers. Each home care worker team was used as the unit for randomization. Sixteen teams were randomly assigned to either VR group or non-VR control group There was a total of 124 participants completed the study, the VR group (n = 61) received a dementia VR-based activity and 1-h monthly face-to-face peer support group meetings. The non-VR control group (n = 63) only receive the 3-month dementia care e-book modules and 1-h monthly regular staff meetings with no VR activity. Outcome measures were assessed at three time points: baseline, the end of the 3-month intervention, and 1-month post intervention. <b>Results:</b> Generalized estimating equations results indicate that the improvement in dementia knowledge, attitudes, competence, and empathy over time is significant 1 month after the end of the 3-month intervention. <b>Conclusions:</b> Innovative and accessible dementia training using VR technology with peer support is a promising training approach to improve dementia





Wijeysingha ES, Chin VY, Lian CP. Utilising virtual environments for radiation therapy teaching and learning. *Journal of Medical Imaging and Radiation Sciences*. 2021;52(4):S83-S95. doi:10.1016/j.jmir.2021.07.0 01 Introduction: Modern radiation therapy undergraduate education comprises the illustration of theoretical, technical concepts in a classroom setting, coupled with the acquisition of practical handling and patient communication skills within the clinical environment. In recent years, there has been renewed interest in the application of virtual environments to education, despite ongoing inconclusive evidence on the use of virtual environments for enhancing student educational achievement. Aim and objectives: The aim of our research is to evaluate a custom-built 3D virtual radiation oncology department created within Second Life<sup>®</sup>, an online virtual world, as an alternative to traditional physical classroom-based didactic instruction, in tandem with a Virtual Environment for Radiotherapy Training (VERT) system, for the peer support and training of junior radiation therapy students in their first and second year of undergraduate studies. To achieve this aim, we investigated learning achievement outcomes, knowledge retention over a 2-week time interval and learner self-perceived confidence post-instruction, using both quantitative and qualitative analysis. Methods: Institutional ethics approval was granted for an exempted review. Participants were currently enrolled undergraduate Year 1 and Year 2 students at our institution. Student participants were randomized into two groups; the control group attended a face-to-face classroom session centered on the illustration of theoretical, technical concepts, while the intervention group attended a virtual classroom session online on Second Life®, where similar content was delivered. Both groups then attended a VERT practical session to acquire practical handling and communication skills in radiation therapy. Upon completion of the sessions, confidence surveys, knowledge-based written and practical assessments were administered to the student participants. Results: We found that the instructional session conducted within the custom-built 3D virtual radiation oncology department in Second Life<sup>®</sup> compared to the traditional didactic classroom setting increased undergraduate Year 1 radiation therapy students' perceived confidence to a greater extent compared to Year 2 students, in performing radiation therapy treatment procedures. In addition, our findings revealed that overall learning achievement outcomes and knowledge retention scores between Second Life® and non- Second Life® student participants were closely similar and statistically insignificant. Thematic analysis of the confidence survey questionnaires revealed that the students in general desired more clinical hands-on practice. Discussion: Second Life® is equally effective in disseminating theoretical, technical course content delivery to undergraduate radiation therapy students. The use of virtual environments appears to have increased the perceived confidence of the Year 1 undergraduate students to a greater extent compared to the Year 2 undergraduates, suggesting that the adoption of virtual environments early in the students' educational journey can have a positive effect on students' learning experience. Conclusions and Recommendations: The development and use of our custom-built Second Life<sup>®</sup> radiation oncology department provides a novel way of delivering remote, virtual training instruction to undergraduate radiation therapy students over traditional, didactic classroom instructional delivery. We recommend, based on the results of this pilot study, that future research can





involve a larger study sample of undergraduate RT students, to explore both the short-term and long-term impact of virtual environments on student learning outcomes across their enrolled years of study. This would in turn mean progressive attempts to revamp our existing curricula structure, to deliberately incorporate the use of virtual environments, especially during early undergraduate years, towards enhanced modern RT education.





## Table 5: Pulmonary Rehabilitation

Citation	Abstract
Ahmadi Marzaleh M, Peyravi	Background and Aims: The COVID-19 pandemic has changed people's
M, Azhdari N, et al. Virtual	lifestyles as well as the way healthcare services are delivered. Undoubtedly, the
reality applications for	difficulties associated with COVID-19 infection and rehabilitation and those
rehabilitation of COVID-19	associated with quarantine and viral preventive efforts may exacerbate the need
patients: A systematic	for virtual reality to be used as a part of a complete rehabilitation strategy for
review. Health Science	these individuals. Thus, the present research aimed to evaluate the potential
Reports. 2022;5(6):e853.	uses of virtual reality for the rehabilitation of individuals suffering from COVID-
doi:10.1002/hsr2.853	19. Methods: From 2019 to March 1, 2022, a systematic search was conducted
	in PubMed, Cochran Library, Scopus, Science Direct, ProQuest, and Web of
	Science databases. The papers were selected based on search terms and those
	that discussed the use of virtual reality in the rehabilitation of COVID-19 patients
	were reviewed. Each step of the study was reviewed by two authors. <b>Results:</b> A
	total of 699 papers were found during the first search. Three papers were chosen
	for further investigation after a thorough evaluation of the publications' titles,
	abstracts, and full texts. Cross-sectional studies, randomized controlled clinical
	trials, and case reports comprised 33%, 33%, and 33% of the publications,
	respectively. Based on the results, people suffering from COVID-19 were the
	focus of two papers (66%) that employed immersion virtual reality for cognitive
	rehabilitation, whereas one study (33%) used non-immersive virtual reality for
	physical rehabilitation. In two papers (66%), virtual reality was also offered to
	patients in the form of a game. <b>Conclusion:</b> According to the results of the
	present research, virtual reality games may enhance functional and cognitive
	consequences, contentment levels among patients, and their ability to take
	charge of their own health care. In light of the obstacles faced by COVID-19
	patients, alterations in the delivery of healthcare, and the significance of
	rehabilitation in this group during quarantine, new techniques have been
	considered for these patients to maintain treatment, return to regular life, and
	enhance their standard of life.





Alhammad SA. Advocating for Action: Exploring the Potential of Virtual Reality in Breathing Exercise - A Review of The Clinical Applications. <i>Patient Prefer</i> <i>Adherence</i> . 2024;18:695- 707. Published 2024 Mar 19. doi:10.2147/PPA.S451609	The emergence of virtual reality (VR) technologies is currently shaping the healthcare system and is now being employed in various healthcare interventions. Pulmonary rehabilitation remains one such area in which VR is currently thriving to ensure overall health and well-being. While the importance of these novel technologies is being primarily researched in pulmonary rehabilitation, especially over passive conventional breathing exercise training, there seems to be a limited number of studies that have comprehensively put together these findings. This study utilizes a scoping review methodology to review VR exercises in clinical settings related to pulmonary rehabilitation. To achieve this objective, three electronic databases (Web of Science, PubMed, and Cochrane Library) were searched using a formulated search string related to the research objective. Following the database search, a total of 236 references were retrieved and managed using the reference manager. The screening of references was conducted according to the PRISMA 2020 screening process, and their quality was assessed using the JBI checklist. Ultimately, a total of eight publications of high quality were selected for inclusion in the scoping review. The results of the synthesis validate the importance of utilizing VR in the context of breathing exercises are primarily attributed to the engaging and immersive experience they provide. The use of biofeedback and self-regulation techniques into VR exercise systems was also seen to have a notable impact on the effectiveness of the preathing exercise system.
Betka S. Adler D. Similowski	Breathing is peculiar among autonomic functions through several
Betka S, Adler D, Similowski T, Blanke O. Breathing control, brain, and bodily self-consciousness: Toward immersive digiceuticals to alleviate respiratory suffering. <i>Biol Psychol</i> . 2022;171:108329. doi:10.1016/j.biopsycho.202 2.108329	Breathing is peculiar among autonomic functions through several characteristics. It generates a very rich afferent traffic from an array of structures belonging to the respiratory system to various areas of the brain. It is intimately associated with bodily movements. It bears particular relationships with consciousness as its efferent motor control can be automatic or voluntary. In this review within the scope of "respiratory neurophysiology" or "respiratory neuroscience", we describe the physiological organisation of breathing control. We then review findings linking breathing and bodily self-consciousness through respiratory manipulations using virtual reality (VR). After discussing the currently admitted neurophysiological model for dyspnea, as well as a new Bayesian model applied to breathing control, we propose that visuo-respiratory paradigms -as developed in cognitive neuroscience- will foster insights into some of the basic mechanisms of the human respiratory system and will also lead to the development of immersive VR-based digital health tools (i.e. digiceuticals).





Betka S, Kannape OA, Fasola J, et al. Virtual reality intervention alleviates dyspnoea in patients recovering from COVID-19 pneumonia. *ERJ Open Res*. 2023;9(6):00570-02022. doi:10.1183/23120541.0057 0-2022 **Background:** Immersive virtual reality (iVR)-based digital therapeutics are gaining clinical attention in the field of pain management. Based on known analogies between pain and dyspnoea, we investigated the effects of visual respiratory feedback on persistent dyspnoea in patients recovering from coronavirus disease 2019 (COVID-19) pneumonia. Methods: We performed a controlled, randomised, single-blind, crossover proof-of-concept study (feasibility and initial clinical efficacy) to evaluate an iVR-based intervention to alleviate dyspnoea in patients recovering from COVID-19 pneumonia. Included patients reported persistent dyspnoea (≥5 on a 10-point scale) and preserved cognitive function (Montreal Cognitive Assessment score >24). Assignment was random and concealed. Patients received synchronous (intervention) or asynchronous (control) feedback of their breathing, embodied via a gendermatched virtual body. The virtual body flashed in a waxing and waning visual effect that could be synchronous or asynchronous to the patient's respiratory movements. Outcomes were assessed using questionnaires and breathing recordings. Results: Study enrolment was open between November 2020 and April 2021. 26 patients were enrolled (27% women; median age 55 years, interquartile range (IQR) 18 years). Data were available for 24 of 26 patients. The median rating on a 7-point Likert scale of breathing comfort improved from 1 (IQR 2) at baseline to 2 (IQR 1) for synchronous feedback, but remained unchanged at 1 (IQR 1.5) for asynchronous feedback (p<0.05 between iVR conditions). Moreover, 91.2% of all patients were satisfied with the intervention (p<0.0001) and 66.7% perceived it as beneficial for their breathing (p<0.05). **Conclusion:** Our iVR-based digital therapy presents a feasible and safe respiratory rehabilitation tool that improves breathing comfort in patients recovering from COVID-19 infection presenting with persistent dyspnoea. Future research should investigate the intervention's generalisability to persistent dyspnoea with other aetiologies and its potential for preventing chronification.





Chai X, Wu L, He Z. Effects of virtual reality-based pulmonary rehabilitation in patients with chronic obstructive pulmonary disease: A meta-analysis. <i>Medicine</i> . 2023;102(52):e36702. doi:10.1097/MD.00000000 0036702	<b>Background:</b> Virtual reality (VR)-based pulmonary rehabilitation has been used in the management of chronic obstructive pulmonary disease (COPD). The efficacy of VR-based pulmonary rehabilitation for improving lung function in patients with COPD is controversial. Therefore, the aim of this meta-analysis was to evaluate the efficacy of VR combined with pulmonary rehabilitation for lung function in patients with COPD. <b>Methods:</b> This study followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines. The search was performed in the Cochrane Library, EMBASE, Web of Science, PubMed, and China National Knowledge Infrastructure databases from inception to February 1, 2023. All included studies were randomized controlled trials that assessed VR combined with pulmonary rehabilitation for COPD patients. The effect size was calculated with standardized mean difference (SMD) and its 95% confidence interval (CI). The Cochrane Collaboration tool was used to assess the risk of bias. Publication bias was assessed by Egger test. <b>Results:</b> A total of 11 studies met the inclusion criteria and were included in this study. The combined effect size showed that VR combined with pulmonary rehabilitation was more effective than pulmonary rehabilitation alone at improving forced expiratory volume in 1 second% (SMD: 0.51; 95% CI 0.19,0.82; P = .002), forced expiratory volume in 1 second% (SMD: 0.51; 95% CI 0.19,0.82; P = .002), forced expiratory volume in 1 second% (SMD: 0.51; 95% CI 0.19,0.82; P = .002), forced expiratory volume in 1 second% (SMD: 0.57; 95% CI 0.19,0.82; P = .003), and 6-minute walking test (SMD: 059; 95% CI 0.39, 0.79; P < .001). In addition, the VR combined with pulmonary rehabilitation improved depression (SMD: $-0.34$ ; 95% CI $-0.05$ , -0.03; P = .033) and anxiety mood (SMD: $-0.57$ ; 95% CI $-1.11$ , $-0.04$ ; P = .036) compared with the pulmonary rehabilitation group. <b>Conclusion:</b> This meta- analysis indicated that VR regimens could be used to enhance the therapeutic effect of pulm
Colombo V, Aliverti A, Sacco M. Virtual reality for COPD rehabilitation: a technological perspective. <i>Pulmonology</i> . 2022;28(2):119-133. doi:10.1016/j.pulmoe.2020. 11.010	Virtual Reality (VR) is a promising technology for implementing personalized, motivating and controlled rehabilitation scenarios. Although its clear potential benefits, VR has been poorly investigated in pulmonary rehabilitation. This review analyses the state of the art, by searching the scientific and grey literature, regarding the use of VR for the rehabilitation of patients with chronic obstructive pulmonary disease, providing a technological perspective. First, the main characteristics of the included systems are presented in terms of visualization devices, way of interaction and type of feedback they provide. Then, results of the selected studies are reported considering feasibility, safety, usability and user experience as outcomes. Finally, the main findings are discussed and future directions for research are outlined.





Dincelli E, Yayla A.	Immersive virtual reality (VR) that utilizes head-mounted displays (HMD) is one
Immersive virtual reality in	of the key emerging technologies of the 21st century and has drawn keen
the age of the Metaverse: A	attention from consumers, practitioners, and scholars in various disciplines.
hybrid-narrative review	Nevertheless, the information systems (IS) discipline has neglected immersive
based on the technology	VR, given that only a handful of studies have been published in mainstream IS
affordance perspective. The	journals. However, the recent advancements in immersive VR technology
Journal of Strategic	provide new opportunities for organizations and IS researchers. In light of these
Information Systems.	points, we reviewed the immersive VR literature to provide a holistic view of
2022;31(2):101717.	opportunities and challenges for organizations and future research directions for
doi:10.1016/j.jsis.2022.1017	the IS field. By examining the technical capabilities of immersive VR and the
17	previous literature, we identified five affordances: embodiment, interactivity,
	navigability, sense-ability, and create-ability. Our review of the 151 studies from
	the IS and related fields synthesized how these affordances were utilized in
	various research domains. Guided by the affordance-actualization theory, we
	also identified the strategic opportunities and challenges that come with
	implementing VR. The actualization of immersive VR affordances in
	organizations is indeed a fruitful area for IS scholars as there are various venues
	to move the IS field as well as the VR research in the organizational context
	forward.
Finkelstein J, Parvanova I,	One of the major barriers to joining pulmonary rehabilitation (PR) programs is a
Huo X. Feasibility of a Virtual	lack of awareness about its benefits, combined with overall skepticism about
Reality App to Promote	regular exercise among COPD patients. Empowering COPD patients with
Pulmonary	foundational knowledge about PR may potentially facilitate their decision to join
Rehabilitation. Stud Health	a PR program. A virtual reality (VR) app may serve as an engaging and interactive
Technol Inform.	means to deliver PR education; however, the feasibility of this approach in COPD
2023;302:458-462.	patients is unknown. The goal of this project was to assess the feasibility of VR-
doi:10.3233/SHTI230172	based PR education in COPD patients. Using mixed methods design, the
	feasibility of the VR app was assessed by evaluating its usability, patient
	acceptance, and its impact on patient knowledge about PR. The results of the
	usability assessment showed high user acceptance of the VR system and the
	ability to successfully operate the VR appliances. The use of the VR education
	app resulted in a statistically significant increase in patient understanding of the
	main concepts of pulmonary rehabilitation. Further development and evaluation
	of VR-based systems for patient engagement and empowerment are warranted.





Gabriel AS, Tsai TY, Xhakli T, Finkelstein J. Mixed-Methods Assessment of a Virtual Reality-Based System for Pulmonary Rehabilitation. <i>Stud Health</i> <i>Technol Inform</i> . 2023;309:245-249. doi:10.3233/SHTI230789	Barriers to pulmonary rehabilitation (PR) (e.g., finances, mobility, and lack of awareness about the benefits of PR). Reducing these barriers by providing COPD patients with convenient access to PR educational and exercise training may help improve the adoption of PR. Virtual reality (VR) is an emerging technology that may provide an interactive and engaging method of supporting a home- based PR program. The goal of this study was to systematically evaluate the feasibility of a VR app for a home-based PR education and exercise program using a mixed-methods design. 18 COPD patients were asked to complete three brief tasks using a VR-based PR application. Afterward, patients completed a series of quantitative and qualitative assessments to evaluate the usability, acceptance, and overall perspectives and experience of using a VR system to engage with PR education and exercise training. The findings from this study demonstrate the high acceptability and usability of the VR system to promote participation in a PR program. Patients were able to successfully operate the VR system with minimal assistance. This study examines patient perspectives thoroughly while leveraging VR-based technology to facilitate access to PR. The future development and deployment of a patient-centered VR-based system in the future will consider patient insights and ideas to promote PR in COPD patients.
Gabriel AS, Tsai TY, Xhakli T, Finkelstein J. Patient Perceptions of a Virtual Reality-Based System for Pulmonary Rehabilitation: A Qualitative Analysis. <i>Stud</i> <i>Health Technol Inform</i> . 2023;305:406-409. doi:10.3233/SHTI230517	The objective of this study was to evaluate the attitudes, beliefs, and perspectives of patients diagnosed with Chronic Obstructive Pulmonary Disease (COPD) while using a virtual reality (VR) system supporting a home-based pulmonary rehabilitation (PR) program. Patients with a history of COPD exacerbations were asked to use a VR app for home-based PR and then undergo semi-structured qualitative interviews to provide their feedback on using the VR app. The mean age of the patients was 72±9 years ranging between 55 and 84 years old. The qualitative data were analyzed using a deductive thematic analysis. Findings from this study indicated the high acceptability and usability of the VR-based system for engaging in a PR program. This study offers a thorough examination of patient perceptions while utilizing a VR-based technology to facilitate access to PR. Future development and deployment of a patient- centered VR-based system will consider patient insights and suggestions to support COPD self-management according to patient requirements, preferences, and expectations.





Høeg ER, Andersen NB, Malmkjær N, Vaaben AH, Uth J. Hospitalized older adults' experiences of virtual reality-based group exercise therapy with cycle ergometers: An early feasibility study. *Computers in Human Behavior Reports*. 2023;11:100301. doi:10.1016/j.chbr.2023.100 301 Sedentary behavior among hospitalized older adults is a well-described challenge that can increase the risk of loss of function and mortality. Therefore, it is important to encourage physical activity (PA) during hospitalization. Exertion Games (exergames) have repeatedly been suggested as a tool to encourage and sustain motivation in rehabilitation programs. This article presents early findings from a convergent parallel mixed methods study that explored whether social presence and PA could be combined through the novel use of immersive virtual reality technology in a feasible group exercise constellation. Inpatients (n=10, 50% female, 80.3±8.2 years) were invited to participate in a bi-weekly VR group session. Most participants (62%) responded that it was a good experience to a large/great extent, which they would like to use repeatedly (76%). The technology was easy for untrained healthcare professionals and had minimal adverse events for the participants. However, a major finding illustrates that the enclosing immersiveness of the headset hindered conversation during exercise sessions. The exclusion of sight likely had a negative effect on forming relations between the participants, which conversely caused the participants to experience a lack of cohesion and relatedness with the other participants. VRmediated group therapy may be a promising solution to existing physiotherapy practices since it may incorporate basic psychological needs. However, to optimize for social interaction, future systems will need to afford a higher degree of social presence, e.g., through avatar embodiment in a shared virtual environment, to support older adults' autonomous motivation for PA through social interaction and novel technologies.





Jung T, Moorhouse N, Shi X, Amin MF. A Virtual Reality– Supported Intervention for Pulmonary Rehabilitation of Patients With Chronic Obstructive Pulmonary Disease: Mixed Methods Study. <i>J Med Internet Res</i> . 2020;22(7):e14178. doi:10.2196/14178	<b>Background:</b> The uptake of traditional pulmonary rehabilitation classes by patients with chronic obstructive pulmonary disease (COPD) is poor because of personal factors that prevent accessibility to the venue. Therefore, there is a need for innovative methods of pulmonary rehabilitation, and virtual reality (VR) could be a promising technology for patients with COPD to access services remotely. <b>Objective:</b> This study aimed to investigate whether VR improves compliance with pulmonary rehabilitation among patients with COPD, a particularly vulnerable patient group (Medical Research Council [MRC] 4 or 5), and whether VR provides a credible alternative to traditional pulmonary rehabilitation programs. <b>Methods:</b> This was an 8-week patient trial using an innovative VR pulmonary rehabilitation program. A purposive sample of 10 patients with COPD graded MRC 4 or 5 and registered at a selected health care center and a hospital in Cumbria, United Kingdom, were included. Qualitative (focus groups and interviews) data were collected, and to further support the qualitative findings, quantitative data (self-report patient surveys) were gathered before and after the 8-week trial. The 5 self-reported surveys included the Patient Activation Measure, Generalized Anxiety Disorder-7, Patient Health Questionnaire-9, Short Physical Performance Battery, and the Edmonton Frail Scale. <b>Results:</b> In a thematic analysis of the qualitative data, 11 themes emerged specific to delivering pulmonary rehabilitation using VR. The quantitative data further support the qualitative findings by revealing significant improvements in all physical measures.
Obrero-Gaitán E, Chau-	<b>Background:</b> In addition to conventional pulmonary rehabilitation (PR) programs
Cubero CY, Lomas-Vega R,	for the treatment of chronic obstructive pulmonary disease (COPD), the use of
Osuna-Pérez MC, García-	virtual reality-based therapy (VRBT) has been proposed as an effective
López H, Cortés-Pérez I.	complementary tool to be included in PR programs for COPD. <b>Objectives:</b> To
Effectiveness of virtual	analyze the effectiveness of VRBT on functional capacity, pulmonary function,
nulmonary rehabilitation of	carried out through a hibliographic search in PubMed (Medline) WOS PEDro
chronic obstructive	CINAHL, CENTRAL, and Scopus since inception up to June 2023. The risk of bias
pulmonary disease. A	was assessed using the PEDro scale, and the effect was determined using the
systematic review with	standardized mean difference (SMD) and its 95 % confidence interval (95 % CI)
meta-analysis. <i>Heart Lung</i> .	in a random effects model. <b>Results:</b> Five RCTs, providing data from 344
2024;65:1-10.	participants with a mean age 65.7 ± 5.3 years old, were included. The mean
doi:10.1016/j.hrtlng.2024.01	methodological quality of the studies included was good (6.8 $\pm$ 1.6 points). The
.011	meta-analysis showed that VRBT was effective in increasing functional capacity,
	assessed with the 6 Min Walking Test, (SMD=0.4, 95 $\%$ Cl 0.07 to 0.71, p = 0.017);
	pulmonary function, assessed with FEV1 (SMD=0.33, 95 %CI 0.01 to 0.65, p =
	0.048); and functional mobility, assessed with the Get Up and Go Test
	(SMU)=0.77, 95% CI 0.5 to 1.1, p<0.001) in patients with COPD.
	conclusion: VRB1 is suggested to be effective in increasing functional capacity,
	immersive VBBT is the most used modality of VBBT in PB
	miniorate with its the most used modulity of with mining.





Patsaki I, Avgeri V, Rigoulia T, Chronic Obstructive Pulmonary Disease (COPD) is characterized by irrevers	ible
Zekis T, Koumantakis GA, airflow limitation. Patient participation in Pulmonary Rehabilitation (PR)	
Grammatopoulou E. Benefits programs has a beneficial effect on disease management, improving patient	s'
from Incorporating Virtual functional capacity and quality of life. As an alternative to traditional program	ns
Reality in Pulmonary or as a complementary activity, the inclusion of virtual reality (VR) games is	
Rehabilitation of COPD proposed. The aim of this research study was to investigate the effectiveness	s of
Patients: A Systematic incorporating VR in the pulmonary rehabilitation program of patients with CC	OPD.
Review and Meta-Analysis. A systematic literature search was performed for randomized controlled tria	ls
Advances in Respiratory (RCTs) in the electronic databases Google Scholar, PubMed and Pedro from	
Medicine. 2023; 91(4):324- January 2014 to March 2022. The search involved screening for studies	
336. examining the effectiveness of enhancing PR with VR. The PEDro (Physiother	ару
https://doi.org/10.3390/arm9 Evidence Database) scale was chosen as the tool to assess the quality of	
1040026 studies. A meta-analysis was performed where possible. Six studies were	
included in this systematic review. The PEDro scale showed five studies of g	ood
methodological quality and one of fair quality. The variables examined were:	
aerobic capacity for exercise, lung function, anxiety and depression, with no	n-
significant improvement for the MRC Dyspnea scale, marginally non-signific	ant
improvement regarding 6MWT ( $p = 0.05$ ) and significant improvement for FEV	/1 (p
< 0.05). There was variability noted in the VR applications and the proposed	
rehabilitation that the experimental groups followed. The application of VR is	5
recommended in COPD patients, in combination with conventional PR. VR w	vas
found effective in increasing the therapeutic effect and should be considered	d as
a mean of increasing accessibility to PR. Therefore, further research, as well	as
additional RCTs regarding the effectiveness of VR in patients with COPD, see	em
necessary.	





Pittara M, Matsangidou M, Pattichis CS. Virtual Reality for Pulmonary Rehabilitation: Comprehensive Review. *JMIR Rehabil Assist Technol*. 2023;10:e47114. Published 2023 Oct 2. doi:10.2196/47114 Background: Pulmonary rehabilitation is a vital component of comprehensive care for patients with respiratory conditions, such as lung cancer, chronic obstructive pulmonary disease, and asthma, and those recovering from respiratory diseases like COVID-19. It aims to enhance patients' functional ability and quality of life, and reduce symptoms, such as stress, anxiety, and chronic pain. Virtual reality is a novel technology that offers new opportunities for customized implementation and self-control of pulmonary rehabilitation through patient engagement. **Objective:** This review focused on all types of virtual reality technologies (nonimmersive, semi-immersive, and fully immersive) that witnessed significant development and were released in the field of pulmonary rehabilitation, including breathing exercises, biofeedback systems, virtual environments for exercise, and educational models. Methods: The review screened 7 electronic libraries from 2010 to 2023. The libraries were ACM Digital Library, Google Scholar, IEEE Xplore, MEDLINE, PubMed, Sage, and ScienceDirect. Thematic analysis was used as an additional methodology to classify our findings based on themes. The themes were virtual reality training, interaction, types of virtual environments, effectiveness, feasibility, design strategies, limitations, and future directions. **Results:** A total of 2319 articles were identified, and after a detailed screening process, 32 studies were reviewed. Based on the findings of all the studies that were reviewed (29 with a positive label and 3 with a neutral label), virtual reality can be an effective solution for pulmonary rehabilitation in patients with lung cancer, chronic obstructive pulmonary disease, and asthma, and in individuals and children who are dealing with mental health-related disorders, such as anxiety. The outcomes indicated that virtual reality is a reliable and feasible solution for pulmonary rehabilitation. Interventions can provide immersive experiences to patients and offer tailored and engaging rehabilitation that promotes improved functional outcomes of pulmonary rehabilitation, breathing body awareness, and relaxation breathing techniques. **Conclusions:** The identified studies on virtual reality in pulmonary rehabilitation showed that virtual reality holds great promise for improving the outcomes and experiences of patients. The immersive and interactive nature of virtual reality interventions offers a new dimension to traditional rehabilitation approaches, providing personalized exercises and addressing psychological well-being. However, additional research is needed to establish standardized protocols, identify the most effective strategies, and evaluate long-term benefits. As virtual reality technology continues to advance, it has the potential to revolutionize pulmonary rehabilitation and significantly improve the lives of patients with chronic lung diseases.





Rutkowski S, Bogacz K, Czech O, Rutkowska A, Szczegielniak J. Effectiveness of an Inpatient Virtual Reality-Based Pulmonary Rehabilitation Program among COVID-19 Patients on Symptoms of Anxiety, Depression and Quality of Life: Preliminary Results from a Randomized Controlled Trial. Int J Environ Res Public Health. 2022;19(24):16980. Published 2022 Dec 17. doi:10.3390/ijerph19241698 0

Forms of rehabilitation for patients after COVID-19 are gaining interest. The purpose of this study was to investigate and compare an innovative in-hospital pulmonary rehabilitation programs augmented with training elements performed in virtual reality. This randomized controlled study included 32 patients enrolled in post-COVID-19 rehabilitation at a Public Hospital in Poland. The rehabilitation models included exercise capacity training on a cycle ergometer, breathing and general fitness workout, resistance training, and relaxation. The forms of training and relaxation differed between the groups: the experimental group employed virtual reality, and the control group used a traditional form of therapy. Exercise tolerance was assessed using a 6 min walk test (6 MWT), while psychological parameters were evaluated using the Hospital Anxiety and Depression Scale (HADS) and the brief World Health Organization Quality of Life Scale (WHOQOL-BRIEF). The analysis of the post-rehabilitation results showed a statistically significant improvement in both groups regarding depression (VR: 6.9 (3.9) vs. 4.7 (3.5), p = 0.008; CG: 7.64 (4.5) vs. 6.6 (4.8), p = 0.017) and anxiety (VR: 8.6 (4.6) vs. 5.6 (3.3), *p* < 0.001; CG: 9.57 (6.0) vs. 8 (4.8), *p* = 0.003). No statistically significant improvements in quality of life were noted in both groups. Moreover, the analysis showed a statistically significant improvement in the exercise capacity in both groups after completion of the rehabilitation program, expressed as a distance in the 6 MWT, as well as a statistically significant improvement in dyspnea in the VR group. To conclude, the analysis of the preliminary data revealed that a 3-week hospital-based pulmonary rehabilitation program for COVID-19 patients led to an improvement in exercise tolerance as well as a reduction in the symptoms of anxiety and depression. The virtual reality-based form of training delivery, despite its attractiveness, did not significantly affect patients' performance.





Rutkowski S, Bogacz K,	Background: Numerous recommendations from pulmonary scientific societies
Rutkowska A, Szczegielniak	Indicate the need to implement rehabilitation programs for patients after COVID-
J, Casaburi R. Inpatient post-	19. The aim of this study was to propose an innovative comprehensive
COVID-19 rehabilitation	intervention based on a hospital-based pulmonary rehabilitation program for
program featuring virtual	individuals with post-acute sequelae of COVID-19. <b>Methods:</b> It was decided to
reality-Preliminary results of	evaluate two forms of hospital rehabilitation: traditional and one provided
randomized controlled	through virtual reality. Preliminary results are based on a group of 32 patients (20
trial. Front Public Health.	female and 12 male), of average age 57.8 (4.92) years in the period of 3-6 months
2023;11:1121554. Published	after the initial infection. Primary outcomes included analysis of lung function,
2023 Feb 6.	exercise performance and stress level. A 3-week, high-intensity, five-times per
doi:10.3389/fpubh.2023.112	week pulmonary rehabilitation program was designed to compare the
1554	effectiveness of a traditional form with a VR-led, novel form of therapy.
	<b>Results:</b> The analysis of the results showed a statistically significant
	improvement in both groups with regard to exercise performance expressed as
	6MWT distance. Moreover, a statistically significant decrease in dysphoea levels
	following the 6MWT was also noted in intergroup comparison, but the between-
	group comparison revealed non-statistically significant changes with low effect
	size. Regarding lung function, the analysis showed essentially normal lung
	function at baseline and a non-statistically significant improvement after the
	completion of the rehabilitation program. The analysis of the stress level showed
	a statistically significant improvement in both groups within the inter-group
	comparison, yet the between-group comparison of deltas values showed a non-
	significant difference with low effect size. <b>Conclusion:</b> A 3-weeks inpatients
	pulmonary rehabilitation program led to improvement of the exercise
	performance of people with post-acute sequelae of COVID-19, but not lung
	function. Furthermore, the program was shown to reduce patients' stress levels.
	A comparison of the traditional form of rehabilitation to the novel form using VR.
	shows similar effectiveness in terms of exercise performance and stress levels.
Butkowski S. Butkowska A	The aim of the study was to evaluate the effects of rehabilitation in patients with
lastrzebski D. Bacheniuk H	chronic obstructive nulmonary disease (COPD) using the Kinect system during
Pawełczyk W Szczegielniak	stationary rehabilitation. The study included 68 natients with COPD (35 men. 33
L Effect of Virtual Reality-	women mean age 61.3 $\pm$ 3.7) The subjects were randomly assigned to one of
Based Behabilitation on	the two experimental groups described below. Group Lincluded 34 patients -
Physical Fitness in Patients	non-participants in Kinect training. Group II included 34 patients - participants in
with Chronic Obstructivo	Kinest training. In all nations before and after rehabilitation physical fitness was
Bulmonony Diagona / Hum	concerned using the Senior Eitness Test (SET). The View 260 and Vinest motion
Vinot 2010:60:140 157	assessed using the serior Fitness rest (SFT). The Abox 300 and Kinect motion
Nillel. 2019,09.149-157.	significant improvements in SET performance were observed. Detionts in group II
	significant improvements in SFT performance were observed. Patients in group II
000.10.2478/NUKIN-2019-	also snowed statistically significant improvement in physical fitness in all
0022	attempts of the SFI. Virtual renabilitation training in patients with COPD seems
	to be a practical and beneficial intervention capable of enhancing mobility and
	physical fitness.





Rutkowski S, Szczegielniak J, Szczepańska-Gieracha J. Evaluation of the Efficacy of Immersive Virtual Reality Therapy as a Method Supporting Pulmonary Rehabilitation: A Randomized Controlled Trial. <i>J Clin Med</i> . 2021;10(2):352. Published 2021 Jan 18. doi:10.3390/jcm10020352	Anxiety has been estimated to occur in 21-96% and depression in 27-79% of patients with chronic obstructive pulmonary disorder (COPD). We found a scarcity of literature providing evidence on how virtual reality (VR) therapy affects the intensity of depressive and anxiety symptoms and stress levels in COPD patients undergoing in-hospital pulmonary rehabilitation (PR). This study enrolled 50 COPD patients with symptoms of stress, depression, and anxiety, randomly assigned to one of two groups. The two groups participated in the traditional PR programme additionally: the VR-group performed 10 sessions of immersive VR-therapy and the control group performed 10 sessions of Schultz autogenic training. Comparison of the changes in stress levels and depressive and anxiety symptoms was the primary outcome. Analysis of the results showed a reduction in stress levels only in the VR-group ( $p < 0.0069$ ), with a medium effect size (d = 0.353). The symptoms of depression ( $p < 0.001$ , d = 0.836) and anxiety ( $p < 0.0009$ , d = 0.631) were statistically significantly reduced only in the VR-group, with a strong effect size. The enrichment of pulmonary rehabilitation with immersive VR therapy brings benefits in terms of mood improvement and reduction in anxiety and stress in patients with COPD.
Rutkowski, S., Rutkowska,	<b>Purpose:</b> This study compared the effects of inpatient-based rehabilitation
A., Kiper, P., Jastrzebski, D., Racheniuk, H., Turolla, A., Casaburi, R. (2020). Virtual Reality Rehabilitation in Patients with Chronic Obstructive Pulmonary Disease: A Randomized Controlled Trial. International Journal of Chronic Obstructive Pulmonary Disease, 15, 117– 124. https://doi.org/10.2147/COP D.S223592	<b>Purpose:</b> This study compared the effects of inpatient-based ferabilitation program of patients with chronic obstructive pulmonary disease (COPD) using non-immersive virtual reality (VR) training with a traditional pulmonary rehabilitation program. The aims of this study were to determine 1) whether rehabilitation featuring both VR as well as exercise training provides benefits over exercise training (ET) alone and 2) whether rehabilitation featuring VR training instead of exercise training provides equivalent benefits. <b>Patients and Methods:</b> The study recruited 106 patients with COPD to a 2-week high-intensity, five times a week intervention. Randomized into three groups, 34 patients participated in a traditional pulmonary rehabilitation program including endurance exercise training (ET), 38 patients participated in traditional pulmonary rehabilitation, including both endurance exercise training and virtual reality training (ET+VR) and 34 patients participated in pulmonary rehabilitation program including virtual reality training but no endurance exercise training (VR). The traditional pulmonary rehabilitation program consisted of fitness exercises, resistance respiratory muscle and relaxation training. Xbox 360° and Kinect® Adventures software were used for the VR training of lower and upper body strength, endurance, trunk control and dynamic balance. Comparison of the changes in the Senior Fitness Test was the primary outcome. Analysis was performed using linear mixed- effects models. <b>Results:</b> The comparison between ET and ET+VR groups showed that ET+VR group was superior to ET group in Arm Curl (p<0.003), Chair stand (p<0.000), 6-min walk test (p<0.011). Whereas, the comparison between ET and VR groups showed that VR group was superior to ET group in Arm Curl (p<0.000), Chair stand (p<0.001), 6-min walk test (p<0.031). <b>Conclusion:</b> Results suggest that pulmonary rehabilitation program supplemented with VR training is beneficial intervention to improve physical fitness in patients with





Zhang J, Zhao Z, Zhao J. Biofeedback Respiratory Rehabilitation Training System Based on Virtual Reality Technology. <i>Sensors</i> . 2023; 23(22):9025. https://doi.org/10.3390/s232 29025	quantification of respiratory data in improving problems such as decreased lung function and dyspnea in people with respiratory disorders, and the respiratory rehabilitation training process is simple and boring. Therefore, this article designs a biofeedback respiratory rehabilitation training system based on virtual reality technology. It collects respiratory data through a respiratory sensor and preprocesses it. At the same time, it combines the biofeedback respiratory rehabilitation training virtual scene to realize the interaction between respiratory data and virtual scenes. This drives changes in the virtual scene, and finally the respiratory data are fed back to the patient in a visual form to evaluate the improvement of the patient's lung function. This paper conducted an experiment with 10 participants to evaluate the system from two aspects: training effectiveness and user experience. The results show that this system has significantly improved the patient's lung function. Compared with traditional training methods, the respiratory data are quantified and visualized, the rehabilitation training effect is better, and the training process is more active and interesting.
Stavrou VT, Vavougios GD,	Long-post-coronavirus disease-2019 (COVID-19) patients tend to claim residual
Kalogiannis P, et al.	symptomatology from various systems, most importantly the respiratory and
Breathlessness and exercise	central nervous systems. Breathlessness and brain fog are the main complaints.
with virtual reality system in	The pulmonary function pattern is consistent with restrictive defects, which, in
long-post-coronavirus	most cases, are self-resolved, while the cognitive profile may be impaired.
disease 2019 patients.	Rehabilitation is an ongoing field for holistic management of long-post-COVID-
Frontiers in Public Health.	19 patients. Virtual reality (VR) applications may represent an innovative
2023;11.	implementation of rehabilitation. We aimed to investigate the effect of exercise
https://www.frontiersin.org/j	with and without the VR system and to assess further breathlessness and
ournals/public-	functional fitness indicators in long-post-COVID-19 patients with mild cognitive
health/articles/10.3389/fpub	impairment after self-selected exercise duration using the VR system. Twenty
h.2023.1115393	long-post-COVID-19 patients were enrolled in our study (age: $53.9 \pm 9.1$ years,
	male: 80%, body mass index: 28.1 ± 3.1 kg/m2). Participants' anthropometric
	data were recorded, and they underwent pulmonary functional test evaluation
	as well as sleep quality and cognitive assessment. The participants randomly
	exercised with and without a VR system (VR vs. no-VR) and, later, self-selected
	the exercise duration using the VR system. The results showed that exercise with
	VR resulted in a lower dysphea score than exercise without VR. In conclusion, VR
	applications seem to be an attractive and safe tool for implementing
	renabilitation. They can enhance performance during exercise and benefit
	patients with both respiratory and cognitive symptoms.





Su Z, Zhang L, Lian X, Guan M. Virtual Reality-Based Exercise Rehabilitation in Cancer-Related Dysfunctions: Scoping Review. *J Med Internet Res.* 2024;26:e49312. Published 2024 Feb 26. doi:10.2196/49312 Background: Virtual reality-based exercise rehabilitation (VRER) is a promising intervention for patients with cancer-related dysfunctions (CRDs). However, studies focusing on VRER for CRDs are lacking, and the results are inconsistent. **Objective:** We aimed to review the application of VRER in patients with CRDs. Methods: This scoping review was conducted following the PRISMA-ScR (Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for Scoping Reviews) checklist framework. Publications were included from the time of database establishment to October 14, 2023. The databases were PubMed, Embase, Scopus, Cochrane, Web of Science, ProQuest, arXiv, IEEE Xplore, MedRxiv, CNKI, Wanfang Data, VIP, and SinoMed. The population included patients with cancer. A virtual reality (VR) system or device was required to be provided in exercise rehabilitation as an intervention. Eligible studies focused on VRER used for CRDs. Study selection and data extraction were performed by 2 reviewers independently. Extracted data included authors, year, country, study type, groups, sample size, participant age, cancer type, existing or potential CRDs, VR models and devices, intervention programs and durations, effectiveness, compliance, satisfaction, and safety. Results: We identified 25 articles, and among these, 12 (48%) were randomized clinical trials, 11 (44%) were other experimental studies, and 2 (8%) were observational studies. The total sample size was 1174 (range 6-136). Among the 25 studies, 22 (88%), 2 (8%), and 1 (4%) included nonimmersive VR, immersive VR, and augmented reality, respectively, which are models of VRER. Commercial game programs (17/25, 68%) were the most popular interventions of VRER, and their duration ranged from 3 to 12 weeks. Using these models and devices, VRER was mostly applied in patients with breast cancer (14/25, 56%), leukemia (8/25, 32%), and lung cancer (3/25, 12%). Furthermore, 6 CRDs were intervened by VRER, and among these, postmastectomy syndromes were the most common (10/25, 40%). Overall, 74% (17/23) of studies reported positive results, including significant improvements in limb function, joint range of motion, edema rates, cognition, respiratory disturbance index, apnea, activities of daily living, and quality of life. The compliance rate ranged from 56% to 100%. Overall, 32% (8/25) of studies reported on patient satisfaction, and of these, 88% (7/8) reported satisfaction with VRER. Moreover, 13% (1/8) reported mild sickness as an adverse event. Conclusions: We found that around half of the studies reported using VRER in patients with breast cancer and postmastectomy dysfunctions through nonimmersive models and commercial game programs having durations of 3-12 weeks. In addition, most studies showed that VRER was effective owing to virtualization and interaction. Therefore, VRER may be an alternate intervention for patients with CRDs. However, as the conclusions were drawn from data with acknowledged inconsistencies and limited satisfaction reports, studies with larger sample sizes and more outcome indictors are required.





Tesarz J, Lange H, Kirchner M, Görlach A, Eich W, Friederich HC. Efficacy of supervised immersive virtual reality-based training for the treatment of chronic fatigue in post-COVID syndrome: study protocol for a doubleblind randomized controlled trial (IFATICO Trial). *Trials*. 2024;25(1):232. doi:10.1186/s13063-024-08032-w Background: The treatment of persistent fatigue after COVID-19 infection is complex. On the one hand, it involves maintaining a sufficient level of physical and mental activity to counteract possible degenerative processes of the body and nervous system. On the other hand, physical and mental activities can also lead to worsening of symptoms. Therefore, the challenge in treating Post-COVID fatigue is to stimulate the body and central nervous system in a way that stimulates growth and improvement, but does not overtax individual physical and mental limits. Special training programs try to take these characteristics into account, but often reach their limits. A promising approach is offered by new fitness technologies based on immersive virtual realities that stimulate both body and brain while minimizing physical and psychological stress. The aim of this study is to investigate the efficacy of supervised immersive Virtual Reality (VR)-based activity training compared to conventional activity training for patients with Post-COVID-associated fatigue. Methods: In a single centre, individually randomised, prospective, double-blind two-arm exploratory superiority trial with parallel group design, N = 100 patients with persistent fatigue after COVID-19 infection will be recruited. The intervention includes a supervised immersive neuromuscular training (12 sessions of 30 min over 6 weeks) based on a novel VR-exercise device. We will systematically compare the effects of this intervention on Post-COVID-associated fatigue with a supervised conventional activation program of comparable scope without an immersive environment. The primary outcome is the difference between groups in absolute change in the mean fatigue symptom severity measured on the Fatigue Severity Scale (FSS) from baseline to posttreatment assessment. Posttreatment assessment in both groups will be conducted by blinded outcome assessors. At three and six months afterwards, patients are sent self-report questionnaires for follow up. The main analysis will be based on the intention-to-treat principle. Discussion: To the best of our knowledge, this is the first exploratory study on a supervised immersive neuromuscular training for the treatment of persistent fatigue after COVID-19 infection.





Zeng Y, Guan Q, Su Y, et al. A self-administered immersive virtual reality tool for assessing cognitive impairment in patients with cancer. *Asia Pac J Oncol Nurs*. 2023;10(3):100205. Published 2023 Feb 28. doi:10.1016/j.apjon.2023.10 0205 Objective: This study was aimed at exploring the feasibility and validity of a selfadministered immersive virtual reality (VR) tool designed to assess cognitive impairment in patients with cancer. **Methods:** In a cross-sectional survey study, an immersive tool was used to rate the previously recommended core assessment domains of cancer-related cognitive impairment-comprising attention, verbal learning memory, processing speed, executive function and verbal fluency-via an interactive VR scenario. **Results:** A total of 165 patients with cancer participated in this study. The participants' mean age was 47.74 years (SD = 10.59). Common cancer types included lung, liver, breast and colorectal cancer, and most patients were in early disease stages (n = 146, 88.5%). Participants' performance in the VR cognition assessment showed a moderate to strong positive correlation with their paper-and-pencil neurocognitive test results (r = 0.34-0.76, P < 0.001), thus indicating high concurrent validity of the immersive VR cognition assessment tool. For all participants, the mean score for the VR-based cognition assessment was 5.41 (SD = 0.70) out of a potential maximum of 7.0. The mean simulation sickness score for the VR-based tool, as rated by the patients, was 0.35 (SD = 0.19), thereby indicating that minimal simulation sickness occurred during the VRassisted cognition assessment. **Conclusions:** Given its demonstrated validity, and the patients' high presence scores and minimal sickness scores, this VRbased cognition assessment tool is a feasible and acceptable instrument for measuring cognitive impairment in patients with cancer. However, further psychometric assessments should be implemented in clinical settings.





## Table 6: Clinical Education

Citation	Abstract
Adhikari R, Kydonaki C,	Background: Virtual Reality (VR) simulation has been a topic of interest in recent
Lawrie J, et al. A mixed-	years as an innovative strategy for healthcare education. Although there are a
methods feasibility study to	handful of studies evaluating VR simulation on knowledge, motivation, and
assess the acceptability and	satisfaction; there is a paucity of evidence to evaluate the effectiveness,
applicability of immersive	acceptability and usability of 'Immersive' VR (IVR) simulation in nursing
virtual reality sepsis game as	students. Objectives: A two-stage sequential mixed-methods feasibility study
an adjunct to nursing	underpinned by gaming theory investigated; (1) the impact of IVR sepsis game on
education. Nurse Educ	pre-registration nurses' self-efficacy and, (2) their perceptions of the
<i>Today</i> . 2021;103:104944.	acceptability and applicability of IVR sepsis game as an adjunct to nursing
doi:10.1016/j.nedt.2021.104	simulation education. Methods: The IVR simulation intervention was designed in
944	collaboration with serious game specialists. Stage one collated pre and post-
	intervention self-efficacy scores with 19 pre-registration nurses using the
	validated instrument, Nursing Anxiety and Self-Confidence with Clinical
	Decision Making (NASC-CDM©) scale. Stage two used a descriptive qualitative
	approach to explore student nurses' perceptions of the game. <b>Results:</b> In stage
	one, pre and post-test scores revealed significant increase in self-confidence
	(26.1%, $P < 0.001$ ) and a significant decrease in anxiety (23.4%, $P < 0.001$ ). Stage
	two qualitative responses revealed four over-arching themes: acceptability,
	applicability, areas of improvement of IVR sepsis game and limitations of IVR
	game. Conclusion: IVR simulation show promise as an adjunct for nurse
	simulation and it appears to increase self-efficacy in pre-registration nursing
	students. Further testing with a sufficiently powered sample size will ratify
	findings and provide effective solutions to distance and online learning.





Aiello S, Cochrane T, Sevigny C. The affordances of clinical simulation immersive technology within healthcare education: a scoping review. *Virtual Real*. Published online January 14, 2023. doi:10.1007/s10055-022-00745-0 Whilst clinical simulation is established as an effective education tool within the healthcare community, the inability to offer authentic educational learning environments remains problematic. Advances in technology such as immersive virtual reality offer new opportunities to enhance traditional practice to an extent that may transform learning. However, with traditional clinical simulation stress and anxiety can both hinder performance and learning, yet it is unknown what nuances are applicable within a clinical virtual simulation environment. Determining potential benefits, drawbacks (including related stress and anxiety) and affordances of immersive technology clinical simulation designs may help provide an understanding of its usefulness. The aim of this scoping review is to investigate the range and nature of evidence associated with immersive virtual reality clinical simulation and education design. In addition, the review will describe authentic immersive technology clinical simulation use and reported stress response measurements. A search of seven electronic database and grey literature was performed in accordance with the Joanna Briggs Institute methodology. A key term search strategy was employed with five themes identified and investigated: (1) Healthcare professionals, (2) Clinical simulation, (3) Immersive virtual reality, (4) Stress/anxiety and (5) Authentic learning design. Application of the search strategy resulted in a hit total of 212 articles. Twelve articles met inclusion criteria. With most literature focusing on procedural performance and non-transferable education needs, there was a paucity of research that specifically investigated immersive virtual reality clinical simulation education and related stress. Therefore, this scoping review contributes new understandings by providing valuable insight and potential research gaps into current immersive virtual reality clinical simulation, its relationship to stress and the education design models currently being utilised to develop these concepts.





Amini H, Gregory ME, Abrams MA, et al. Feasibility and usability study of a pilot immersive virtual realitybased empathy training for dental providers. *J Dent Educ*. 2021;85(6):856-865. doi:10.1002/jdd.12566 Purpose: Social determinants of health (SDOH) significantly impact individuals' engagement with the healthcare system. To address SDOH-related oral health disparities, providers must be equipped with knowledge, skills, and attitudes (KSAs) to understand how SDOH affect patients and how to mitigate these effects. Traditional dental school curricula provide limited training on recognizing SDOH or developing empathy for those with SDOH-related access barriers. This study describes the design and evaluation of such a virtual reality (VR)-based simulation in dental training. We hypothesize the simulation will increase post-training KSAs. Methods: We developed "MPATHI" (Making Professionals Able THrough Immersion), a scripted VR simulation where participants take the role of an English-speaking caregiver with limited socioeconomic resources seeking dental care for a child in a Spanish-speaking country. The simulation is a combination of 360° video recording and virtual scenes delivered via VR headsets. A pilot was conducted with 29 dental residents/faculty, utilizing a pre-post design to evaluate effectiveness in improving immediate and retention of KSAs toward care delivery for families facing barriers. Results: MPATHI led to increased mean scores for cognitive (pre = 3.48 ± 0.80, post = 4.56 ± 0.51, p < 0.001), affective (pre = 4.20 ± 0.4, post =  $4.47 \pm 0.44$ , p < 0.001), and skill-based learning (pre =  $4.00 \pm 0.47$ , post =  $4.52 \pm$ 0.37, p < 0.001) immediately post-training. There was not a significant difference between skills measured immediately post-training and in the 1-month posttraining survey (p = 0.41). Participants reported high satisfaction with the content and methods used in this training. Conclusions: This pilot study supports using VR SDOH training in dental education. VR technology provides new opportunities for innovative content design.





Andersen AG, Rahmoui L, Dalsgaard TS, et al. Preparing for Reality: A Randomized Trial on Immersive Virtual Reality for Bronchoscopy Training. *Respiration*. 2023;102(4):316-323. doi:10.1159/000528319 **Background:** Bronchoscopy is an essential procedure in the diagnosis and treatment of pulmonary diseases. However, the literature suggests that distractions affect the quality of bronchoscopy and affect inexperienced doctors more than experienced. **Objectives:** The objective of the study was as follows: does simulation-based bronchoscopy training with immersive virtual reality (iVR) improve the doctors' ability to handle distractions and thereby increase the quality, measured in procedure time, structured progression score, diagnostic completeness (%), and hand motor movements of a diagnostic bronchoscopy in a simulated scenario. Exploratory outcomes were heart rate variability and a cognitive load questionnaire (Surg-TLX). Methods: Participants were randomized. The intervention group practiced in an iVR environment with a head-mounted display (HMD) while using the bronchoscopy simulator, while the control group trained without the HMD. Both groups were tested in the iVR environment using a scenario with distractions. Results: 34 participants completed the trial. The intervention group scored significantly higher in diagnostic completeness (100 i.q.r. 100-100 vs. 94 i.q.r. 89-100, p value = 0.03) and structured progress (16 i.q.r. 15-18 vs. 12 i.q.r. 11-15, p value 0.03) but not in procedure time (367 s standard deviation [SD] 149 vs. 445 s SD 219, p value = 0.06) or hand motor movements (-1.02 i.q.r. -1.03-[-1.02] versus -0.98 i.q.r. -1.02-[-0.98], p value = 0.27). The control group had a tendency toward a lower heart rate variability (5.76 i.q.r. 3.77-9.06 vs. 4.12 i.q.r. 2.68-6.27, p = 0.25). There was no significant difference in total Surg-TLX points between the two groups. **Conclusion:** iVR simulation training increases the quality of diagnostic bronchoscopy in a simulated scenario with distractions compared with conventional simulation-based training.





Andersen NL, Jensen RO, Konge L, et al. Immersive Virtual Reality in Basic Pointof-Care Ultrasound Training: A Randomized Controlled Trial. *Ultrasound Med Biol*. 2023;49(1):178-185. doi:10.1016/j.ultrasmedbio. 2022.08.012 This study was aimed at comparing the learning efficacy of a traditional instructor-led lesson with that of a completely virtual, self-directed lesson in immersive virtual reality (IVR) in teaching basic point-of-care ultrasound (PoCUS) skills. We conducted a blinded, non-inferiority, parallel-group, randomized controlled trial in which final-year medical students were randomized to an instructor-led (n = 53) or IVR (n = 51) lesson. Participants' learning efficacy was evaluated by blinded assessors, who rated each participant's performance using the Objective Structured Assessment of Ultrasound Skills (OSAUS) assessment tool. The mean total scores for participants were 11.0 points (95% confidence interval: 9.8-12.2) for the instructor-led lesson and 10.3 points (95% confidence interval: 9.0-11.5) for the IVR lesson. No significant differences were observed between the groups with respect to total score (p = 0.36) or subgroup objectives of the OSAUS score (p = 0.34 for familiarity, p = 0.45 for image optimization, p = 0.96 for systematic approach and p = 0.07 for interpretation). Maintenance costs for both courses were estimated at 400 euros each. Startup costs for the instructor-led course were estimated 16 times higher than those for the IVR course. The learning efficacy of an instructor-led lesson on basic US did not differ significantly from that of a self-directed lesson in IVR, as assessed using the OSAUS. The results suggest that IVR could be an equivalent alternative to instructor-led lessons in future basic US courses, but further research is warranted to clarify the role of IVR in PoCUS courses.




Andersen NL, Jensen RO, Posth S, Laursen CB, Jørgensen R, Graumann O. Teaching ultrasound-guided peripheral venous catheter placement through immersive virtual reality: An explorative pilot study. *Medicine (Baltimore)*. 2021;100(27):e26394. doi:10.1097/MD.00000000 0026394 Introduction: Immersive virtual reality (IVR)-based training is gaining ground as an educational tool in healthcare. When combined with well-established educational methods, IVR can potentially increase competency and autonomy in ultrasound (US)-guided peripheral venous cannulation. The aim of this study was to examine the impact of adding IVR training to a course in US-guided peripheral venous cannulation. Methods: Medical students (n = 19) from the University of Southern Denmark with no former standardized US education were recruited to voluntarily participate in a pilot study, designed as a randomized controlled trial. The primary outcome was the proportion of successful peripheral venous cannulations on a phantom. Secondary outcomes included the proportion of surface punctures on the phantom and procedure time. Participants received e-learning on the basic US before randomization to either IVR (n = 10) or no further training (n = 9). The additional IVR training comprised 10 virtual scenarios for US-guided peripheral venous catheter (PVC) placement. Students were subsequently evaluated in peripheral venous cannulation by a blinded assessor. **Results:** The proportion of successful peripheral venous cannulations was significantly higher in the IVR group ( $P \le .001$ ). The proportions of successful cannulations were significantly higher in the IVR group compared to the control group for the 1st and 2nd PVC (P = .011, P = .023), but not for the 3rd PVC (P = .087). Similar results were found for the proportion of surface punctures (1st:  $P \le .001$ , 2nd: P = .001, and 3rd: P = .114). No significant differences in procedure times were found between the groups. **Conclusion:** This pilot study showed that adding an IVR-based training simulation to an existing e-learning curriculum significantly increased the learning efficacy of US-guided PVC placement for medical students.





Barré J, Michelet D, Truchot J,	Background: Novice surgeons experience high levels of physical and mental
et al. Virtual Reality Single-	workload during the early stages of their curriculum and clinical practice.
Port Sleeve Gastrectomy	Laparoscopic sleeve gastrectomy is the first bariatric procedure worldwide.
Training Decreases Physical	Feasibility and safety of single-port sleeve gastrectomy (SPSG) has been
and Mental Workload in	demonstrated. An immersive virtual reality (VR) simulation was developed to
Novice Surgeons: An	provide a repetitive exercise to learn this novel technique. The primary objective
Exploratory Study. Obes	of this study was to evaluate the impact of the VR training tool on mental and
Surg. 2019;29(4):1309-1316.	physical workload in novice surgeons. The secondary objective included an
doi:10.1007/s11695-018-	evaluation of the VR simulator. <b>Methods:</b> A monocentric-controlled trial was
03680-9	conducted. Ten participants were divided into two groups, the VR group and the
	control group (without VR training). Surgery residents participated in a first real
	case of SPSG and a second case 1 month later. The VR group underwent a VR
	training between the two surgeries. Mental and physical loads were assessed
	with self-assessment questionnaires: NASA-TLX, Borg scale, and manikin
	discomfort test. The VR simulator was evaluated through presence,
	cybersickness, and usability questionnaires. <b>Results:</b> This study showed a
	decrease of the mental demand and effort dimensions of NASA-TLX between the
	first and the second surgery in the VR group ( $P < .05$ ). During the second surgery,
	a marginally significant difference was shown concerning the mental demand
	between the two groups. Postural discomfort of the VR group decreased with
	practice ( $P < .01$ ), mainly between the first and the second surgery ( $P < .05$ ).
	Furthermore, participants characterized the VR simulator as realistic, usable,
	and very useful to learned surgery. <b>Conclusion:</b> This exploratory study showed
	an improvement in mental and physical workload when novice surgeons trained
	with VR (repetitive practice, gesture improvement, reduction of stress, etc.).
	Virtual reality appears to be a promising perspective for surgical training.
Bonnin C, Pejoan D, Ranvial	Immersive virtual patient simulation could help medical students in clinical
E, et al. Immersive virtual	reasoning, but there is a lack of literature on the effectiveness of this method in
patient simulation compared	healthcare learning. A pilot randomised controlled study compared
with traditional education for	performance (exam score) on a clinical case in immersive virtual simulation to a
clinical reasoning: a pilot	text for physiotherapy students. In the experimental group, the clinical case was
randomised controlled	presented by an immersive 360° video that students watched with a standalone
study. J Vis Commun Med.	headset, whereas the control group used the text only. A survey investigated
2023;46(2):66-74.	students' perceptions of the clinical case, their experience of virtual reality, and
doi:10.1080/17453054.2023.	sense of presence. Twenty-three students in immersive virtual reality had a
2216243	significantly lower total score than 25 students with a text. This difference
	appeared in the assessment part of a clinical case. More precisely, it concerned
	patient history (including a few other elements of assessment and bio-psycho-
	social factors, $p = 0.007$ ). Satisfaction and motivation were strong in the
	experimental group. In conclusion, the performance was higher in text than in
	virtual reality situations. Nevertheless, immersive virtual patient simulation
	remains an interesting tool could train novices to follow history-taking skills of a
	new patient, as similar to a real-life situation.





Botha BS, De Wet L, Botma Y. Undergraduate Nursing Student Experiences in Using Immersive Virtual Reality to Manage a Patient With a Foreign Object in the Right Lung. <i>Clinical</i> <i>Simulation in Nursing</i> . 2021;56:76-83. doi:10.1016/j.ecns.2020.10. 008	<b>Background:</b> Within the ever-expanding world of virtual reality for education, numerous strides have been made towards providing students with quality teaching and learning opportunities. One such application area that has not been exhaustively investigated is within nursing education. <b>Methods:</b> To help the research community to understand nursing students' perceptions towards the use of virtual reality as a possible alternative to high-fidelity simulation and to determine whether students would enjoy virtual clinical simulation, undergraduate nursing students for a South African higher education institution were asked to partake in a virtual clinical simulation where they could manage a patient with a foreign object in the airway. The virtual environment (VE) already existed and was previously tested for the purpose of training third and fourth year undergraduate nurses during previous research endeavours. For the project discussed in this article, the participants consisted of third year undergraduate nursing students, as they had the theoretical knowledge to partake in the simulation. During the testing sessions, observational data were recorded along with subjective opinions captured through questionnaires to determine how the students experienced the VE and the simulation. <b>Results:</b> Although the results indicated that future improvements were needed to maintain a relevant and evolving VE and scenario, the students' experiences were overwhelmingly positive. <b>Conclusion:</b> The created VE and scenario were found to be useable to the extent where the nursing students indicated that they would benefit from this togething and loarning method.
Chan KC, Hui CL, Suen YN, et al. Application of Immersive Virtual Reality for Assessment and Intervention in Psychosis: A Systematic Review. <i>Brain</i> <i>Sci</i> . 2023;13(3):471. Published 2023 Mar 10. doi:10.3390/brainsci130304 71	Virtual reality (VR) has emerged as a safe and non-invasive technology for the assessment of psychotic symptoms, social and cognitive impairments, and psychosocial intervention in improving outcomes in psychosis. This study systematically reviewed the current state of evidence in applying semi- and fully immersive VR for assessing and treating patients with psychosis. A systematic review was conducted adhering to the PRISMA statement and was conducted in Embase, PsycINFO, and PubMed databases for articles published between January 2013 and April 2022, which identified 28 eligible studies, including 12 for assessment and 16 for intervention. In the assessment studies, not all VR tasks could distinguish the differences between patients and healthy controls regarding their physiological responses, paranoid ideation, and certain aspects of cognitive functioning such as memory bias on the object tasks. Comparatively, VR-based interventions are more promising, especially for improving cognitive impairments, social skills, agoraphobic avoidance, negative and positive affective states, auditory verbal hallucination, paranoid ideation and persecutory delusions, and other psychiatric symptoms in patients. We conclude that more rigorous studies are needed to confirm treatment effectiveness and to understand the underlying mechanism of VR-based intervention for psychotic disorders. Future studies should also improve the reliability and validity of VR-based assessments for psychotic disorders.





Chang YM, Lai CL. Exploring the experiences of nursing students in using immersive virtual reality to learn nursing skills. *Nurse Education Today*. 2021;97:104670. doi:10.1016/j.nedt.2020.104 670 Background: In recent years, virtual reality teaching applications exhibited exponential development in numerous fields. An increasing number of virtual reality application cases and modules have been developed in the nursing education field to verify their effectiveness. Objective: The research objective is to understand the experience of nursing students in using virtual reality skill learning process. **Design:** This study is a qualitative research that adopts focus group research methods. The participants were able to freely describe their subjective feelings toward the virtual reality skill learning process. **Participants/settings:** This research was conducted in a nursing school in Taiwan. Purposive sampling was adopted to select 60 nursing students who participated in the Adult Nursing and Practice course. The participants were divided into six focus groups containing 10 participants each. Method: Aside from learning with traditional practice equipment, the students also experienced the virtual reality nasogastric tube care skill learning system. Focus group interviews were held from March 25 to 27, 2019. During the interview, we inquired about the students' subjective feelings toward the virtual reality skill learning system and reflected on its influence on the students' learning process. **Results:** An analysis of the focus group interview content of 60 students, revealed that the students' experience toward the virtual reality skill learning process could be classified into five themes, namely "convenient to practice, but requires adaptation," "fast skill learning process," "stress-free learning environment," "environmentally friendly," and "lacks a sense of reality." **Conclusions:** Instead of replacing conventional skill teaching methods, future applications of the virtual reality nursing skill education support system shall serve as a student self-learning supporting tool. Additionally, the research and development of the virtual reality nursing skill education support system should focus on its stereognosis aspect and include an interactive function to upgrade the system into a practical teaching and learning support material.





Chang YY, Chao LF, Chang W, et al. Impact of an immersive virtual reality simulator education program on nursing students' intravenous injection administration: A mixed methods study. <i>Nurse Educ</i> <i>Today</i> . 2024;132:106002. doi:10.1016/j.nedt.2023.106 002	<b>Background:</b> Undergraduate nursing students often face limited opportunities to gain hands-on experience in performing invasive procedures and techniques. Immersive media tools may be helpful in training and enhancing skill development among nursing students. <b>Objectives:</b> The specific aims of this study were threefold: (1) to describe the development process of an intravenous injection virtual reality simulator (IIVRS) program, (2) to determine the effect of the IIVRS program on intravenous injection knowledge, and (3) to examine the acceptability, learning motivation, and experience of the IIVRS program among nursing students. <b>Methods:</b> This study is a mixed method design, encompassing a one-group pre- and post-test approach and the utilization of reflection logs among 128 second-year nursing students enrolled at a university in northern Taiwan. An innovative gamification IIVRS program was developed by our research team. Knowledge of intravenous injection was assessed using a point visual analog scale at pre-and post-testing. Acceptability and motivation were assessed using items on a 5-point Likert scale. The IIVRS program experience was evaluated using open-ended questions of reflection. A paired t-test was used for comparing knowledge at pre-and post-tests, independent t-tests were conducted to compare levels of acceptance and learning motivation among different students' characteristics, and content analysis was used for qualitative data. <b>Results:</b> Students' knowledge of intravenous injection was significantly improved (Pre-test Mean = 3.08 vs. Post-test Mean = 4.96, p < 0.001). Students reported high levels of acceptance (Mean = 4.65) and learning motivation (Mean = 4.69). Students reported three themes of their experience: (1) attracts my attention and stimulates my motivation to learn, (2) enhanced memorization of the skill and process, and (3) a sense of presence and realism/unrealism.
Choi J, Thompson CE. Faculty Driven Virtual Reality (VR) Scenarios and Students Perception of Immersive VR in Nursing Education: A Pilot Study. <i>AMIA Annu Symp</i> <i>Proc.</i> 2023;2022:377-384. Published 2023 Apr 29. https://www.ncbi.nlm.nih.go v/pmc/articles/PMC1014833 3/	Innovative nursing education methods became essential due to the COVID-19 pandemic. Immersive Virtual Reality (VR) education offers nursing students authentic patient encounters in a realistic simulated environment. A pilot study was conducted to identify nursing education clinical scenarios that should be developed for immersive VR and to assess students' perception of immersive VR in education. We formed a focus group composed of nursing faculty (N=10) with expertise in the clinical setting and simulation. Faculty participants identified important topics and aspects of immersive VR scenarios during focus group discussions. We assessed nursing student participants' (N=11) perception of immersive VR in nursing education using a VR game (Anatomy Explorer 2020). Most student participants indicated that a VR game was immersive and realistic and recommended using immersive VR to learn clinical nursing skills. Realistic immersive VR clinical education scenarios could result in effective clinical nursing education.





Cieslowski B, Haas T. Innovative Learning: Implementing Virtual Reality in a Large Class of Prelicensure Students Using Limited Equipment, Time, and Resources. Nurs Educ *Perspect.* Published online March 8, 2023. doi:10.1097/01.NEP.000000 0000001110 Crockatt WK, Confino JE, Kopydlowski NJ, Jobin CM, Levine WN. Comparing Skill Acquisition and Validity of Immersive Virtual Reality with Cadaver Laboratory Sessions in Training for **Reverse Total Shoulder** Arthroplasty. JB JS Open Access. 2023;8(3):e22.00141. Published 2023 Jul 6. doi:10.2106/JBJS.OA.22.001 41

The development of critical thinking and decision-making skills is essential to link knowledge to practice in prelicensure nursing education. Immersive virtual reality (VR) is a teaching modality that provides students with an interactive way to develop their knowledge and skills. Faculty at a large mid-Atlantic university developed an innovative strategy to deploy immersive VR in a senior-level advanced laboratory technologies course with 110 students. Implementation of this approach to VR was intended to augment clinical learning in a safe learning environment.

Immersive virtual reality (iVR) allows surgical trainees to practice skills without risking harm to patients or the need for cadaveric training resources. However, iVR has never been directly compared with cadaver training, the longtime gold standard for surgical skill training. We aimed to compare skill acquisition using cadaver laboratory and iVR training methods for augmented baseplate implantation during reverse total shoulder arthroplasty (rTSA). Methods: In a randomized controlled trial, junior orthopaedic surgery residents were assigned to a 1-hour training with either iVR or a cadaveric laboratory session with shoulder specimens. Before training, all participants viewed an overview lecture and technique video demonstrating key steps of augmented baseplate implantation for rTSA. Participants were assessed by a blinded evaluator using validated competency checklists during cadaveric glenoid baseplate implantation. Continuous and categorial variables were analyzed using the 2sample t test and Fisher exact test. Results: Fourteen junior residents (3 incoming matched postgraduate year [PGY1], 6 PGY1s, 1 PGY2, and 4 PGY3s) were randomized to training with either iVR (n = 6) or cadaver laboratory (n = 8). There were no significant differences in demographic data, previous experience with rTSA, or previous use of iVR (p > 0.05). There were no significant difference in total Objective Structured Assessment of Technical Skill score (91.2% [15.2] vs. 93.25% [6.32], -0.1406 to 0.1823, p = 0.763), Global Rating Scale score (4.708 [0.459] vs. 4.609 [0.465], -0.647 to 0.450, p = 0.699), or time to completion (546 seconds [158] vs. 591 seconds [192], -176.3 to 266.8, p = 0.655) in cadaveric glenoid baseplate implantation. Average cost of iVR hardware and a 1-year software license was \$4,900, and average cost of a single cadaver laboratory was \$1,268.20 per resident. Conclusions: Among junior orthopaedic residents, there is similar skill acquisition when training with either cadaver laboratory or iVR. Although additional research into this field is needed, iVR may provide an important and cost-effective tool in surgical education. Clinical relevance: Emerging simulation and iVR technology simulation in surgical training programs can increase access to effective and high-level surgical training across the globe and improve quality of care.





Edwards TC, Patel A, Szyszka B, et al. Immersive virtual reality enables technical skill acquisition for scrub nurses in complex revision total knee arthroplasty. *Arch Orthop Trauma Surg*. 2021;141(12):2313-2321. doi:10.1007/s00402-021-04050-4 Introduction: Immersive Virtual Reality (iVR) is a novel technology which can enhance surgical training in a virtual environment without supervision. However, it is untested for the training to select, assemble and deliver instrumentation in orthopaedic surgery-typically performed by scrub nurses. This study investigates the impact of an iVR curriculum on this facet of the technically demanding revision total knee arthroplasty. Materials and methods: Ten scrub nurses completed training in four iVR sessions over a 4-week period. Initially, nurses completed a baseline real-world assessment, performing their role with real equipment in a simulated operation assessment. Each subsequent iVR session involved a guided mode, where the software taught participants the procedural choreography and assembly of instrumentation in a simulated operating room. In the latter three sessions, nurses also undertook an assessment in iVR. Outcome measures were related to procedural sequence, duration of surgery and efficiency of movement. Transfer of skills from iVR to the real world was assessed in a post-training simulated operation assessment. A pre- and posttraining questionnaire assessed the participants knowledge, confidence and anxiety. Results: Operative time reduced by an average of 47% across the 3 unguided sessions (mean  $55.5 \pm 17.6$  min to  $29.3 \pm 12.1$  min, p > 0.001). Assistive prompts reduced by 75% ( $34.1 \pm 16.8$  to  $8.6 \pm 8.8$ , p < 0.001), dominant hand motion by 28% (881.3 ± 178.5 m to 643.3 ± 119.8 m, p < 0.001) and head motion by 36% (459.9 ± 99.7 m to 292.6 ± 85.3 m, p < 0.001). Real-world skill improved from 11% prior to iVR training to 84% correct post-training. Participants reported increased confidence and reduced anxiety in scrubbing for rTKA procedures (p < 0.001). Conclusions: For scrub nurses, unfamiliarity with complex surgical procedures or equipment is common. Immersive VR training improved their understanding, technical skills and efficiency. These iVR-learnt skills transferred into the real world.





Edwards TC, Soussi D, Gupta S, et al. Collaborative Team Training in Virtual Reality is Superior to Individual Learning For Performing Complex Open Surgery: A Randomized Controlled Trial. *Ann Surg.* 2023;278(6):850-857. doi:10.1097/SLA.00000000 0006079 Objective: To assess whether multiplayer immersive Virtual Reality (iVR) training was superior to single-player training for the acquisition of both technical and nontechnical skills in learning complex surgery. Background: Superior teamwork in the operating room (OR) is associated with improved technical performance and clinical outcomes. iVR can successfully train OR staff individually; however, iVR team training has yet to be investigated. Methods: Forty participants were randomized to individual or team iVR training. Individually trained participants practiced alongside virtual avatar counterparts, whereas teams trained live in pairs. Both groups underwent 5 iVR training sessions over 6 weeks. Subsequently, they completed a real-life assessment in which they performed anterior approach total hip arthroplasty surgery on a highfidelity model with real equipment in a simulated OR. Teams performed together, and individually trained participants were randomly paired up. Videos were marked by 2 blinded assessors recording the 'Non-Operative Technical Skills for Surgeons, Oxford NOn-TECHnical Skills II and Scrub Practitioners' List of Intraoperative Non-Technical Skills' scores. Secondary outcomes were procedure duration and the number of technical errors. Results: Teams outperformed individually trained participants for nontechnical skills in the realworld assessment (Non-Operative Technical Skills for Surgeons: 13.1±1.5 vs 10.6±1.6, P = 0.002, Non-TECHnical Skills II score: 51.7 ± 5.5 vs 42.3 ± 5.6, P = 0.001 and Scrub Practitioners' List of Intraoperative Non-Technical Skills: 10 ±  $1.2 \text{ vs } 7.9 \pm 1.6, P = 0.004$ ). They completed the assessment 33% faster (28.2 minutes ± 5.5 vs 41.8 ± 8.9, P < 0.001), and made fewer than half the number of technical errors ( $10.4 \pm 6.1 \text{ vs } 22.6 \pm 5.4, P < 0.001$ ). **Conclusions:** Multiplayer training leads to faster surgery with fewer technical errors and the development of superior nontechnical skills.





Eley CL, Palaniappan V, Carter A, et al. Randomized controlled trial of the CMR immersive virtual reality (IVR) headset training compared to e-learning for operating room configuration of the CMR versius robot. *J Robot Surg.* 2024;18(1):143. Published 2024 Mar 30. doi:10.1007/s11701-024-01885-y Robotic surgery offers potential advantages over laparoscopic procedures, but the training for configuring robotic systems in the operating room remains underexplored. This study seeks to validate immersive virtual reality (IVR) headset training for setting up the CMR Versius in the operating room. This single-blinded randomized control trial randomised medical students with no prior robotic experience using an online randomiser. The intervention group received IVR headset training, and the control group, e-learning modules. Assessors were blinded to participant group. Primary endpoint was overall score (OS): Likert-scale 1-5: 1 reflecting independent performance, with increasing verbal prompts to a maximum score of 5, requiring physical assistance to complete the task. Secondary endpoints included task scores, time, inter-rater reliability, and concordance with participant confidence scores. Statistical analysis was performed using IBM SPSS Version 27. Of 23 participants analysed, 11 received IVR and 12 received e-learning. The median OS was lower in the IVR group than the e-learning group 53.5 vs 84.5 (p < 0.001). VR recipients performed tasks independently more frequently and required less physical assistance than e-learning participants (p < 0.001). There was no significant difference in time to completion (p = 0.880). Self-assessed confidence scores and assessor scores differed for e-learning participants (p = 0.008), though not IVR participants (p =0.607). IVR learning is more effective than e-learning for preparing robot-naïve individuals in operating room set-up of the CMR Versius. It offers a feasible, realistic, and accessible option in resource-limited settings and changing dynamics of operating theatre teams. Ongoing deliberate practice, however, is still necessary for achieving optimal performance.





Farcas M, Reynolds LF, Lee JY. Simulation-Based Percutaneous Renal Access Training: Evaluating a Novel 3D Immersive Virtual Reality Platform. *J Endourol*. 2021;35(5):695-699. doi:10.1089/end.2020.0674 Introduction: Percutaneous nephrolithotomy (PCNL) is the gold standard treatment for patients with a large stone burden. There are a variety of methods to teach this important endourologic procedure, including simulation. We evaluated three different PCNL simulation platforms for potential use in teaching and assessing percutaneous renal access skills. Materials and Methods: Urology residents, fellows, and faculty were recruited to participate in this study, which included completing standardized tasks on three PCNL simulation platforms: a virtual reality (VR) simulator (PercMentor, 3D Systems™), a porcine tissue simulator (Cook™ Medical), and a new 3D immersive VR simulator-Marion K181 (Marion Surgical™). Participants were asked to complete a standardized task-gaining prone percutaneous renal access using a fluoroscopic-guided technique. Participants were asked to rate the simulators, and performance data were recorded for analysis. Results: A total of 18 participants with varying levels of PCNL experience completed the study. The Marion K181 had higher ratings by participants in all domains (realism, tactile feedback, instrument movement, renal anatomy, fidelity of simulation, utility as teaching tool) compared with the PercMentor (p < 0.05) but did not differ in any domain when compared with the porcine PCNL model. Participants felt that the Marion K181 was comparable with the porcine PCNL model as a teaching tool, but had the advantage of not requiring radiation exposure. Fluoroscopy time was the variable that most consistently correlated with participant PCNL experience and level of training, across all three PCNL simulation platforms. **Conclusions:** There are a variety of PCNL simulation platforms available for teaching percutaneous renal access skills. Based on our initial comparative study, there is validity evidence to support the use of the novel Marion K181 PCNL simulator as a training tool rather than higher fidelity models requiring real radiation exposure. However, evidence is yet lacking for its use as an assessment tool.





Fealy S, Jones D, Hutton A, et al. The integration of immersive virtual reality in tertiary nursing and midwifery education: A scoping review. <i>Nurse Educ</i> <i>Today</i> . 2019;79:14-19. doi:10.1016/j.nedt.2019.05. 002	<b>Background:</b> Immersive virtual reality is an advancing technology that has the potential to change the traditional pedagogical approaches to teaching tertiary nursing and midwifery students. The application of immersive virtual reality in nursing and midwifery education may be a novel, accessible method for information provision and skill acquisition, however little is known of the extent of immersive virtual reality technology integration into tertiary nursing and midwifery programs. <b>Objectives:</b> The purpose of this review is to identify the application and integration of immersive virtual reality within nursing and midwifery tertiary education programs. <b>Design:</b> A scoping review based on the Joanna Briggs Institute methodology for scoping reviews was undertaken. An a priori review protocol and eligibility criterion was developed with the protocol subject to review a posteriori following first round screening. An electronic search of ten databases was conducted in January 2018. <b>Results:</b> A total of n = 506 non-duplicate records were identified and subjected to level one and level two screening. The search strategy and screening process identified n = 2 articles that were quality checked and included for review. <b>Conclusions:</b> There is currently a paucity of quality published literature on the application and/or integration of immersive virtual reality into nursing and midwifery tertiary education. Immersive virtual reality has the potential to increase competence and confidence for students providing accessible and repeatable learning opportunities in a fail-safe environment. There is a need for educators to be involved in the conceptualisation, design, integration and research of immersive virtue reactives and confidence for students providing accessible and repeatable learning opportunities in a fail-safe environment. There is a need for educators to be involved in the conceptualisation, design, integration and research of immersive
Ferrandini Price M,	<b>Objectives:</b> The main objective of the study is to determine the efficiency in the
Escribano Tortosa D, Nieto	execution of the START (Simple Triage and Rapid Treatment) triage, comparing
Fernandez-Pacheco A, et al.	Virtual Reality (VR) to Clinical Simulation (CS) in a Mass Casualty Incident (MCI).
Comparative study of a	The secondary objective is to determine the stress produced in the health
simulated incident with	professionals in the two situations described. Materials: A comparative study
multiple victims and	on the efficiency and the stress during triage in a MSI was conducted. The basal
immersive virtual	and post levels of salivary $\alpha$ -amylase (sAA) activity were measured in all the
reality. Nurse Educ Today.	participants before and after the simulation. <b>Results:</b> The percentage of victims
2018;71:48-53.	that were thaged confectly was $87.65\%$ (SD = $8.3$ ); $88.3\%$ (SD = $9.65$ ) for the Virtual
006	Reality Simulation (VRG) group, without any significant differences ( $n = 0.612$ )
	between both groups. The basal sAA was $103.26$ (SD = 79.13) U/L with a
	significant increase ( $p < 0.001$ ) with respect to the post-simulation levels
	(182.22, SD = 148.65 U/L). The increase of sAA was 80.70 (SD = 109.67) U/mL,
	being greater for the CSA group than the VRG group. Conclusion: The results
	show that virtual reality method is as efficient as clinical simulation for training
	on the execution of basic triage (START model). Also, based on the sAA results,
	we can attest that clinical simulation creates a more stressful training
	experience for the student, so that is should not be substituted by the use of
	virtual reality, although the latter could be used as a complementary activity.





Frederiksen JG, Sørensen SMD, Konge L, et al. Cognitive load and performance in immersive virtual reality versus conventional virtual reality simulation training of laparoscopic surgery: a randomized trial. <i>Surg Endosc</i> . 2020;34(3):1244- 1252. doi:10.1007/s00464- 019-06887-8	<b>Background:</b> Virtual reality simulators combined with nead-mounted displays enable highly immersive virtual reality (VR) for surgical skills training, potentially bridging the gap between the simulation environment and real-life operating room conditions. However, the increased complexity of the learning situation in immersive VR could potentially induce high cognitive load thereby inhibiting performance and learning. This study aims to compare cognitive load and performance in immersive VR and conventional VR simulation training. <b>Methods:</b> A randomized controlled trial of residents (n = 31) performing laparoscopic salpingectomies with an ectopic pregnancy in either immersive VR or conventional VR simulation. Cognitive load was estimated by secondary-task reaction time at baseline, and during nonstressor and stressor phases of the procedure. Simulator metrics were used to evaluate performance. <b>Results:</b> Cognitive load was increased by 66% and 58% during immersive VR and conventional VR simulation, respectively (p < 0.001), compared to baseline. A light stressor induced a further increase in cognitive load by 15.2% and a severe stressor by 43.1% in the immersive VR group compared to 23% (severe stressor) in the conventional VR group. Immersive VR also caused a significantly worse performance on most simulation metrics. <b>Conclusion:</b> Immersive VR simulation training induces a higher cognitive load and results in a poorer performance than conventional VR simulation training in laparoscopy. High extraneous load and element interactivity in the immersive VR are suggested as mechanisms explaining this finding. However, immersive VR offers some potential advantages over conventional VR such as more real-life conditions but we only recommend introducing immersive VR in surgical skills training after initial training in conventional VR
Goh GS. Lohre R. Parvizi J.	<b>Background:</b> Immersive virtual reality (IVR), augmented reality and mixed reality
Goel DP. Virtual and	form a spectrum of extended reality technology integration that has gained
augmented reality for	popularity in orthopaedics recently. This review article examines the role of
surgical training and	extended reality technologies in knee arthroplasty. Methods: Existing literature
simulation in knee	on the applications of extended reality technologies in preoperative planning
arthroplasty. Arch Orthop	and intraoperative navigation were reviewed. A sample workflow of a novel IVR
Trauma Surg.	simulator for improving surgical training was also provided to demonstrate its
2021;141(12):2303-2312.	utility in educating trainees on knee arthroplasty techniques. <b>Results:</b> Extended
aoi:10.100//s00402-021-	reality technologies enable the surgeon to visualise patient-specific anatomy in
04037-1	real-time, enhancing preoperative planning and providing intraoperative
	guidance. IVR technology has the potential to revolutionise modern surgical
	uaning and optimise surgical performance in a cost-efficient manner, with
	transfer <b>Conclusions:</b> Extended reality technologies have a myriad of notantial
	applications in orthonaedic surgery. Further research is needed to evaluate the
	cost-effectiveness of its incorporation into training programmes.





Hannans J. Integrating LGBTQI+ Content in Nursing Education Using Immersive Virtual Reality: Embodying Eden. <i>Nurs Educ Perspect</i> . 2023;44(5):321-322. doi:10.1097/01.NEP.000000 0000001181	Teaching nursing students to understand LGBTQI+ health care perspectives is critical in providing safe and effective care. Nursing curricula often have limited LGBTQI+ content to prepare students, with clinical experiences too varied to ensure exposure to specific gender diversity learning opportunities. Immersive virtual reality is a promising strategy to offer rich learning experiences from the perspective of the LGBTQI+ community.
Huber I, Paschold M, Hansen C, Lang H, Kneist W. Artificial Versus Video-Based Immersive Virtual Surroundings: Analysis of Performance and User's Preference. <i>Surg Innov</i> . 2018;25(3):280-285. doi:10.1177/1553350618761 756	<b>Introduction:</b> Immersive virtual reality (VR) taparoscopy simulation connects VR simulation with head-mounted displays to increase presence during VR training. The goal of the present study was the comparison of 2 different surroundings according to performance and users' preference. <b>Methods:</b> With a custom immersive virtual reality laparoscopy simulator, an artificially created VR operating room (AVR) and a highly immersive VR operating room (IVR) were compared. Participants (n = 30) performed 3 tasks (peg transfer, fine dissection, and cholecystectomy) in AVR and IVR in a crossover study design. <b>Results:</b> No overall difference in virtual laparoscopic performance was obtained when comparing results from AVR with IVR. Most participants preferred the IVR surrounding (n = 24). Experienced participants (n = 10) performed significantly better than novices (n = 10) in all tasks regardless of the surrounding (P < .05). Participants with limited experience (n = 10) showed differing results. Presence, immersion, and exhilaration were significantly higher in IVR. Two thirds assumed that IVR would have a positive influence on their laparoscopic simulator use. <b>Conclusion:</b> This first study comparing AVR and IVR did not reveal differences in virtual laparoscopic performance. IVR is considered the more realistic surrounding and is therefore preferred by the participants.





Huber T, Paschold M,	Introduction: Virtual reality (VR) and head mount displays (HMDs) have been
Hansen C, Wunderling T,	advanced for multimedia and information technologies but have scarcely been
Lang H, Kneist W. New	used in surgical training. Motion sickness and individual psychological changes
dimensions in surgical	have been associated with VR. The goal was to observe first experiences and
training: immersive virtual	performance scores using a new combined highly immersive virtual reality (IVR)
reality laparoscopic	laparoscopy setup. <b>Methods:</b> During the study, 10 members of the surgical
simulation exhilarates	department performed three tasks (fine dissection per transfer and
surgical staff Surg Endosc	cholecystectomy) on a VB simulator. We then combined a VB HMD with the VB
2017-21/11)-4472 4477	langroscopic simulator and displayed the simulation on a 260° video of a
2017,31(11).4472-4477.	laparoscopic simulator and displayed the simulation of a 500 video of a
	then repeated Validated questionneires an immersion and mation sieless
5500-6	then repeated. Validated questionnaires on immersion and motion sickness
	were used for the study. <b>Results:</b> Participants' times for fine dissection were
	significantly longer during the IVR session (regular: 86.51 s [62.57 s; 119.62 s] vs.
	IVR: $112.35 \text{ s} [82.08 \text{ s}; 179.40 \text{ s}]; \text{ p} = 0.022$ ). The cholecystectomy task had
	higher error rates during IVR. Motion sickness did not occur at any time for any
	participant. Participants experienced a high level of exhilaration, rarely thought
	about others in the room, and had a high impression of presence in the
	generated IVR world. <b>Conclusion:</b> This is the first clinical and technical
	feasibility study using the full IVR laparoscopy setup combined with the latest
	laparoscopic simulator in a 360° surrounding. Participants were exhilarated by
	the high level of immersion. The setup enables a completely new generation of
	surgical training.
Huber T, Wunderling T,	<b>Purpose:</b> Virtual reality (VR) applications with head-mounted displays (HMDs)
Paschold M, Lang H, Kneist	have had an impact on information and multimedia technologies. The current
W, Hansen C. Highly	work aimed to describe the process of developing a highly immersive VR
immersive virtual reality	simulation for laparoscopic surgery. <b>Methods:</b> We combined a VR laparoscopy
laparoscopy simulation:	simulator (LapSim) and a VR-HMD to create a user-friendly VR simulation
development and future	scenario. Continuous clinical feedback was an essential aspect of the
aspects. Int J Comput Assist	development process. We created an artificial VR (AVR) scenario by integrating
Radiol Surg. 2018;13(2):281-	the simulator video output with VR game components of figures and equipment
290. doi:10.1007/s11548-	in an operating room. We also created a highly immersive VR surrounding (IVR)
017-1686-2	by integrating the simulator video output with a [Formula: see text] video of a
	standard laparoscopy scenario in the department's operating room.
	<b>Besults:</b> Clinical feedback led to optimization of the visualization
	synchronization and resolution of the virtual operating rooms (in both the IVB
	and the AVP). Preliminany testing results revealed that individuals experienced a
	high degree of exhibition and presence, with rare events of motion sickness
	The technical performance showed no significant difference compared to that
	me technical performance showed to significant difference compared to that
	achieved with the standard Lapsin. <b>Conclusion:</b> Our results provided a proof of
	concept for the technical reasibility of an custom highly immersive VR-HMD
	setup. Future technical research is needed to improve the visualization,
	immercian and conchility of interacting within the virtual cooperio





et al. Integration of advanced technologies to enhance problem-based learning over distance: Project TOUCH. <i>Anat Rec B New</i> <i>Anat</i> . 2003;270(1):16-22. doi:10.1002/ar.b.10003	result of the rapid advancement of communication technology. The National Computational Science Alliance's Access Grid represents a significant advancement in communication technology with potential for distance medical education. The purpose of this study is to provide an overview of the TOUCH project (Telehealth Outreach for Unified Community Health; http://hsc.unm.edu/touch) with special emphasis on the process of problem- based learning case development for distribution over the Access Grid. The objective of the TOUCH project is to use emerging Internet-based technology to overcome geographic barriers for delivery of tutorial sessions to medical students pursuing rotations at remote sites. The TOUCH project also is aimed at developing a patient simulation engine and an immersive virtual reality environment to achieve a realistic health care scenario enhancing the learning experience. A traumatic head injury case is developed and distributed over the Access Grid as a demonstration of the TOUCH system. Project TOUCH serves as an example of a computer-based learning system for developing and implementing problem-based learning cases within the medical curriculum, but this system should be easily applied to other educational environments and disciplines involving functional and clinical anatomy. Future phases will explore BC variance of the TOUCH cases for increased distribution
Jacobson N. Larson ID	Contract onbanced ultrasound (CEUS) is used in various modical enocial tios as
Falster C, et al. Using Immersive Virtual Reality	a diagnostic imaging tool and for procedural guidance. Experience in the procedure is currently attained via supervised clinical practice that is challenged
Simulation to Ensure Competence in Contrast-	by patient availability and risks. Prior simulation-based training and subsequent assessment could improve and ensure competence before performance on
Enhanced	patients, but no simulator currently exists. Immersive virtual reality (IVR) is a new
Ultrasound. Ultrasound Med	promising simulation tool that can replicate complex interactions and
<i>Biol.</i> 2022;48(5):912-923.	environments that are unfeasible to achieve by traditional simulators. This study
doi:10.1016/j.uttrasmedbio.	was almed at developing an IVR simulation-based test for core CEUS
2022.01.015	Competencies and gathering validity evidence for the test in accordance with Messick's framework. The test was developed by IVP software specialists and
	clinical experts in CEUS and medical education and imitated a CEUS
	examination of a nation with a focal liver lesion with emphasis on the pre-
	contrast preparations. Twenty-five medical doctors with varying CEUS
	experience were recruited as test participants, and their results were used to
	analyze test quality and to establish a pass/fail standard. The final test of 23 test
	items had good internal reliability (Cronbach's $\alpha$ = 0.85) and discriminatory
	abilities. The risks of false positives and negatives (9.1% and 23.6%,
	respectively) were acceptable for the test to be used as a certification tool prior
	to supervised clinical training in CEUS.





Jans C, Bogossian F, Andersen P, Levett-Jones T. Examining the impact of virtual reality on clinical decision making - An integrative review. *Nurse Educ Today*. 2023;125:105767. doi:10.1016/j.nedt.2023.105 767 Background: Clinical decision making is an essential cognitive skill in nursing. It is a process undertaken daily by nurses as they make judgements about patient care and manage complex issues as they arise. Virtual reality is an emerging technology that is increasingly being used pedagogically to teach non-technical skills including CDM, communication, situational awareness, stress management, leadership, and teamwork. **Objective:** The objective of this integrative review are to synthesise the research findings regarding the impact of virtual reality on clinical decision making in undergraduate nurses. Design: An integrative review using Whittemore and Knafl's framework for integrated reviews. Data sources: An extensive search was conducted of healthcare databases including CINAHL, Medline and Web of Science between 2010 and 2021 using the terms virtual reality, clinical decision and undergraduate nursing. Review methods: The initial search located 98 articles. After screening and checking for eligibility, 70 articles were critically reviewed. Eighteen studies were included in the review and were critically appraised using the Critical Appraisal Skills Program checklist for qualitative papers and McMaster's Critical appraisal form for quantitative papers. Results: Research in the use of VR has demonstrated its potential to improve undergraduate nurses' critical thinking, clinical reasoning, clinical judgement and clinical decision-making skills. Students perceive these teaching modalities to be beneficial to the development of their clinical decision-making ability. There is lack of research related to the use of immersive virtual reality in developing and enhancing undergraduate nursing students' clinical decision-making skills. Conclusion: Current research on the impact of virtual reality on the development of nursing CDM has demonstrated positive results. VR is one pedagogical approach that could further assist, however, there are no identified studies that focus on its impact in developing CDM, therefore further studies are required to address this gap in the literature.





Junge K, Larsen JD, Stougaard SW, et al. Education in Focused Assessment With Sonography for Trauma Using Immersive Virtual Reality: A Prospective, Interventional Cohort Study and Non-inferiority Analysis With a Historical Control. <i>Ultrasound Med Biol</i> . 2024;50(2):277-284. doi:10.1016/j.ultrasmedbio. 2023.10.013	<b>Objective:</b> Focused assessment with sonography for trauma (FAST) is a valuable ultrasound procedure in emergency settings, and there is a need for evidence-based education in FAST to ensure competencies. Immersive virtual reality (IVR) is a progressive training modality gaining traction in the field of ultrasound training. IVR holds several economic and practical advantages to the common instructor-led FAST courses using screen-based simulation (SBS). <b>Methods:</b> This prospective, interventional cohort study investigated whether training FAST using IVR unsupervised and out-of-hospital was non-inferior to a historical control group training at a 90 min SBS course in terms of developing FAST competencies in novices. Competencies were assessed in both groups using the same post-training simulation-based FAST test with validity evidence, and a non-inferiority margin of 2 points was chosen. <b>Results:</b> A total of 27 medical students attended the IVR course, and 27 junior doctors attended the SBS course. The IVR group trained for a median time of 117 min and scored a mean 14.2 ± 2.0 points, compared with a mean 13.7 ± 2.5 points in the SBS group. As the lower bound of the 95% confidence interval at 13.6 was within the range of the non-inferiority margin (11.7-13.7 points), training FAST in IVR for a median of 117 min was found non-inferior to training at a 90 min SBS course. No significant correlation was found between time spent in IVR and test scores. <b>Conclusion:</b> Within the limitations of the use of a historical control group, the results suggest that IVR could be an alternative to SBS FAST training and suitable for unsure of the point of the point of the point of a basic course in point.
Kerr H. Birch M. Donovan M.	<b>Background:</b> Few studies have explored the potential educational value of
Best P Exploring the	immersive 360° video in continuing education. This study explored the potential
Educational Value of an	value of immersive 360° video as an acceptable educational method in a
Immersive Virtual Reality	continuing education module in nursing. <b>Method:</b> A convergent parallel mixed
Method Within a Continuing	methods design was adopted. The setting was a nursing and midwifery school at
Education Module in	a university. The 11 participants were RNs. Data were collected at three time
Nursing: A Mixed Methods	points with surveys and focus groups. <b>Results:</b> Participants found educational
Study. J Contin Educ Nurs.	value in the triggering of a deep reflective process, supported by a subsequent
Published online February 7,	classroom discussion. Further, there were nuances and complexities to be
2024.	considered, with a need to tailor material toward high-acuity, low-frequency, or
doi:10.3928/00220124-	challenging clinical events when considering content. <b>Conclusion:</b> Immersive
20240201-04	360° videos are a potentially useful method for providing continuing education;
	however, the content must be tailored to students' learning needs. A reflective
	model may provide a valuable structure for discussions after the use of
	Immersive 360° video.
Kilmon CA, Brown L, Ghosh	This article explores immersive virtual reality as a potential educational strategy
S, MIKITIUK A. Immersive	for nursing education and describes an immersive learning experience now
virtual reality simulations in	being developed for nurses. This pioneering project is a virtual reality application
nursing education. Nurs	targeting speed and accuracy of nurse response in emergency situations
Eauc Perspect.	requiring cardiopulmonary resuscitation. Other potential uses and implications
2010;31(5):314-317.	for the development of virtual reality learning programs are discussed.





Kim HJ, Lee HK, Jang JY, et al. Immersive virtual reality simulation training for cesarean section: a randomized controlled trial. <i>Int J Surg</i> . 2024;110(1):194-201. Published 2024 Jan 1. doi:10.1097/JS9.000000000 000843	<b>Background:</b> Caesarean section (CS) is a complex surgical procedure that involves many steps and requires careful precision. Virtual reality (VR) simulation has emerged as a promising tool for medical education and training, providing a realistic and immersive environment for learners to practice clinical skills and decision-making. This study aimed to evaluate the educational effectiveness of a VR simulation program in training the management of patients with premature rupture of membranes (PROM) and CS. <b>Materials and methods:</b> A two-arm parallel randomized controlled trial was conducted with 105 eligible participants randomly assigned to the VR group (n =53) or the control group (n =52) in a 1:1 ratio. The VR group received VR simulation training focused on PROM management and CS practice, while the control group watched a video presentation with narrative of clinical scenario and recording of CS. Both groups completed questionnaires assessing their prior experiences with VR, experience in managing patients with PROM and performing CS, as well as their confidence levels. These questionnaires were administered before and after the intervention, along with a mini-test quiz. <b>Results:</b> Baseline characteristics and previous experiences were comparable between the two groups. After the intervention, the VR group had higher confidence scores in all four aspects, including managing patients with PROM, performing CS as an operator, and understanding the indications and complications of CS, compared to the control group. The VR group also achieved significantly higher scores on the mini-test quiz [median (interquartile range), 42 (37-48) in the VR group; 36 (32-40) in the control group, P <0.001]. <b>Conclusion:</b> VR simulation program can be an effective educational tool for improving participants' knowledge and
Larsen JD, Jensen RO, Pietersen PI, et al. Education in Focused Lung Ultrasound Using Gamified Immersive Virtual Reality: A Randomized Controlled Study. <i>Ultrasound Med Biol</i> . 2023;49(3):841-852. doi:10.1016/j.ultrasmedbio. 2022.11.011	Focused lung ultrasound (FLUS) has high diagnostic accuracy in many common conditions seen in a variety of emergency settings. Competencies are essential for diagnostic success and patient safety but can be challenging to acquire in clinical environments. Immersive virtual reality (IVR) offers an interactive risk-free learning environment and is progressing as an educational tool. First, this study explored the educational impact of novice FLUS users participating in a gamified or non-gamified IVR training module in FLUS by comparing test scores using a test with proven validity evidence. Second, the learning effect was assessed by comparing scores of each group with known test scores of novices, intermediates and experienced users in FLUS. A total of 48 participants were included: 24 received gamified and 24 received non-gamified IVR training. No significant difference was found between gamified (mean = 15.5 points) and non-gamified (mean = 15.2 points), indicating that chosen gamification elements for our setup did not affect learning outcome (p = 0.66). The mean scores of both groups did not significantly differ from those of known intermediate users in FLUS (gamified p = 0.63, non-gamified p = 0.24), indicating that both IVR modules could be used as unsupervised out-of-hospital training for novice trainees in FLUS.





Lau ST, Liaw SY, Loh WL, et al. Mid-career switch nursing students' perceptions and experiences of using immersive virtual reality for clinical skills learning: A mixed methods study. *Nurse Educ Today*. 2023;124:105760. doi:10.1016/j.nedt.2023.105 760 **Background:** There has been an increase of mid-career professionals joining nursing. These adult students possess significant expertise in other areas and may benefit substantially in deliberate practice to acquire skills competency using immersive virtual reality (IVR) for clinical procedures before they practise in actual clinical settings. **Objectives:** This study aims to (1) examine the impact of IVR clinical procedures on mid-career switch students in knowledge, game perception and user reaction; (2) to explore the mid-career switch students' perceptions and experiences in using the IVR clinical procedures. **Design:** A mixed methods feasibility study was used. Setting and participants: This study was conducted at a university in Singapore with 34 first-year mid-career switch students. **Methods:** This study is a single-group pre-test and post-test experimental study on learning clinical procedures using IVR in the home setting. The study took place from September to November 2021. Focus group discussions were conducted and analysed verbatim using thematic analysis. **Results:** The students demonstrated significant improvement of knowledge for subcutaneous insulin, but overall, the increase in combined scores for both intravenous therapy and subcutaneous insulin were not statistically significant. Three overarching themes included: 1) Learning and practice, 2) Challenges and barriers, and 3) Personal attributes. Most of the participants found the experiences to be engaging, relevant, and satisfying. Some reported experiencing giddiness, headache, and lack of familiarity with technologies. **Conclusions:** IVR simulation can potentially be used as a supplementary learning tool to improve knowledge of clinical procedures in mid-career switch students.





Lau ST, Siah RCJ, Dzakirin Bin Rusli K, et al. Design and Evaluation of Using Head-Mounted Virtual Reality for Learning Clinical Procedures: Mixed Methods Study. *JMIR Serious Games*. 2023;11:e46398. Published 2023 Aug 30. doi:10.2196/46398 Background: The capacity of health care professionals to perform clinical procedures safely and competently is crucial as it will directly impact patients' outcomes. Given the ability of head-mounted virtual reality to simulate the authentic clinical environment, this platform should be suitable for nurses to refine their clinical skills for knowledge and skills acquisition. However, research on head-mounted virtual reality in learning clinical procedures is limited. Objective: The objectives of this study were (1) to describe the design of a headmounted virtual reality system and evaluate it for education on clinical procedures for nursing students and (2) to explore the experience of nursing students using head-mounted virtual reality for learning clinical procedures and the usability of the system. **Methods:** This usability study used a mixed method approach. The stages included developing 3D models of the necessary instruments and materials used in intravenous therapy and subcutaneous injection procedures performed by nurses, followed by developing the procedures using the Unreal Engine (Epic Games). Questionnaires on the perception of continuance intention and the System Usability Scale were used along with open-ended questions. **Results:** Twenty-nine nursing students took part in this questionnaire study after experiencing the immersive virtual reality (IVR) intervention. Participants reported largely favorable game perception and learning experience. Mean perception scores ranged from 3.21 to 4.38 of a maximum score of 5, while the mean system usability score was 53.53 of 100. The majority found that the IVR experience was engaging, and they were immersed in the game. The challenges encountered included unfamiliarity with the new learning format; technological constraints, such as using hand controllers; and physical discomfort. Conclusions: The conception of IVR for learning clinical procedures through deliberate practice to enhance nurses' knowledge and skills is promising. However, refinement of the prototypes is required to improve user experience and learning. Future research can explore other ways to use IVR for better education and health care purposes.





Lee Y, Kim SK, Eom MR. Usability of mental illness simulation involving scenarios with patients with schizophrenia via immersive virtual reality: A mixed methods study. <i>PLoS One</i> . 2020;15(9):e0238437. Published 2020 Sep 16. doi:10.1371/journal.pone.02 38437	<b>Objectives:</b> Schizophrenia is one of the most prevalent mental illnesses contributing to national burden worldwide. It is well known that mental health nursing education, including clinical placement, is still insufficient to reach the optimal level of competency in nursing students. This study suggests a new form of mental health virtual reality (VR) simulation that is user-friendly and engaging to improve education about schizophrenia, thereby improving its treatment. <b>Method:</b> A mixed-methods study was conducted with a total of 60 nursing students, using 360-degree videos of five different scenarios reflecting clinical symptoms of schizophrenia patients and related treatment tasks delivered via head-mounted displays (HMDs). We used a 17-item quantitative questionnaire and a 7-item open-ended qualitative questionnaire to evaluate the ease of use and usefulness of the VR simulation program and to identify areas where further improvement is required. <b>Results:</b> The VR simulation program was perceived as useful and exciting. Participants stressed that the high realism of the simulation increased their engagement in and motivation to learn about mental health nursing. Some participants made suggestions, such as further refining the picture and sound quality in order to achieve satisfactory educational outcomes. <b>Conclusion:</b> VR simulation using 360-degree videos and HMDs could serve as an effective alternative form of clinical training in mental health nursing. Education could be enhanced by its benefits of being engaging and exciting, as reported by this study's participants.
Lin Q, Xu Z, Li B, et al. Immersive Virtual Reality for Visualization of Abdominal CT. <i>Proc SPIE Int Soc Opt</i> <i>Eng.</i> 2013;8673:10.1117/12.2008 050. doi:10.1117/12.2008050	Immersive virtual environments use a stereoscopic head-mounted display and data glove to create high fidelity virtual experiences in which users can interact with three-dimensional models and perceive relationships at their true scale. This stands in stark contrast to traditional PACS-based infrastructure in which images are viewed as stacks of two-dimensional slices, or, at best, disembodied renderings. Although there has substantial innovation in immersive virtual environments for entertainment and consumer media, these technologies have not been widely applied in clinical applications. Here, we consider potential applications of immersive virtual environments for ventral hernia patients with abdominal computed tomography imaging data. Nearly a half million ventral hernias occur in the United States each year, and hernia repair is the most commonly performed general surgery operation worldwide. A significant problem in these conditions is communicating the urgency, degree of severity, and impact of a hernia (and potential repair) on patient quality of life. Hernias are defined by ruptures in the abdominal wall (i.e., the absence of healthy tissues) rather than a growth (e.g., cancer); therefore, understanding a hernia necessitates understanding the entire abdomen. Our environment allows surgeons and patients to view body scans at scale and interact with these virtual models using a data glove. This visualization and interaction allows users to perceive the relationship between physical structures and medical imaging data. The system provides close integration of PACS-based CT data with immersive virtual environments and creates opportunities to study and optimize interfaces for patient communication, operative planning, and medical education.





Lo YT, Yang CC, Yeh TF, Tu HY, Chang YC. Effectiveness of immersive virtual reality training in nasogastric tube feeding education: A randomized controlled trial. *Nurse Educ Today*. 2022;119:105601. doi:10.1016/j.nedt.2022.105 601 Background: Given rapidly aging societies worldwide, improving the quality of long-term care through the cultivation of immense nursing assistants is critical. Accordingly, developing a satisfactory learning model to improve the learning outcomes of nursing assistant students is imperative. Objective: This study tested the hypothesis that students in long-term care departments who underwent immersive virtual reality (IVR) training would have significantly (1) higher levels of knowledge about the skills of nasogastric tube feeding, (2) higher learning motivations (i.e., intrinsic and extrinsic motivations, task values, and self-efficacy), (3) lower cognitive load, and (4) higher satisfaction than a control group. **Design:** A randomized controlled trial with pretest and posttest design. Settings and participants: We randomly assigned 107 students from the longterm care departments of two universities in central Taiwan to the IVR group (n = 54) or the control group (n = 53). Methods: The IVR group learned the procedure of nasogastric tube feeding through IVR, whereas the control group watched a 15-min 2D video. The participants filled pretest and posttest questionnaires on nasogastric tube feeding knowledge. After the experiment was completed, the participants answered another questionnaire on their learning motivations, cognitive load, and learning satisfaction. **Results:** The nasogastric tube feeding knowledge improved significantly in the IVR and control groups after the intervention, with no significant between-group differences. The IVR group scored significantly higher than the control group on extrinsic goals, task value, and satisfaction; nevertheless, they also experienced a significantly higher cognitive load. Conclusions: Both the IVR training and the traditional 2D video improved the learning outcomes of the nursing assistant students. The students were more satisfied with IVR than with the conventional learning model and indicated that IVR inspired their extrinsic learning motivations and perceived task value. However, IVR incurred a high cognitive load, which must be addressed in future course designs.





Logishetty K, Gofton WT, Rudran B, Beaulé PE, Cobb JP. Fully Immersive Virtual Reality for Total Hip Arthroplasty: Objective Measurement of Skills and Transfer of Visuospatial Performance After a Competency-Based Simulation Curriculum. J Bone Joint Surg Am. 2020;102(6):e27. doi:10.2106/JBJS.19.00629 Background: Fully immersive virtual reality (VR) uses headsets to situate a surgeon in a virtual operating room to perform open surgical procedures. The aims of this study were to determine (1) if a VR curriculum for training residents to perform anterior approach total hip replacement (AA-THR) was feasible, (2) if VR enabled residents' performance to be measured objectively, and (3) if cognitive and motor skills that were learned with use of VR were transferred to the physical world. Methods: The performance of 32 orthopaedic residents (surgical postgraduate years [PGY]-1 through 4) with no prior experience with AA-THR was measured during 5 consecutive VR training and assessment sessions. Outcome measures were related to procedural sequence, efficiency of movement, duration of surgery, and visuospatial precision in acetabular component positioning and femoral neck osteotomy, and were compared with the performance of 4 expert hip surgeons to establish competency-based criteria. Pretraining and post-training assessments on dry bone models were used to assess the transfer of visuospatial skills from VR to the physical world. **Results:** Residents progressively developed surgical skills in VR on a learning curve through repeated practice, plateauing, on average, after 4 sessions (4.1 ± 0.6 hours); they reached expert VR levels for 9 of 10 metrics (except femoral osteotomy angle). Procedural errors were reduced by 79%, assistive prompts were reduced by 70%, and procedural duration was reduced by 28%. Dominant and nondominant hand movements were reduced by 35% and 36%, respectively, and head movement was reduced by 44%. Femoral osteotomy was performed more accurately, and acetabular implant orientation improved in VR assessments. In the physical world assessments, experts were more accurate than residents prior to simulation, but were matched by residents after simulation for all of the metrics except femoral osteotomy angle. The residents who performed best in VR were the most accurate in the physical world, while 2 residents were unable to achieve competence despite sustained practice. Conclusions: For novice surgeons learning AA-THR skills, fully immersive VR technology can objectively measure progress in the acquisition of surgical skills as measured by procedural sequence, efficiency of movement, and visuospatial accuracy. Skills learned in this environment are transferred to the physical environment.





Lohre R, Bois AJ, Athwal GS, Goel DP; Canadian Shoulder and Elbow Society (CSES). Improved Complex Skill Acquisition by Immersive Virtual Reality Training: A Randomized Controlled Trial. *J Bone Joint Surg Am*. 2020;102(6):e26. doi:10.2106/JBJS.19.00982 **Background:** There has been limited literature on immersive virtual reality (VR) simulation in orthopaedic education. The purpose of this multicenter, blinded, randomized controlled trial was to determine the validity and efficacy of immersive VR training in orthopaedic resident education. Methods: Nineteen senior orthopaedic residents (resident group) and 7 consultant shoulder arthroplasty surgeons (expert group) participated in the trial comparing immersive VR with traditional learning using a technical journal article as a control. The examined task focused on achieving optimal glenoid exposure. Participants completed demographic questionnaires, knowledge tests, and a glenoid exposure on fresh-frozen cadavers while being examined by blinded shoulder arthroplasty surgeons. Training superiority was determined by the outcome measures of the Objective Structured Assessment of Technical Skills (OSATS) score, a developed laboratory metric, verbal answers, and time to task completion. Results: Immersive VR had greater realism and was superior in teaching glenoid exposure than the control (p = 0.01). The expert group outperformed the resident group on knowledge testing (p = 0.04). The immersive VR group completed the learning activity and knowledge tests significantly faster (p < 0.001) at a mean time (and standard deviation) of  $11 \pm 3$  minutes than the control group at 20 ± 4 minutes, performing 3 to 5 VR repeats for a reduction in learning time of 570%. The immersive VR group completed the glenoid exposure significantly faster (p = 0.04) at a mean time of 14 ± 7 minutes than the control group at 21 ± 6 minutes, with superior OSATS instrument handling scores (p = 0.03). The immersive VR group scored equivalently in surprise verbal scores (p = 0.85) and written knowledge scores (p = 1.0). Conclusions: Immersive VR demonstrated substantially improved translational technical and nontechnical skills acquisition over traditional learning in senior orthopaedic residents. Additionally, the results demonstrate the face, content, construct, and transfer validity for immersive VR. Clinical relevance: This adequately powered, randomized controlled trial demonstrated how an immersive VR system can efficiently (570%) teach a complex surgical procedure and also demonstrate improved translational skill and knowledge acquisition when compared with a traditional learning method.





Lohre R, Bois AJ, Pollock JW, et al. Effectiveness of Immersive Virtual Reality on Orthopedic Surgical Skills and Knowledge Acquisition Among Senior Surgical Residents: A Randomized Clinical Trial. JAMA Netw Open. 2020;3(12):e2031217. Published 2020 Dec 1. doi:10.1001/jamanetworkop en.2020.31217 Importance: Video learning prior to surgery is common practice for trainees and surgeons, and immersive virtual reality (IVR) simulators are of increasing interest for surgical training. The training effectiveness of IVR compared with video training in complex skill acquisition should be studied. **Objectives:** To evaluate whether IVR improves learning effectiveness for surgical trainees and to validate a VR rating scale through correlation to real-world performance. Design, setting, and participants: This block randomized, intervention-controlled clinical trial included senior (ie, postgraduate year 4 and 5) orthopedic surgery residents from multiple institutions in Canada during a single training course. An intention-to-treat analysis was performed. Data were collected from January 30 to February 1, 2020. Intervention: An IVR training platform providing a casebased module for reverse shoulder arthroplasty (RSA) for advanced rotator cuff tear arthropathy. Participants were permitted to repeat the module indefinitely. Main outcomes and measures: The primary outcome measure was a validated performance metric for both the intervention and control groups (Objective Structured Assessment of Technical Skills [OSATS]). Secondary measures included transfer of training (ToT), transfer effectiveness ratio (TER), and costeffectiveness (CER) ratios of IVR training compared with control. Additional secondary measures included IVR performance metrics measured on a novel rating scale compared with real-world performance. Results: A total of 18 senior surgical residents participated; 9 (50%) were randomized to the IVR group and 9 (50%) to the control group. Participant demographic characteristics were not different for age (mean [SD] age: IVR group, 31.1 [2.8] years; control group, 31.0 [2.7] years), gender (IVR group, 8 [89%] men; control group, 6 [67%] men), surgical experience (mean [SD] experience with RSA: IVR group, 3.3 [0.9]; control group, 3.2 [0.4]), or prior simulator use (had experience: IVR group 6 [67%]; control group, 4 [44%]). The IVR group completed training 387% faster considering a single repetition (mean [SD] time for IVR group: 4.1 [2.5] minutes; mean [SD] time for control group: 16.1 [2.6] minutes; difference, 12.0 minutes; 95% CI, 8.8-14.0 minutes; P < .001). The IVR group had significantly better mean (SD) OSATS scores than the control group (15.9 [2.5] vs 9.4 [3.2]; difference, 6.9; 95% CI, 3.3-9.7; P < .001). The IVR group also demonstrated higher mean (SD) verbal questioning scores (4.1 [1.0] vs 2.2 [1.7]; difference, 1.9; 95% CI, 0.1-3.3; P = .03). The IVR score (ie, Precision Score) had a strong correlation to real-world OSATS scores (r = 0.74) and final implant position (r = 0.73). The ToT was 59.4%, based on the OSATS score. The TER was 0.79, and the system was 34 times more cost-effective than control, based on CER. Conclusions and relevance: In this study, surgical training with IVR demonstrated superior learning efficiency, knowledge, and skill transfer. The TER of 0.79 substituted for 47.4 minutes of operating room time when IVR was used for 60 minutes.





Lohre R, Leveille L, Goel DP.	Case: A percutaneous pinning of a slipped capital femoral epiphysis is
Novel Application of	described after the use of immersive virtual reality (iVR) training. This case report
Immersive Virtual Reality	documents the first reported example of an immediate translation of surgical
Simulation Training: A Case	skill from iVR to the operating room. <b>Conclusion:</b> There is increasing evidence
Report. J Am Acad Orthop	for the use of iVR in orthopaedic education. Several randomized controlled trials
Surg Glob Res Rev.	demonstrate improved trainee performance relative to control when measured
2021;5(11):e21.00114.	in analogous operating room assessments. This is the first case report
Published 2021 Nov 18.	demonstrating direct patient care after the use of iVR. The implications of cost-
doi:10.5435/JAAOSGlobal-D-	effectiveness through skill transfer and patient safety are highlighted.
21-00114	
Lohre R, Warner JJP, Morrey	Background: The COVID-19 pandemic has interrupted orthopaedic training
BR, et al. Mitigating Surgical	structures for both surgeons and trainees. The concept of skill decay must be
Skill Decay in Orthopaedics	considered during inactivity of elective practice. The purpose of this study was to
Using Virtual Simulation	provide an evidence-based curriculum in association with immersive virtual
Learning. J Am Acad Orthop	reality (iVR) to prevent skill decay during periods of training cessation and
Surg Glob Res Rev.	beyond. <b>Methods:</b> A review of pertinent literature for orthopaedic surgical skill
2021;5(10):10.5435/JAAOSGl	decay was performed. Early experience by faculty instructors and residency and
obal-D-21-00193. Published	fellowship program directors was gathered from multiple institutions with
2021 Oct 12.	experience in virtual training methods including iVR. A proposed curriculum for
doi:10.5435/JAAOSGlobal-D-	cognitive and manual skill acquisition during COVID-19 was produced from
21-00193	qualitative narrative group opinion. <b>Results:</b> Skill decay can occur on the order
	of days to months and is dependent on the initial skill level. A novel curriculum
	for structured continuing medical education during and after periods of surgical
	disruption including e-learning, virtual meetings, and iVR simulators was
	produced from expert opinion and based on competency-based curriculum
	standards. Conclusion: Skill decay mitigation strategies should use best
	available evidence technologies and course structures that satisfy advanced
	learning concepts. The virtual curriculum including iVR simulators may provide
	cost-effective solutions to training.





López Chávez O, Rodríguez LF, Gutierrez-Garcia JO. A	<b>Background and objective:</b> The workings of medical educational tools are implemented using a myriad of approaches ranging from presenting static
comparative case study of	content to immersing students in gamified virtual-reality environments. The
2D, 3D and immersive-	objective of this paper is to explore whether and how different approaches for
virtual-reality applications	designing medical educational tools affect students' learning performance.
for healthcare education. Int	Materials and methods: Four versions of an educational tool for the study of
J Med Inform.	clinical cases were implemented: a 2D version, a gamified 2D version, a
2020;141:104226.	gamified 3D version, and a gamified immersive-virtual-reality version. All
doi:10.1016/j.ijmedinf.2020.	complying with the same functional requirements. Each version was used and
104226	evaluated by an independent group of students. The participants (n = 78)
	evaluated the applications regarding usefulness, usability, and gamification.
	Afterward, the students took an exam to assess the retention of information on
	the clinical cases presented. <b>Results:</b> One-sample Wilcoxon signed-rank tests
	confirmed that the participants perceived that it was at least quite likely that
	gamification helped improved their learning. In addition, based on the
	participants' perception, the gamification of the immersive-virtual-reality version
	helped the most to improve their learning performance in comparison with the
	gamified 2D and 3D versions. <b>Conclusions:</b> Regardless of whether different
	versions of a medical educational tool (complying with the same functional
	requirements) are perceived as equally useful and usable, the design approach
	(either 2D, 3D, or immersive-virtual-reality with or without gamification) affects
	students' retention of information on clinical cases.
Lu J, Leng A, Zhou Y, et al. An	Virtual reality (VR) surgery using the High Technology Computer Corporation
innovative virtual reality	Very Immersive Virtual Experience professional 2(HTC VIVE Pro2) suite is a
training tool for the pre-	multi-sensory, holistic surgical training experience. A multimedia combination
hospital treatment of	including videos and three-dimensional interaction in VR has been developed to
cranialmaxillofacial	enable trainees to experience a realistic battlefield environment. The innovation
trauma. Comput Assist Surg	allows trainees to interact with the individual components of the
(Abingdon).	cranialmaxillofacial(CMF) anatomy and apply surgical instruments while
2023;28(1):2189047.	watching close-up stereoscopic three-dimensional videos of the surgery. In this
doi:10.1080/24699322.2023.	study, a novel training tool for the pre-hospital treatment of CMF trauma based
2189047	on immersive virtual reality (iVR) was developed and validated. Twenty-five CMF
	surgeons evaluated the application for face and content validity. Using a
	structured assessment process, the surgeons commented on the content of the
	developed training tool, its realism and usability and the applicability of VR
	surgery for CMF trauma rescue simulation training. The results confirmed the
	applicability of VR for delivering training in the pre-hospital treatment of CMF
	trauma. Modifications were suggested to improve the user experience and
	Interactions with the surgical instruments. This training tool is ready for testing
	with surgical trainees.





Mandal P, Ambade R. Surgery Training and Simulation Using Virtual and Augmented Reality for Knee Arthroplasty. *Cureus*. 2022;14(9):e28823. Published 2022 Sep 6. doi:10.7759/cureus.28823 A range of extended reality technology integration, including immersive virtual reality (IVR), augmented reality (AR), as well as mixed reality, has lately acquired favour in orthopaedics. The utilization of extended reality machinery in knee arthroplasty is examined in this review study. Virtual reality (VR) and AR are usually exercised together in orthopaedic surgical training as alluring training outside of the operation theatre is acknowledged as a good surgical training tool. The use of this technology, its consequences for orthopaedic surgeons and their patients, and its moral and practical issues are also covered. Head-mounted displays (HMDs) are a potential addition directed toward improving surgical precision along with instruction. Although the hardware is cutting-edge, substantial effort needs to be done to develop software that enables seamless, trustworthy integration into clinical practice and training. Remote virtual rehabilitation has drawn increasing attention in recent years, and its significance has increased in light of the recent outbreak of the COVID-19 epidemic. Numerous medical sectors have shown the benefits of telerehabilitation, gamification, VR, and AR. Given the rising demand for orthopaedic therapy and its rising costs, this is a requirement. A remote surgeon can impart knowledge without being present, by virtually placing his or her hands in the visual field of a local surgeon using AR technology. With the use of this innovation, orthopaedic surgery seems to have been able to participate in the telemedicine revolution. This technology may also have an impact on how surgeons collaborate and train for orthopaedic residencies in the future. Volatility in the HMD market will probably stall improvements in surgical education.





Mao RQ, Lan L, Kay J, et al. Immersive Virtual Reality for Surgical Training: A Systematic Review. *J Surg Res*. 2021;268:40-58. doi:10.1016/j.jss.2021.06.04 5 Background: Immersive virtual reality (iVR) simulators provide accessible, low cost, realistic training adjuncts in time and financially constrained systems. With increasing evidence and utilization of this technology by training programs, clarity on the effect of global skill training should be provided. This systematic review examines the current literature on the effectiveness of iVR for surgical skills acquisition in medical students, residents, and staff surgeons. Methods: A literature search was performed on MEDLINE, EMBASE, CENTRAL, Web of Science and PsycInfo for primary studies published between January 1, 2000 and January 26, 2021. Two reviewers independently screened titles, abstracts, and full texts, extracted data, and assessed quality and strength of evidence using the Medical Education Research Quality Instrument (MERSQI) and Cochrane methodology. Results were qualitatively synthesized, and descriptive statistics were calculated. Results: The literature search yielded 9650 citations, with 17 articles included for qualitative synthesis. The mean (SD) MERSQI score was 11.7 (1.9) out of 18. In total, 307 participants completed training in four disciplines. Immersive VR-trained groups performed 18% to 43% faster on procedural time to completion compared to control (pooled standardized mean difference = -0.90 [95% CI=-1.33 to -047, I<sup>2</sup>=1%, P < 0.0001]). Immersive VR trainees also demonstrated greater post-intervention scores on procedural checklists and greater implant placement accuracy compared to control. **Conclusions:** Immersive VR incorporation into surgical training programs is supported by high-quality, albeit heterogeneous, studies demonstrating improved procedural times, task completion, and accuracy, positive user ratings, and cost-effectiveness.





McKinney B, Dbeis A, Lamb A, Frousiakis P, Sweet S. Virtual Reality Training in Unicompartmental Knee Arthroplasty: A Randomized, Blinded Trial. *J Surg Educ*. 2022;79(6):1526-1535. doi:10.1016/j.jsurg.2022.06. 008 Objective: The objective of this study was to evaluate the effectiveness of immersive virtual reality training in orthopedic surgery education in comparison to the standard technique guide for fixed-bearing medial unicompartmental knee arthroplasty **Design:** Participants included 22 orthopedic surgery residents who were randomized to undergo fixed-bearing medial unicompartmental knee arthroplasty (UKA) surgical training with either an immersive virtual reality technology or by studying the traditional technique guide. Participants were randomized within their training year via block randomization. Participants then performed a medial UKA on a SawBone model using standard industry system surgical trays and equipment. Proficiency, timing, number of errors made, and subjective data were obtained during and after the SawBone procedure. A blinded observer was utilized to obtain objective data. Setting: Community Memorial Health System, a primary clinical care institution in Ventura, California. Participants: Twenty-two orthopedic surgery residents were randomly selected. There were 7 PGY-1 residents (3 TG, 4 VR), 7 PGY-2s (4 TG, 3 VR), 3 PGY-3s (1 TG, 2 VR), 3 PGY-4s (2 TG, 1 VR), and 2 PGY-5s (1 TG, 1 VR) in total. Eligibility criteria were 1) an active orthopedic surgery resident, 2) no prior immersive VR surgical training, and 3) no prior experience with the Zimmer PPK implants or its technique guide. All participants completed the study. **Results:** Residents were randomized evenly in the virtual reality (n = 11) and technique guide groups (n = 11). Analysis showed that residents who trained with the immersive VR executed significantly more steps correctly (33 vs. 27, p < 0.01) and completed their procedure in significantly faster time (26.7 vs. 35.4 minutes, p < 0.01). They also scored higher in all global assessment categories reaching significance in 4 of 5 categories. Subjective questionnaire responses demonstrated positive feedback within both groups with a trend toward virtual reality. No adverse events were recorded. Conclusions: Immersive virtual reality was more effective than traditional training for the participants of this study. There are numerous potential applications of this technology and it provides an alternative learning modality to accommodate different learning styles.





Munawar A, Li Z, Nagururu N, et al. Fully immersive virtual reality for skull-base surgery: surgical training and beyond. *Int J Comput Assist Radiol Surg*. 2024;19(1):51-59. doi:10.1007/s11548-023-02956-5 **Purpose:** A virtual reality (VR) system, where surgeons can practice procedures on virtual anatomies, is a scalable and cost-effective alternative to cadaveric training. The fully digitized virtual surgeries can also be used to assess the surgeon's skills using measurements that are otherwise hard to collect in reality. Thus, we present the Fully Immersive Virtual Reality System (FIVRS) for skullbase surgery, which combines surgical simulation software with a high-fidelity hardware setup. Methods: FIVRS allows surgeons to follow normal clinical workflows inside the VR environment. FIVRS uses advanced rendering designs and drilling algorithms for realistic bone ablation. A head-mounted display with ergonomics similar to that of surgical microscopes is used to improve immersiveness. Extensive multi-modal data are recorded for post-analysis, including eye gaze, motion, force, and video of the surgery. A user-friendly interface is also designed to ease the learning curve of using FIVRS. **Results:** We present results from a user study involving surgeons with various levels of expertise. The preliminary data recorded by FIVRS differentiate between participants with different levels of expertise, promising future research on automatic skill assessment. Furthermore, informal feedback from the study participants about the system's intuitiveness and immersiveness was positive. **Conclusion:** We present FIVRS, a fully immersive VR system for skull-base surgery. FIVRS features a realistic software simulation coupled with modern hardware for improved realism. The system is completely open source and provides feature-rich data in an industry-standard format.





Naef AC, Jeitziner MM, Gerber SM, et al. Virtual reality stimulation to reduce the incidence of delirium in critically ill patients: study protocol for a randomized clinical trial. *Trials*. 2021;22(1):174. Published 2021 Mar 1. doi:10.1186/s13063-021-05090-2 **Background:** Delirium has been long considered as a major contributor to cognitive impairments and increased mortality following a critical illness. Pharmacologic and non-pharmacologic strategies are used against delirium in the intensive care unit (ICU), despite these strategies remaining controversial. Previous studies have shown the feasibility of using virtual reality within the ICU setting, and we propose to use this technology to investigate the effect of immersive virtual reality stimulation on the incidence of delirium in the ICU. Moreover, we propose to use motion sensors to determine if patient movement patterns can lead to early prediction of delirium onset. Methods: This study is conducted as a randomized clinical trial. A total of 920 critically ill patients in the ICU will participate. The control group will receive standard ICU care, whereas the intervention group will, in addition to the standard ICU care, receive relaxing 360-degree immersive virtual reality content played inside a head-mounted display with noise-cancelling headphones, three times a day. The first 100 patients, regardless of their group, will additionally have their movement patterns recorded using wearable and ambient sensors. Follow-up measurements will take place 6 months after discharge from the ICU. **Discussion:** Delirium is widely present within the ICU setting but lacks validated prevention and treatment strategies. By providing patients with virtual reality stimulation presented inside a head-mounted display and noise-cancelling headphones, participants may be isolated from disturbances on an ICU. It is believed that by doing so, the incidence of delirium will be decrease among these patients. Moreover, identifying movement patterns associated with delirium would allow for early detection and intervention, which may further improve long-term negative outcomes associated with delirium during critical care.





Nielsen AB, Dragsbæk J, Jacobsen N, et al. Assessment of Basic Thoracic Ultrasound Skills in Immersive Virtual Reality: Gathering Validity Evidence. *Ultrasound Med Biol*. 2024;50(4):467-473. doi:10.1016/j.ultrasmedbio. 2023.12.002

Objective: Operator skills are essential for thoracic ultrasound (TUS) to ensure diagnostic accuracy. Immersive virtual reality (IVR) has shown potential within medical education but never for assessment of TUS skills. This study was aimed at developing an IVR test for assessing TUS skills, gathering validity evidence and establishing a pass/fail score. Methods: An expert panel developed a test based on the TUS protocol by the European Respiratory Society (ERS), including a tutorial and two clinical cases (pleural effusion and interstitial syndrome), using an IVR platform (VitaSim, Odense, Denmark). Four anterior, four lateral and six posterior zones were available for examination and decision of diagnosis. Each correct examination equaled one point. The contrasting groups' method was used to set a pass/fail score. **Results:** Data were collected during the 2022 ERS Congress. We included 13 novices (N, experience: 0 TUS), 22 intermediates (I, 1-50 TUS) and 11 experienced clinicians (E, >50 TUS). Cronbach's α was 0.86. The total mean point scores in case 1 (C1) were (N) 5.0 ± 2.7, (I) 7.3 ± 2.4 and (E) 8.7 ± 1.3, and the scores in case 2 (C2) were (N) 4.5 ± 1.8, (I) 6.7 ± 2.3 and (E) 8.5 ± 2.1. Significant differences were found between N and I for C1 (p = 0.007) and C2 (p = 0.02), I and E for C1 (p = 0.04) and C2 (p = 0.019) and N and E for C1 (p < 0.001) and C2 (p < 0.001). The pass/fail score was 7 points in each case. **Conclusion:** We established an IVR test that can distinguish between operators with different TUS skills. This enables a standardized, objective and evidencebased approach to assessment of TUS skills.





Omlor AJ, Schwärzel LS, Bewarder M, et al. Comparison of immersive and non-immersive virtual reality videos as substitute for in-hospital teaching during coronavirus lockdown: a survey with graduate medical students in Germany. *Med Educ Online*. 2022;27(1):2101417. doi:10.1080/10872981.2022. 2101417 As a consequence of the continued Covid-19 lockdown in Germany, in-hospital teaching for medical students was impossible. While lectures and other theoretical training were relatively easily converted into online sessions using platforms such as Moodle, Zoom and Microsoft Teams, this was not the case for practical skills and clinical interventions, such as bronchoscopy or colonoscopy. This study describes a workaround that was implemented at the Saarland University Hospital utilizing virtual reality equipment to convey the impressions of shadowing clinical procedures to the students without physical presence. To achieve this, 3D 180° videos of key clinical interventions of various internal medicine specialities were recorded, cut, and censored. The videos were uploaded to the e-learning YouTube channel of our institution and shared with the students via the private share function. The students could choose whether to use a VR-viewer to watch the videos immersively or to watch them without a viewer on a screen non-immersively. At the end of the course after 1 week, the students completed a questionnaire anonymously focusing on learning-success regarding the presented topics, a self-assessment, and an evaluation of the course. A total of 27 students watched the videos with a VR-Viewer and 74 watched non-immersively. Although the VR-viewer group selfassessed their expertise higher, there was no significant difference between the two groups in the learning-success test score. However, students in the VRviewer group rated the learning atmosphere, comprehensibility, and overall recommendation of the course significantly higher. They also agreed significantly more to the statement, that they gained a better conception of the presented procedures, and that virtual reality might be an appropriate tool for online teaching. Video-assisted teaching facilitates learning and might be a valuable add-on to conventional teaching.





Pal S, Benson R, Duvall P, Taylor-Jones V. Do innovative immersive virtual reality simulation videos have a role to play in teaching nontechnical skills and increasing preparedness for clinical placements for medical students?. *MedEdPublish* (2016). 2021;9:164. Published 2021 Sep 29. doi:10.15694/mep.2020.000 164.2 Background: Teaching non-technical skills (NTS) is an important part of the undergraduate medical curriculum. Resource intensive high-fidelity simulation has an established role in this. Alternative methods of delivering large scale simulation-based education should be considered to help further improve NTS and preparedness for clinical placements of medical students. Emerging technologies such as immersive virtual reality (VR) may have a role in this. **Aim:** To assess if a VR simulation-based teaching programme enhances understanding of NTS and preparedness for clinical placements in medical students at the University of Liverpool. Methods: A VR simulation-based teaching programme, consisting of 4 sessions of lecture-based simulation and a hi-fidelity simulation session was delivered to 3 <sup>rd</sup> year medical students. The lecture-based sessions used pre-recorded, immersive clinical scenarios developed by the School of Medicine, with a focus on NTS. The hi-fidelity simulation session was delivered by local hospital trusts. A survey was sent to all students to assess their understanding of key NTS: decision making, task prioritisation and delegation and how the clinical environment works. Preparedness for clinical placement and confidence in the clinical environment was also assessed. A focus group further explored how students felt towards these NTS, with subsequent thematic analysis. **Results:** 101/281 students responded to the survey reporting a greater understanding in all NTS assessed. Students also described feeling better prepared for clinical placements. The focus group reported the programme provided a 'safe space' for learning alongside increasing understanding of role modelling and self-awareness. **Discussion:** Utilising emerging technology alongside hi-fidelity simulation increased students' exposure to the clinical environment and enabled exploration of NTS by students. Additional work with larger focus groups will be required to further validate our results. Whilst restrictions are limiting clinical exposure due to the COVID-19 pandemic, we propose that VR simulation-based teaching programmes could provide an alternative educational tool.





Parkhomenko E, O'Leary M, Safiullah S, et al. Pilot Assessment of Immersive Virtual Reality Renal Models as an Educational and Preoperative Planning Tool for Percutaneous Nephrolithotomy. *J Endourol*. 2019;33(4):283-288. doi:10.1089/end.2018.0626 Background: Percutaneous nephrolithotomy (PCNL) requires the urologist to have detailed knowledge of the stone and its relationship with the renal anatomy. Immersive virtual reality (iVR) provides patient-specific threedimensional models that might be beneficial in this regard. Our objective is to present the initial experience with iVR in surgeon planning and patient preoperative education for PCNL. Materials and methods: From 2017 to 2018 four surgeons, each of whom had varying expertise in PCNL, used iVR models to acquaint themselves with the renal anatomy before PCNL among 25 patients. iVR renderings were also viewed by patients using the same head-mounted Oculus rift display. Surgeons rated their understanding of the anatomy with CT alone and then after CT+iVR; patients also recorded their experience with iVR. To assess the impact on outcomes, the 25 iVR study patients were compared with 25 retrospective matched-paired non-iVR patients. Student's t-test was used to analyze collected data. Results: iVR improved surgeons' understanding of the optimal calix of entry and the stone's location, size, and orientation (p < 0.01). iVR altered the surgical approach in 10 (40%) cases. Patients strongly agreed that iVR improved their understanding of their stone disease and reduced their preoperative anxiety. In the retrospective matched-paired analysis, the iVR group had a statistically significant decrease in fluoroscopy time and blood loss as well as a trend toward fewer nephrostomy tracts and a higher stone-free rate. Conclusions: iVR improved urologists' understanding of the renal anatomy and altered the operative approach in 40% of cases. In addition, iVR improved patient comprehension of their surgery. Clinically, iVR had benefits with regard to decreased fluoroscopy time and less blood loss along with a trend toward fewer access tracts and higher stone-free rates.




Pérez-Escamirosa F, García-Cabra DA, Ortiz-Hernández JR, et al. Face, content, and construct validity of the virtual immersive operating room simulator for training laparoscopic procedures. *Surg Endosc*. 2023;37(4):2885-2896. doi:10.1007/s00464-022-09797-4 Background: The aim of this work is to present the face, content, and construct validation of the virtual immersive operating room simulator (VIORS) for procedural training of surgeons' laparoscopic psychomotor skills and evaluate the immersive training experience. Methods: The VIORS simulator consists of an HMD Oculus Rift 2016 with a visor on a 1080 × 1200 pixel OLED screen, two positioning sensors with two adapted controls to simulate laparoscopic instruments, and an acrylic base to simulate the conventional laparoscopic setup. The immersion consists of a 360° virtual operating room environment, based on the EndoSuite at Hospital Infantil de Mexico Federico Gomez, which reproduces a configuration of equipment, instruments, and common distractions in the operating room during a laparoscopic cholecystectomy procedure. Forty-five surgeons, residents, and medicine students participated in this study: 27 novices, 13 intermediates, and 5 experts. They completed a questionnaire on the realism and operating room immersion, as well as their capabilities for laparoscopic procedural training, scored in the 5-point Likert scale. The data of instrument movement were recorded and analyzed using 13 movement analysis parameters (MAPs). The experience during training with VIORS was evaluated through NASA-TLX. Results: The participants were enthusiastic about the immersion and sensation levels of the VIORS simulator, with positive scores on the realism and its capabilities for procedural training using VIORS. The results proved that the VIORS simulator was able to differentiate between surgeons with different skill levels. Statistically significant differences were found in nine MAPs, demonstrating their construct validity for the objective assessment of the procedural laparoscopic performance. At cognitive level, the inversion experience proves a moderate mental workload when the laparoscopic procedure is carried out. Conclusion: The VIORS simulator has been successfully presented and validated. The VIORS simulator is a useful and effective device for the training of procedural laparoscopic psychomotor skills.





Perron JE, Coffey MJ, Lovell-Simons A, Dominguez L, King ME, Ooi CY. Resuscitating Cardiopulmonary Resuscitation Training in a Virtual Reality: Prospective Interventional Study. *J Med Internet Res.* 2021;23(7):e22920. Published 2021 Jul 29. doi:10.2196/22920 Background: Simulation-based technologies are emerging to enhance medical education in the digital era. However, there is limited data for the use of virtual reality simulation in pediatric medical education. We developed Virtual Doc as a highly immersive virtual reality simulation to teach pediatric cardiopulmonary resuscitation skills to medical students. Objective: The primary objectives of this study were to evaluate participant satisfaction and perceived educational efficacy of Virtual Doc. The secondary aim of this study was to assess the game play features of Virtual Doc. Methods: We conducted a prospective closed betatesting study at the University of New South Wales (Sydney, Australia) in 2018. All medical students from the 6-year undergraduate program were eligible to participate and were recruited through voluntary convenience sampling. Participants attended a 1-hour testing session and attempted at least one full resuscitation case using the virtual reality simulator. Following this, participants were asked to complete an anonymous postsession questionnaire. Responses were analyzed using descriptive statistics. **Results:** A total of 26 participants were recruited, consented to participate in this study, and attended a 1-hour inperson closed beta-testing session, and 88% (23/26) of participants completed the anonymous questionnaire and were included in this study. Regarding participant satisfaction, Virtual Doc was enjoyed by 91% (21/23) of participants, with 74% (17/23) intending to recommend the simulation to a colleague and 66% (15/23) intending to recommend the simulation to a friend. In assessment of the perceived educational value of Virtual Doc, 70% (16/23) of participants agreed they had an improved understanding of cardiopulmonary resuscitation, and 78% (18/23) agreed that Virtual Doc will help prepare for and deal with real-life clinical scenarios. Furthermore, 91% (21/23) of participants agreed with the development of additional Virtual Doc cases as beneficial for learning. An evaluation of the game play features as our secondary objective revealed that 70% (16/23) of participants agreed with ease in understanding how to use Virtual Doc, and 74% (17/23) found the game play elements useful in understanding cardiopulmonary resuscitation. One-third (7/23, 30%) found it easy to work with the interactive elements. In addition, 74% (17/23) were interested in interacting with other students within the simulation. Conclusions: Our study demonstrates a positive response regarding trainee satisfaction and perceived educational efficacy of Virtual Doc. The simulation was widely accepted by the majority of users and may have the potential to improve educational learning objectives.





Pinter C, Lasso A, Choueib S,	Virtual reality (VR) provides immersive visualization that has proved to be useful
et al. SlicerVR for Medical	in a variety of medical applications. Currently, however, no free open-source
Intervention Training and	software platform exists that would provide comprehensive support for
Planning in Immersive Virtual	translational clinical researchers in prototyping experimental VR scenarios in
Reality. IEEE Trans Med	training, planning or guiding medical interventions. By integrating VR functions in
Robot Bionics.	3D Slicer, an established medical image analysis and visualization platform,
2020;2(2):108-117.	SlicerVR enables virtual reality experience by a single click. It provides functions
doi:10.1109/tmrb.2020.2983	to navigate and manipulate the virtual scene, as well as various settings to abate
199	the feeling of motion sickness. SlicerVR allows for shared collaborative VR
	experience both locally and remotely. We present illustrative scenarios created
	with SlicerVR in a wide spectrum of applications, including echocardiography,
	neurosurgery, spine surgery, brachytherapy, intervention training and
	personalized patient education. SlicerVR is freely available under BSD type
	license as an extension to 3D Slicer and it has been downloaded over 7,800
	times at the time of writing this article.
Pulijala Y, Ma M, Pears M,	Virtual reality (VR) surgery using Oculus Rift and Leap Motion devices is a multi-
Peebles D, Ayoub A. An	sensory, holistic surgical training experience. A multimedia combination
innovative virtual reality	including 360° videos, three-dimensional interaction, and stereoscopic videos in
training tool for orthognathic	VR has been developed to enable trainees to experience a realistic surgery
surgery. Int J Oral Maxillofac	environment. The innovation allows trainees to interact with the individual
Surg. 2018;47(9):1199-1205.	components of the maxillofacial anatomy and apply surgical instruments while
doi:10.1016/j.ijom.2018.01.0	watching close-up stereoscopic three-dimensional videos of the surgery. In this
05	study, a novel training tool for Le Fort I osteotomy based on immersive virtual
	reality (iVR) was developed and validated. Seven consultant oral and
	maxillofacial surgeons evaluated the application for face and content validity.
	Using a structured assessment process, the surgeons commented on the
	content of the developed training tool, its realism and usability, and the
	applicability of VR surgery for orthognathic surgical training. The results
	confirmed the clinical applicability of VR for delivering training in orthognathic
	surgery. Modifications were suggested to improve the user experience and
	interactions with the surgical instruments. This training tool is ready for testing
	with surgical trainees.





Pulijala Y, Ma M, Pears M, Peebles D, Ayoub A. Effectiveness of Immersive Virtual Reality in Surgical Training-A Randomized Control Trial. *J Oral Maxillofac Surg*. 2018;76(5):1065-1072. doi:10.1016/j.joms.2017.10. 002 **Purpose:** Surgical training methods are evolving with the technological advancements, including the application of virtual reality (VR) and augmented reality. However, 28 to 40% of novice residents are not confident in performing a major surgical procedure. VR surgery, an immersive VR (iVR) experience, was developed using Oculus Rift and Leap Motion devices (Leap Motion, Inc, San Francisco, CA) to address this challenge. Our iVR is a multisensory, holistic surgical training application that demonstrates a maxillofacial surgical technique, the Le Fort I osteotomy. The main objective of the present study was to evaluate the effect of using VR surgery on the self-confidence and knowledge of surgical residents. Materials and methods: A multisite, single-blind, parallel, randomized controlled trial (RCT) was performed. The participants were novice surgical residents with limited experience in performing the Le Fort I osteotomy. The primary outcome measures were the self-assessment scores of trainee confidence using a Likert scale and an objective assessment of the cognitive skills. Ninety-five residents from 7 dental schools were included in the RCT. The participants were randomly divided into a study group of 51 residents and a control group of 44. Participants in the study group used the VR surgery application on an Oculus Rift with Leap Motion device. The control group participants used similar content in a standard PowerPoint presentation on a laptop. Repeated measures multivariate analysis of variance was applied to the data to assess the overall effect of the intervention on the confidence of the residents. **Results:** The study group participants showed significantly greater perceived self-confidence levels compared with those in the control group (P = .034;  $\alpha$  = 0.05). Novices in the first year of their training showed the greatest improvement in their confidence compared with those in their second and third year. **Conclusions:** iVR experiences improve the knowledge and self-confidence of the surgical residents.





Qi F, Gan Y, Wang S, Tie Y, Chen J, Li C. Efficacy of a virtual reality-based basic and clinical fused curriculum for clinical education on the lumbar intervertebral disc. *Neurosurg Focus*. 2021;51(2):E17. doi:10.3171/2021.5.FOCUS2 0756 Objective: Today, minimally invasive procedures have become mainstream surgical procedures. Percutaneous endoscopic transforaminal discectomy for lumbar disc herniation (LDH) requires profound knowledge of the laparoscopic lumbar anatomy. Immersive virtual reality (VR) provides three-dimensional patient-specific models to help in the process of preclinical surgical preparation. In this study, the authors investigated the efficacy of VR application in LDH for training orthopedic residents and postgraduates. Methods: VR images of the lumbar anatomy were created with immersive VR and mAnatomy software. The study was conducted among 60 residents and postgraduates. A questionnaire was developed to assess the effect of and satisfaction with this VR-based basic and clinical fused curriculum. The teaching effect was also evaluated through a postlecture test, and the results of the prelecture surgical examination were taken as baselines. **Results:** All participants in the VR group agreed that VR-based education is practical, attractive, and easy to operate, compared to traditional teaching, and promotes better understanding of the anatomical structures involved in LDH. Learners in the VR group achieved higher scores on an anatomical and clinical fusion test than learners in the traditional group (84.67 ± 14.56 vs 76.00 ± 16.10, p < 0.05). **Conclusions:** An immersive VRbased basic and clinical fused curriculum can increase residents' and postgraduates' interest and support them in mastering the structural changes and complicated symptoms of LDH. However, a simplified operational process and more realistic haptics of the VR system are necessary for further surgical preparation and application.





Qiao J, Xu J, Li L, Ouyang YQ. The integration of immersive virtual reality simulation in interprofessional education: A scoping review. *Nurse Educ Today*. 2021;98:104773. doi:10.1016/j.nedt.2021.104 773 Background: Contemporary healthcare systems are in dire need of teamwork and interprofessional collaboration, however, existing curricula of health education programs offer few opportunities to build these capabilities. Virtual simulations enable interaction and cooperative learning for students pursuing health majors. Objective: To explore the effectiveness of immersive virtual reality simulation (IVRS) in interprofessional education (IPE) and the experience of students from various disciplines in a virtual clinical environment. Design, data sources and methods: A scoping review was conducted. Literature was systematically searched from CINAHL, EMBASE, ERIC, MEDLINE/PubMed, ProQuest, PsycINFO, Scopus, Science Direct, Cochrane Library and Open Grey databases. Among 2352 records, 12 research articles were found and analyzed. Results: The experiences of students participating in IVRS centered on enhanced cooperation and communication across their disciplines. They obtained a more accurate picture of the patient and developed an interdisciplinary care plan. After the IPE session, they had greater appreciation of the importance of a team approach and shared learning. Students acknowledged the usability of virtual worlds (VWs) and appreciated the immersive learning experience that was offered. They gained valuable insight into mutual roles and believed that this experience would benefit their role as a health care team member. Conclusions: This study supports the usability of VWs for IPE. As a new teaching modality, the IVRS experience effectively promotes interprofessional collaboration and communication. Future advances in the use of these technologies are expected to revolutionize health science education.





Raab DL, Ely K, Israel K, et al. Impact of Virtual Reality Simulation on New Nurses' Assessment of Pediatric Respiratory Distress. <i>Am J</i> <i>Crit Care</i> . 2024;33(2):115- 124. doi:10.4037/ajcc2024878	<b>Background:</b> Children often experience respiratory illnesses requiring bedside nurses skilled in recognizing respiratory decompensation. Historically, recognizing respiratory distress has relied on teaching during direct patient care. Virtual reality simulation may accelerate such recognition among novice nurses. <b>Objective:</b> To determine whether a virtual reality curriculum improved new nurses' recognition of respiratory distress and impending respiratory failure in pediatric patients based on assessment of physical examination findings and appropriate escalation of care. <b>Methods:</b> New nurses (n = 168) were randomly assigned to complete either an immersive virtual reality curriculum on recognition of respiratory distress (intervention) or the usual orientation curriculum (control). Group differences and changes from 3 months to 6 months after the intervention were examined. <b>Results:</b> Nurses in the intervention group were significantly more likely to correctly recognize impending respiratory failure at both 3 months (23.4% vs 3.0%, P < .001) and 6 months (31.9% vs 2.6%, P < .001), identify respiratory distress without impending respiratory failure at 3 months (57.8% vs 29.6%, P = .002) and 6 months (57.9% vs 17.8%, P < .001), and recognize patients' altered mental status at 3 months (51.4% vs 18.2%, P < .001) and 6 months (46.8% vs 18.4%, P = .006). <b>Conclusions:</b> Implementation of a virtual reality-based training curriculum was associated with improved recognition of pediatric respiratory distress, impending respiratory failure, and altered mental status at 3 and 6 months compared with standard training approaches. Virtual reality may offer a new approach to nurse orientation to ophoment training in podiatriae apositio approach to nurse orientation to
Ramashia PN. Radiotherapy	Introduction: Simulation is becoming increasingly popular in clinical education
plan evaluation tool in a	due to a shortage of resources. The Virtual Environment for Radiotherapy
resource-limited setting:	Iraining (VERI) assists students in developing their skills by providing realistic
treatment planning software	simulations of clinical radiation oncology treatments. It has also been used to help students around the world learn how to evaluate treatment plans. <b>Aim:</b> The
Journal of Medical Imaging	aim of this research is to evaluate version 5 of the VERT as a radiation therapy
and Radiation Sciences.	teaching tool for evaluating 3D treatment plans compared with treatment
2023;54(4):719-725.	planning software tools in a limited resource setting. Methods: A quantitative
doi:10.1016/j.jmir.2023.07.0	design using an adapted online questionnaire was used for the study. All
14	students registered for a bachelor's degree in a radiation therapy programme at
	the university's Department of Medical Imaging and Radiation Sciences were
	invited to a 90 min treatment planning session to evaluate two plans. First to
	fourth year students were evenly divided among eight groups. Four groups used
	the ECLIPSE TPS software (Varian Medical Systems, Palo Alto), and the other
	four groups used VERT version 5.0 (Virtual Ltd, Hull) to evaluate the same plans.
	<b>Results:</b> This study demonstrated that VERT version 5.0 has the potential to
	improve the training of radiation therapy students in environments with limited
	tools. All respondents found the session useful, with 55% of students indicating
	that the session was extremely useful <b>Conclusion</b> : Inside the value of
	VERT as a teaching tool could contribute to improving training efficacy in
	contexts with resource limitations that are present in many clinical settings.





Rashidian N, Giglio MC, Van Herzeele I, et al. Effectiveness of an immersive virtual reality environment on curricular training for complex cognitive skills in liver surgery: a multicentric crossover randomized trial. <i>HPB (Oxford)</i> . 2022;24(12):2086-2095. doi:10.1016/j.hpb.2022.07.0 09	<b>Background:</b> Virtual reality (VR) is increasingly used in surgical education, but evidence of its benefits in complex cognitive training compared to conventional 3-dimensional (3D) visualization methods is lacking. The objective of this study is to assess the impact of 3D liver models rendered visible by VR or desktop interfaces (DIs) on residents' performance in clinical decision-making. <b>Method:</b> From September 2020 to April 2021, a single-blinded, crossover randomized educational intervention trial was conducted at two university hospitals in Belgium and Italy. A proficiency-based stepwise curriculum for preoperative liver surgery planning was developed for general surgery residents. After completing the training, residents were randomized in one of two assessment sequences to evaluate ten real clinical scenarios. <b>Results:</b> Among the 50 participants, 46 (23 juniors/23 seniors) completed the training and were randomized. Forty residents (86.96%) achieved proficiency in decision-making. The accuracy of virtual surgical planning using VR was higher than that using DI in both groups A (8.43 ± 1.03 vs 6.86 ± 1.79, p < 0.001) and B (8.08 ± 0.9 vs 6.52 ± 1.37, p < 0.001). <b>Conclusion:</b> Proficiency-based curricular training for liver surgery planning successfully resulted in the acquisition of complex cognitive
	skills. VR was superior to DI visualization of 3D models in decision-making.
Real FJ, DeBlasio D, Ollberding NJ, et al. Resident perspectives on communication training that utilizes immersive virtual reality. <i>Educ Health</i> <i>(Abingdon).</i> 2017;30(3):228- 231. doi:10.4103/efh.EfH_9_17	<b>Background:</b> Communication skills can be difficult to teach and assess in busy outpatient settings. These skills are important for effective counseling such as in cases of influenza vaccine hesitancy. It is critical to consider novel educational methods to supplement current strategies aimed at teaching relational skills. <b>Methods:</b> An immersive virtual reality (VR) curriculum on addressing influenza vaccine hesitancy was developed using Kern's six-step approach to curriculum design. The curriculum was meant to teach best-practice communication skills in cases of influenza vaccine hesitancy. Eligible participants included postgraduate level (PL) 2 and PL-3 pediatric residents (n = 24). Immediately following the curriculum, a survey was administered to assess residents' attitudes toward the VR curriculum and perceptions regarding the effectiveness of VR in comparison to other educational modalities. A survey was administered 1 month following the VR curriculum to assess trainee-perceived impact of the curriculum. Ninety-two percent (n = 22) agreed or strongly agreed that VR simulations were like real-life patient encounters. Seventy-five percent (n = 18) felt that VR was equally effective to standardized patient (SP) encounters and less effective than bedside teaching (P < 0.001). At 1-month follow-up, 67% of residents (n = 16) agreed or strongly agreed that the VR experience improved how they counseled families in cases of influenza vaccine hesitancy. <b>Discussion:</b> An immersive VR curriculum at our institution was well-received by learners, and residents rated VR as equally effective as SP encounters. As such, immersive VR may be a promising modality for communication training.





Real FJ, Hood AM, Davis D, et	Although hydroxyurea (HU) is an effective treatment for sickle cell anemia,
al. An Immersive Virtual	uptake remains low. Shared decision-making (SDM) is a recommended strategy
Reality Curriculum for	for HU initiation to elicit family preferences; however, clinicians lack SDM
Pediatric Hematology	training. We implemented an immersive virtual reality (VR) curriculum at 8
Clinicians on Shared	pediatric institutions to train clinicians on SDM that included counseling virtual
Decision-making for	patients. Clinicians' self-reported confidence significantly improved following
Hydroxyurea in Sickle Cell	the VR simulations on all communication skills assessed, including asking open-
Anemia. J Pediatr Hematol	ended questions, eliciting specific concerns, and confirming understanding
Oncol. 2022;44(3):e799-	(Ps≤0.01 for all). VR may be an effective method for educating clinicians to
e803.	engage in SDM for HU.
doi:10.1097/MPH.00000000	
00002289	
Rodríguez-Matesanz M,	The Objective Structured Clinical Exam (OSCE) is an assessment tool used as a
Guzmán-García C, Oropesa	reliable method for clinical competence evaluation of students. This paper
I, Rubio-Bolivar J, Quintana-	presents an investigation focused on the chain of survival, its related
Díaz M, Sánchez-González P.	exploration, management, and technical skills, and how Virtual Reality (VR) can
A New Immersive Virtual	be used for the creation of immersive environments capable of evaluating
Reality Station for	students' performance while applying the correct protocols. In particular, the
Cardiopulmonary	Cardiopulmonary Resuscitation (CPR) procedure is studied as an essential step
Resuscitation Objective	in the development of the chain of survival. The paper also aims to highlight the
Structured Clinical Exam	limitations of traditional methods using mechanical mannequins and the
Evaluation. Sensors (Basel).	benefits of the new approaches that involve the students in virtual, immersive,
2022;22(13):4913. Published	and dynamic environments. Furthermore, an immersive VR station is presented
2022 Jun 29.	as a new technique for assessing CPR performance through objective data
doi:10.3390/s22134913	collection and posterior evaluation. A usability test was carried out with 33
	clinicians and OSCE evaluators to test the viability of the presented scenario,
	reproducing conditions of a real examination. Results suggest that the
	environment is intuitive, quick, and easy to learn and could be used in clinical
	practice to improve CPR performance and OSCE evaluation.





Ros M, Debien B, Cyteval C, Molinari N, Gatto F, Lonjon N. Applying an immersive tutorial in virtual reality to learning a new technique. <i>Neurochirurgie</i> . 2020;66(4):212-218. doi:10.1016/j.neuchi.2020.0 5.006	<b>Objective:</b> The medical world is continuously evolving, with techniques being created or improved almost daily. Immersive virtual reality (VR) is a technology that could be harnessed to develop tools that meet the educational challenges of this changing environment. We previously described the immersive tutorial, a 3D video (filmed from the first-person point of view), displayed on a VR application. This tool offers access to supplementary educational data in addition to the video. Here we attempt to assess improvement in learning a technique using this new educational format. <b>Material and methods:</b> We selected a single neurosurgical technique for the study: external ventricular drainage. We wrote a technical note describing this procedure and produced the corresponding immersive tutorial. All participants read the technical note, and one group used the immersive tutorial as a teaching supplement. The students completed a multiple-choice questionnaire immediately after the training and again at six months. <b>Results:</b> One hundred seventy-six fourth-year medical students participated in the study; 173 were included in assessing the immediate learning outcomes and 72 were included at the six-month follow-up. The VR group demonstrated significantly better short-term results than the control group (P=0.01). The same trend was seen at six months. <b>Conclusion:</b> To our knowledge, this study presents one of the largest cohorts for VR. The use of the immersive tutorial could enable a large number of healthcare professionals to be trained without the need for expensive equipment.
Rosenfeldt Nielsen M,	The primary aim was to evaluate the effect of immersive virtual reality learning
Kristensen EQ, Jensen RO,	for training medical students in basic clinical ultrasound. Secondary outcomes
Mollerup AM, Pfeiffer I, Graumann O, Clinical	skills and if the medical students wanted more virtual reality learning. This pilot
Ultrasound Education for	study was a double-blind, parallel-group, block-randomized, controlled trial.
Medical Students: Virtual	Participants (n = 20) were blinded and randomized to virtual reality or e-learning
Reality Versus e-Learning, a	for basic ultrasound education. Medical students with no previous ultrasound
Randomized Controlled Pilot	education were recruited voluntarily from the University of Southern Denmark.
Trial. Ultrasound Q.	Data were collected during introductory courses on ultrasound from March to
2021;37(3):292-296.	May 2019. Participants were assessed with Objective Structured Assessment on
00000558	(n = 11) scored a significantly higher Objective Structured Assessment on
	Ultrasound Skills score (143 [95% confidence interval {CI}, 135 to 151])
	compared with the e-learning group (n = 9; 126 [95% CI, 113 to 138]; mean
	difference, 17 points [95% Cl, 4 to 30]; $P < 0.01$ ). No significant effect on the
	hand-eye score was found (mean difference, 3 points [95 % CI, -3 to 9]; P = 0.32).
	Ninety-one percent of the virtual reality group wanted more virtual reality
	learning. Immersive virtual reality learning improved medical students'
	was higher in the virtual reality group, although not at a significant level
	Students wanted more virtual reality learning. Further research is needed to
	clarify immersive virtual reality's educational role in the future.





Rudarakanchana N, Van Herzeele I, Bicknell CD, et al. Endovascular repair of ruptured abdominal aortic aneurysm: technical and team training in an immersive virtual reality environment. <i>Cardiovasc</i> <i>Intervent Radiol</i> . 2014;37(4):920-927. doi:10.1007/s00270-013- 0765-1	<b>Purpose:</b> This study evaluates a fully immersive simulated angiosuite for training and assessment of technical endovascular and human factor skills during a crisis scenario. <b>Materials and methods:</b> Virtual reality (VIST-C, Mentice) simulators were integrated into a simulated angiosuite (ORCAMP, Orzone). Teams, lead by experienced (N = 5) or trainee (N = 5) endovascular specialists, performed simulated endovascular ruptured aortic aneurysm repair (rEVAR). Timed performance metrics were recorded as surrogate measures of performance. Participants (N = 22) completed postprocedure questionnaires evaluating face validity, as well as technical and human factor aspects, of the simulation on a Likert scale from 1 (not at all) to 5 (very much). <b>Results:</b> Experienced team leaders were significantly faster than trainees in obtaining proximal control with an intra-aortic occlusion balloon (352 vs. 501 s, p = 0.047) and all completed the procedure within the allotted time, whilst no trainee was able to do so. Total fluoroscopy times were significantly lower in the experienced group (782 vs. 1,086 s, p = 0.016). Realism of the simulated angiosuite was scored highly by experienced team leaders (median 4/5, IQR 4- 5). Participants found the simulation useful for acquiring technical (4/5, IQR 4- 5). Participants found the simulation useful for acquiring technical (4/5, IQR 4- 5) and communication skills (4/5, IQR 4-5) and particularly valuable for enhancing teamwork (5/5, IQR 4-5) and patient safety (5/5, IQR 4-5). <b>Conclusion:</b> This study shows feasibility of creation of a crisis scenario in a fully immersive angiosuite simulation and team performance of a simulated rEVAR. Performance metrics differentiated between experienced specialists and trainees, and the realism of the simulation exercise and environment were rated highly by experienced endovascular specialists. This simulation has potential as a powerful training and assessment tool with opportunities to improve team performance in rEVAR
Sapkaroski D, Baird M, McInerney J, Dimmock MR. The implementation of a haptic feedback virtual reality simulation clinic with dynamic patient interaction and communication for medical imaging students. <i>J</i> <i>Med Radiat Sci</i> . 2018;65(3):218-225. doi:10.1002/jmrs.288	Introduction: An immersive virtual reality (VR) simulation clinic with dynamic patient interaction and communication was developed to facilitate the training of medical radiation science students. The software "CETSOL VR Clinic" was integrated into the Medical Imaging programme at Monash University in 2016 in order to benchmark student experiences against existing simulation techniques (Shaderware <sup>™</sup> ). <b>Methods:</b> An iterative approach to development, based on two cycles of user feedback, was used to develop and refine the simulated clinical environment. This environment uses realistic 3D models, embedded clinical scenarios, dynamic communication, 3D hand gesture interaction, gaze and positional stereoscopic tracking and online user capabilities using the Unity <sup>™</sup> game and physics engines. Students' perceptions of educational enhancement of their positioning skills following the use of the simulation tools were analysed via a 5-point Likert scale questionnaire. <b>Results:</b> Student perception scores indicated a significant difference between simulation modalities in favour of the immersive CETSOL VR Clinic, $\chi^2$ (4, N = 92) = 9.5, P-value <0.001. <b>Conclusion:</b> Student perception scores on improvement of their clinical and technical skills were higher for the hand-positioning tasks performed with the CETSOL VR Clinic <sup>™</sup> than with the comparative benchmark simulation that did not provide dynamic patient interaction and communication.





Sapkaroski D, Baird M, Mundy M, Dimmock MR. Quantification of Student Radiographic Patient Positioning Using an Immersive Virtual Reality Simulation. *Simul Healthc*. 2019;14(4):258-263. doi:10.1097/SIH.00000000 0000380 Introduction: Immersive virtual reality (VR) simulation environments facilitate novel ways for users to visualize anatomy and quantify performance relative to expert users. The ability of software to provide positional feedback before a practitioner progresses with subsequent stages of examinations has broad implications for primary and allied healthcare professionals, particularly with respect to health and safety (eg, exposing to x-rays). The effect of training student-radiographers (radiology technicians), with a VR simulation environment was quantitatively assessed. Methods: Year 1 radiography students (N = 76) were randomly split into 2 cohorts, each of which were trained at performing the same tasks relating to optimal hand positioning for projection x-ray imaging; group 1 was trained using the CETSOL VR Clinic software, whereas group 2 was trained using conventional simulated role-play in a real clinical environment. All participants completed an examination 3 weeks after training. The examination required both posterior-anterior and oblique hand xray positioning tasks to be performed on a real patient model. The analysis of images from the examination enabled quantification of the students' performance. The results were contextualized through a comparison with 4 expert radiographers. Results: Students in group 1 performed on average 36% (P < 0.001) better in relation to digit separation, 11% ( $P \le 0.001$ ) better in terms of palm flatness and 23% (P < 0.05) better in terms of central ray positioning onto the third metacarpal. **Conclusion:** A significant difference in patient positioning was evident between the groups; the VR clinic cohort demonstrated improved patient positioning outcomes. The observed improvement is attributed to the inherent task deconstruction and variety of visualization mechanisms available in immersive VR environments.





Sankaroski D. Mundy M	Introduction: The use of immersive virtual reality simulated learning
Dimmock MR Immersive	environments (VR SI Es) for improving clinical communication can offer
virtual reality simulated	desirable qualities including repetition and determinism in a sets environment
	The size of this starburg to establish whether the mode of delivery VD OLE.
learning environment versus	The aim of this study was to establish whether the mode of delivery, VR SLE
role-play for empathic	versus clinical role-play, could have a measurable effect on clinical empathic
clinical communication	communication skills for MRI scenarios. <b>Methods:</b> A split-cohort study was
training. J Med Radiat Sci.	performed with trainee practitioners ( $n = 70$ ) and qualified practitioners ( $n = 9$ ).
2022;69(1):56-65.	Participants were randomly assigned to four groups: clinician VR (CVR), clinician
doi:10.1002/jmrs.555	role-play (CRP), trainee VR (TVR), and trainee RP (TRP). Clinical communication
	skills were assessed using two methods: firstly, a self-reported measure - the
	SE-12 communication questionnaire and, secondly, a training and assessment
	tool developed by a panel of experts. <b>Results:</b> Participants in the VR trainee
	(TVR) and clinician (CVR) groups reported 11% (P < 0.05) and 7.2% (P < 0.05)
	improvements in communication confidence post training, whereas trainees
	assigned to the role-play (TRP) intervention reported a 4.3% (P < 0.05)
	improvement. Empirical assessment of communication training scores
	assessing a participant's ability to select empathic statements showed the TVR
	group performed 5% better on average than their role-play counterparts (P <
	0.05). <b>Conclusion:</b> The accuracy of participant's selection of appropriate
	empathic responses was shown to differ significantly following the training
	intervention designed to improve interactions with patients that present for an
	MRI scan. The results may demonstrate the capacity for immersion into an
	emotional narrative in a VR environment to increase the user's susceptibility for
	recalling and selecting empathic terminology.
Silverstein JC, Walsh C, Dech	For more than a decade, various approaches have been taken to teach anatomy
F, et al. Immersive virtual	using immersive virtual reality. This is the first complete anatomy course we are
anatomy course using a	aware of which directly substitutes immersive virtual reality via stereo volume
cluster of volume	visualization of clinical radiological datasets for cadaver dissection. The
visualization machines and	students valued highly the new approach and the overall course was very well
passive stereo. Stud Health	received. Students performed well on examinations. The course efficiently
Technol Inform	added human anatomy to the University of Chicago undergraduate biology
2007.125.439-444	
2007,120.400-444.	





Smith SJ, Farra SL, Ulrich DL,	Aim: The aim of the study was to assess two levels of immersive virtual reality
Hodgson E, Nicely S, Mickle	simulation (VRS) to teach the skill of decontamination. <b>Background:</b> Little is
A. Effectiveness of Two	known about the use of VRS in providing disaster education, including retention.
Varying Levels of Virtual	Method: Quasiexperimental design with repeated measures, supplemented by
Reality Simulation. Nurs	qualitative data, using a convenience sample of senior baccalaureate nursing
Educ Perspect.	students (n = 197) from four Midwest campuses was used. Students were
2018;39(6):E10-E15.	randomly assigned to a group (two levels of immersive VRS and a control group)
doi:10.1097/01.NEP.000000	to learn the skill of decontamination. Cognitive learning, performance, and
000000369	performance time were measured pre/post and at six months.
	<b>Results:</b> Outcome measures were significant with immediate postintervention
	improvements and lower retention scores at six months. No significant
	differences were noted between groups. Students were satisfied with the VRS
	but found immersive VRS more interactive. <b>Conclusion:</b> VRS provides another
	alternative for simulated learning experiences: best practice approaches for its
	use still need to be explored.
Sprengel U. Saalfeld P. Stahl	<b>Purpose:</b> The treatment of intracranial arteriovenous malformations (AVM) is
J. et al. Virtual embolization	challenging due to their complex anatomy. For this vessel pathology, arteries are
for treatment support of	directly linked to veins without a capillary bed in between. For endovascular
intracranial AVMs using an	treatment, embolization is carried out, where the arteries that supply the AVM
interactive desktop and VR	are consecutively blocked. A virtual embolization could support the medical
application. Int J Comput	expert in treatment planning. <b>Method:</b> We designed and implemented an
Assist Radiol Surg.	immersive VR application that allows the visualization of the simulated blood
2021;16(12):2119-2127.	flow by displaying millions of particles. Furthermore, the user can interactively
doi:10.1007/s11548-021-	block or unblock arteries that supply the AVM and analyze the altered blood flow
02532-9	based on pre-computed simulations. <b>Results:</b> In a pilot study, the application
	was successfully adapted to three patient-specific cases. We performed a
	qualitative evaluation with two experienced neuroradiologist who regularly
	conduct AVM embolizations. The feature of virtually blocking or unblocking
	feeders was rated highly beneficial, and a desire for the inclusion of quantitative
	information was formulated <b>Conclusion:</b> The presented application allows for
	virtual embolization and interactive blood flow visualization in an immersive
	virtual reality environment. It could serve as useful addition for treatment
	planning and education in clinical practice, supporting the understanding of
	AVM topology as well as understanding the influence of the AVM's feeding
	arteries





Staubli SM, Maloca P,	<b>Objective:</b> The novel picture archiving and communication system (PACS),
Kuemmerli C, et al. Magnetic	compatible with virtual reality (VR) software, displays cross-sectional images in
resonance	VR. VR magnetic resonance cholangiopancreatography (MRCP) was tested to
cholangiopancreatography	improve the anatomical understanding and intraoperative performance of
enhanced by virtual reality	minimally invasive cholecystectomy (CHE) in surgical trainees. <b>Design:</b> We used
as a novel tool to improve	an immersive VR environment to display volumetric MRCP data (Specto VR™).
the understanding of biliary	First, we evaluated the tolerability and comprehensibility of anatomy with a
anatomy and the teaching of	validated simulator sickness questionnaire (SSQ) and examined anatomical
surgical trainees. Front Surg.	landmarks. Second, we compared conventional MRCP and VR MRCP by
2022;9:916443. Published	matching three-dimensional (3D) printed models and identifying and measuring
2022 Aug 12.	common bile duct stones (CBDS) using VR MRCP. Third, surgical trainees
doi:10.3389/fsurg.2022.9164	prepared for CHE with either conventional MRCP or VR MRCP, and we measured
43	perioperative parameters and surgical performance (validated GOALS score).
	Setting: The study was conducted out at Clarunis, University Center for
	Gastrointestinal and Liver Disease, Basel, Switzerland. Participants: For the
	first and second study step, doctors from all specialties and years of experience
	could participate. In the third study step, exclusively surgical trainees were
	included. Of 74 participating clinicians, 34, 27, and 13 contributed data to the
	first, second, and third study phases, respectively. <b>Results:</b> All participants
	determined the relevant biliary structures with VR MRCP. The median SSQ score
	was 0.75 (IQR: 0, 3.5), indicating good tolerability. Participants selected the
	corresponding 3D printed model faster and more reliably when previously
	studying VR MRCP compared to conventional MRCP: We obtained a median of
	90 s (IQR: 55, 150) and 72.7% correct answers with VR MRCP versus 150 s (IQR:
	100, 208) and 49.6% correct answers with conventional MRCP, respectively ( $p <$
	0.001). CBDS was correctly identified in 90.5% of VR MRCP cases. The median
	GOALS score was higher after preparation with VR MRCP than with conventional
	MRCP for CHE: 16 (IQR: 13, 22) and 11 (IQR: 11, 18), respectively ( $p = 0.27$ ).
	Conclusions: VR MRCP allows for a faster, more accurate understanding of
	displayed anatomy than conventional MRCP and potentially leads to improved
	surgical performance in CHE in surgical trainees.





Stepan K, Zeiger J, Hanchuk S, et al. Immersive virtual reality as a teaching tool for neuroanatomy. *Int Forum Allergy Rhinol*. 2017;7(10):1006-1013. doi:10.1002/alr.21986 Background: Three-dimensional (3D) computer modeling and interactive virtual reality (VR) simulation are validated teaching techniques used throughout medical disciplines. Little objective data exists supporting its use in teaching clinical anatomy. Learner motivation is thought to limit the rate of utilization of such novel technologies. The purpose of this study is to evaluate the effectiveness, satisfaction, and motivation associated with immersive VR simulation in teaching medical students neuroanatomy. Methods: Images of normal cerebral anatomy were reconstructed from human Digital Imaging and Communications in Medicine (DICOM) computed tomography (CT) imaging and magnetic resonance imaging (MRI) into 3D VR formats compatible with the Oculus Rift VR System, a head-mounted display with tracking capabilities allowing for an immersive VR experience. The ventricular system and cerebral vasculature were highlighted and labeled to create a focused interactive model. We conducted a randomized controlled study with 66 medical students (33 in both the control and experimental groups). Pertinent neuroanatomical structures were studied using either online textbooks or the VR interactive model, respectively. We then evaluated the students' anatomy knowledge, educational experience, and motivation (using the Instructional Materials Motivation Survey [IMMS], a previously validated assessment). Results: There was no significant difference in anatomy knowledge between the 2 groups on preintervention, postintervention, or retention quizzes. The VR group found the learning experience to be significantly more engaging, enjoyable, and useful (all p < 0.01) and scored significantly higher on the motivation assessment (p < 0.01). **Conclusion:** Immersive VR educational tools awarded a more positive learner experience and enhanced student motivation. However, the technology was equally as effective as the traditional text books in teaching neuroanatomy.





Taylor B, McLean G, Sim J. Immersive virtual reality for pre-registration computed tomography education of radiographers: A narrative review. *J Med Radiat Sci*. 2023;70(2):171-182. doi:10.1002/jmrs.657 To be registered as a medical radiation practitioner, The Medical Radiation Practice Board of Australia (MRPBA) requires radiographers to be capable of performing computed tomography (CT) imaging examinations safely and effectively. Universities meet this requirement by offering practical CT training to radiography students on-campus and during clinical placements. However, institutions face challenges when facilitating on-campus CT practicum. Virtual reality (VR) has been suggested as a possible solution for radiography students to gain CT scanning experience. This narrative review explored relevant literature to investigate the potential for immersive VR to be incorporated into CT practicum. Benefits and limitations of this education technology are examined with resultant recommendations made for integration into the CT curriculum. Results found that VR enhances CT learning for students, increases confidence and raises motivation for the simulated CT task. CT simulation provides a viable alternative in the context of pandemic-imposed restrictions and reduced CT placement duration. However, it remains debatable as to whether immersive VR truly enhances student learning compared with other VR modalities, such as computer-based CT simulation. In addition, a lack of staff training, availability of resources and technical problems were flagged as limitations. We concluded that before immersive VR is integrated into CT education, significant optimisation of the simulation is needed. This includes ensuring VR scenarios are based on learning paradigms and feedback is integrated as part of simulation learning. Engaging clinical partners during the CT VR rollout is imperative to ensure successful transition of students from university learning to clinical placement.





Tsai HP, Lin CW, Lin YJ, Yeh CS, Shan YS. Novel Software for High-level Virological Testing: Self-Designed Immersive Virtual Reality Training Approach. *J Med Internet Res*. 2023;25:e44538. Published 2023 Jun 21. doi:10.2196/44538 Background: To ensure the timely diagnosis of emerging infectious diseases, high-tech molecular biotechnology is often used to detect pathogens and has gradually become the gold standard for virological testing. However, beginners and students are often unable to practice their skills due to the higher costs associated with high-level virological testing, the increasing complexity of the equipment, and the limited number of specimens from patients. Therefore, a new training program is necessary to increase training and reduce the risk of test failure. **Objective:** The aim of the study is to (1) develop and implement a virtual reality (VR) software for simulated and interactive high-level virological testing that can be applied in clinical practice and skills building or training settings and (2) evaluate the VR simulation's effectiveness on reaction, learning, and behavior of the students (trainees). Methods: Viral nucleic acid tests on a BD MAX instrument were selected for our VR project because it is a high-tech automatic detection system. There was cooperation between teachers of medical technology and biomedical engineering. Medical technology teachers were responsible for designing the lesson plan, and the biomedical engineering personnel developed the VR software. We designed a novel VR teaching software to simulate cognitive learning via various procedure scenarios and interactive models. The VR software contains 2D VR "cognitive test and learning" lessons and 3D VR "practical skills training" lessons. We evaluated students' learning effectiveness pre- and posttraining and then recorded their behavior patterns when answering questions, performing repeated exercises, and engaging in clinical practice. **Results:** The results showed that the use of the VR software met participants' needs and enhanced their interest in learning. The average posttraining scores of participants exposed to 2D and 3D VR training were significantly higher than participants who were exposed solely to traditional demonstration teaching (P<.001). Behavioral assessments of students pre- and posttraining showed that students exposed to VR-based training to acquire relevant knowledge of advanced virological testing exhibited significantly improved knowledge of specific items posttraining (P<.01). A higher participant score led to fewer attempts when responding to each item in a matching task. Thus, VR can enhance students' understanding of difficult topics. **Conclusions:** The VR program designed for this study can reduce the costs associated with virological testing training, thus, increasing their accessibility for students and beginners. It can also reduce the risk of viral infections particularly during disease outbreaks (eg, the COVID-19 pandemic) and also enhance students' learning motivation to strengthen their practical skills.





Wan T, Liu K, Li B, Wang X.	Purpose: To evaluate the efficacy of an iVR surgical training system for
Effectiveness of immersive	orthognathic surgery training in medical students. Methods: This study
virtual reality in orthognathic	comprised 20 fifth year medical students who were randomly assigned to the VR
surgical education: A	or traditional group for orthognathic surgical education. All participants were
randomized controlled trial. J	initially provided a lecture on orthognathic surgery. The VR group then received
Dent Educ. 2024;88(1):109-	10 educational sessions using the self-developed iVR training system, whereas
117. doi:10.1002/jdd.13380	the traditional group received 10 sessions using technical manuals and
	annotated operation videos. These sessions were 40-min long in both the
	groups. Before the evaluation, the traditional group completed one session
	using the training and assessment modes to become familiar with the iVR
	training system. The score in the assessment mode, time to complete the
	procedure, number of instrument selection errors, number of prompts given by
	the system, number of positional and angular errors, and number of timeouts
	during each step were recorded to evaluate the learning effect. <b>Results:</b> The VR
	group achieved higher scores than the traditional group (94.67 vs. 87.65).
	Compared with the control group, the VR group completed the procedure more
	quickly, with fewer instrument selection and angular errors. No difference in the
	number of prompts given by the system was observed between the two groups.
	<b>Conclusions:</b> The iVR surgical training system showed a better learning effect
	than the traditional learning method for orthognathic surgery. The iVR surgical
	training system may have utility as a supplement and potential substitute for the
	traditional surgical training method.
Wan T, Liu K, Li B, Wang X.	Virtual reality (VR) has been proven an important supplement for surgical
Validity of an immersive	education in medical students. However, studies on immersive VR (iVR)
virtual reality training system	simulation in orthognathic surgical education are limited. This study aimed to
for orthognathic surgical	assess the validity of the iVR surgical training system for orthognathic surgery.
education. Front Pediatr.	Participants completed questionnaires at the end of the course to assess the
2023;11:1133456. Published	validity of the training system. The questionnaires included questions on the
2023 Mar 23.	experience of using the iVR system and surgical authenticity. Seven experienced
doi:10.3389/fped.2023.1133	surgeons and seven inexperienced students were recruited in this study to use
456	our self-developed iVR training system for orthognathic surgery. The participants
	showed strong agreement to the fidelity of our training system (4.35 out of 5),
	including the virtual environment, instruments, anatomy structures, and surgical
	procedures. The participants also strongly agreed that the iVR technique was
	essential in imparting surgical education. However, most of the participants
	experienced some degree of dizziness or fatigue after 1 h of using the system.
	The iVR training system is a new method for imparting education about
	orthognathic surgery. The iVR training system can act as a supplement and
	potential substitute of the traditional surgical training method.





Xin B, Huang X, Wan W, et al. The efficacy of immersive virtual reality surgical simulator training for pedicle screw placement: a randomized double-blind controlled trial. *Int Orthop*. 2020;44(5):927-934. doi:10.1007/s00264-020-04488-y **Objective:** To verify whether the pedicle screw placement (PSP) skills of young surgeons receiving immersive virtual reality surgical simulator (IVRSS) training could be improved effectively and whether the IVRSS-PSP training mode could produce a real clinical value in clinical surgery. **Methods:** Twenty-four young surgeons were equally randomized to a VR group and a NON-VR group. Participants in VR group received IVRSS-PSP training, and those in NON-VR group used the conventional model of observing a spinal model first and then watching a teaching video of spinal surgery for 40 minutes x five. The nailing outcome of the participants before and after training was evaluated by statistical analysis in both groups. Results: Post-training data analysis showed that the success rate and accuracy rate of screw placement in VR group and NON-VR group were 82.9% and 69.6% vs. 74.2% and 55.4%, respectively, showing statistically significant differences between the two groups by chi-square test (P < 0.05). Conclusion: The present study demonstrated that IVRSS-PSP was helpful to improve the success rate of PSP for young surgeons, and may provide valuable reference for PSP training of young surgeons. In addition, our study also showed a promising potential of the VR technology in surgical simulation training.





Yang SY, Oh YH. The effects of neonatal resuscitation gamification program using immersive virtual reality: A quasi-experimental study. *Nurse Educ Today*. 2022;117:105464. doi:10.1016/j.nedt.2022.105 464 **Background:** Clinical practice in neonatal intensive care units for nursing college students has been restricted due to the COVID-19 pandemic outbreak; thus, the gamification program has emerged as an alternative learning method. Consequently, there is a need to examine the effectiveness of such alternative learning methods to enhance the response to high-risk newborn emergencies. **Objectives:** To examine the effects (neonatal resuscitation nursing knowledge, problem-solving and clinical reasoning ability, self-confidence in practical performance, degree of anxiety, and learning motivation) of a neonatal resuscitation gamification program using immersive virtual reality based on Keller's ARCS model. **Design:** A non-randomized controlled simulation study with a pretest-posttest design. Setting: Lab and lecture rooms of two universities in South Korea, from June to November 2021. Participants: Prelicensure nursing students. Methods: The virtual reality group (n = 29) underwent a neonatal resuscitation gamification program using virtual reality based on Keller's ARCS model. The simulation group (n = 28) received high-fidelity neonatal resuscitation simulations and online neonatal resuscitation program lectures. The control group (n = 26) only received online neonatal resuscitation program lectures. Changes in scores among these groups were compared using analysis of variance and analysis of covariance with SPSS for Windows version 27.0. Results: Post intervention, neonatal resuscitation knowledge [F(2) = 3.83, p = .004] and learning motivation [F(2) = 1.79, p = .025] were significantly higher in the virtual reality and simulation groups than in the control group, whereas problem-solving ability [F(2) = 2.07, p = .038] and self-confidence [F(2) = 6.53, p < .001] were significantly higher in the virtual reality group than in the simulation and control groups. Anxiety [F(2) = 16.14, p < .001 was significantly lower in the simulation group than in the virtual reality and control groups. Conclusions: The neonatal resuscitation gamification program using immersive virtual reality was found to be effective in increasing neonatal resuscitation knowledge, problem-solving ability, selfconfidence, and learning motivation of the nursing students who participated in the trial application process.





Yi WS, Rouhi AD, Duffy CC, Ghanem YK, Williams NN, Dumon KR. A Systematic Review of Immersive Virtual Reality for Nontechnical Skills Training in Surgery. J Surg Educ. 2024;81(1):25-36. doi:10.1016/j.jsurg.2023.11. 012 Objective: Immersive virtual reality (IVR) can be utilized to provide low cost and easily accessible simulation on all aspects of surgical education. In addition to technical skills training in surgery, IVR simulation has been utilized for nontechnical skills training in domains such as clinical decision-making and preoperative planning. This systematic review examines the current literature on the effectiveness of IVR for nontechnical skill acquisition in surgical education. Design: A literature search was performed using MEDLINE, EMBASE, and Web of Science for primary studies published between January 1, 1995 and February 9, 2022. Four reviewers screened titles, abstracts, full texts, extracted data, and analyzed included studies to answer 5 key questions: How is IVR being utilized in nontechnical skills surgical education? What is the methodological quality of studies? What technologies are being utilized? What metrics are reported? What are the findings of these studies? Results: The literature search yielded 2340 citations, with 12 articles included for qualitative synthesis. Of included articles, 33% focused on clinical decision-making and 67% on anatomy/pre-operative planning. Motion sickness was a recorded metric in 25% of studies, with an aggregate incidence of 13% (11/87). An application score was reported in 33% and time to completion in 16.7%. A commercially developed application was utilized in 25%, while 75% employed a noncommercial application. The Oculus Rift was used in 41.7% of studies, HTC Vive in 25%, Samsung Gear in 16.7% of studies, Google Daydream in 8%, and 1 study did not report. The mean Medical Education Research Quality Instrument (MERSQI) score was 10.3 ± 2.3 (out of 18). In all studies researching clinical decision-making, participants preferred IVR to conventional teaching methods and in a nonrandomized control study it was found to be more effective. Averaged across all studies, mean scores were 4.33 for enjoyment, 4.16 for utility, 4.11 for usability, and 3.73 for immersion on a 5-point Likert scale. Conclusions: The IVR nontechnical skills applications for surgical education are designed for clinical decision-making or anatomy/preoperative planning. These applications are primarily noncommercially produced and rely upon a diverse array of HMDs for content delivery, suggesting that development is primarily coming from within academia and still without clarity on optimal utilization of the technology. Excitingly, users find these applications to be immersive, enjoyable, usable, and of utility in learning. Although a few studies suggest that IVR is additive or superior to conventional teaching or imaging methods, the data is mixed and derived from studies with weak design. Motion sickness with IVR remains a complication of IVR use needing further study to determine the cause and means of mitigation.





Yu M, Yang M, Ku B, Mann JS. Effects of Virtual Reality Simulation Program Regarding High-risk Neonatal Infection Control on Nursing Students. <i>Asian</i> <i>Nurs Res (Korean Soc Nurs</i> <i>Sci)</i> . 2021;15(3):189-196. doi:10.1016/j.anr.2021.03.00 2	<b>Purpose:</b> Virtual reality simulation can give nursing students a safe clinical experience involving high-risk infants where access to neonatal intensive care units is limited. This study aimed to examine the effects of a virtual reality simulation program on Korean nursing students' knowledge, performance self-efficacy and learner satisfaction. <b>Methods:</b> A nonequivalent control group design was applied. Senior nursing students were divided into an experimental group (n = 25) experiencing virtual reality simulation and routine neonatal intensive care unit practice and a control group (n = 25) having routine neonatal intensive care unit practice. The program consisted of three scenarios: basic care, feeding management and skin care and environmental management for prevention of neonatal infection. The total execution time for the three scenarios was 40 minutes. The simulation created immersive virtual reality experiences using a head-mounted display with hand-tracking technology. Data were collected from December 9, 2019, to January 17, 2020, and were analyzed using descriptive statistics and the t-test, paired t-tests, Mann-Whitney test and Wilcoxon signed-ranks test. <b>Results:</b> Compared to the control group, the experimental group showed significantly greater improvements in high-risk neonatal infection control performance self-efficacy (t = -2.16, p = .018) and learner satisfaction (t = -5.59, p < .001). <b>Conclusion:</b> The virtual reality simulation program can expand the nursing students' practice experience in safe virtual spaces and enhance their performance self-efficacy and learning satisfaction.
Zackoff MW, Lin L, Israel K, et al. The Future of Onboarding: Implementation of Immersive Virtual Reality for Nursing Clinical Assessment Training. <i>J Nurses Prof Dev</i> . 2020;36(4):235-240. doi:10.1097/NND.0000000 00000629	An immersive virtual reality curriculum was piloted with new nurse graduates that focused on improving clinical reasoning and situational awareness for pediatric respiratory distress and impending respiratory failure. Learnings from this pilot could inform strategies for development of standardized, efficient, and safe onboarding curricula to increase the likelihood of successful transition to practice.
Zackoff MW, Real FJ, Cruse B, Davis D, Klein M. Medical Student Perspectives on the Use of Immersive Virtual Reality for Clinical Assessment Training. <i>Acad</i> <i>Pediatr</i> . 2019;19(7):849-851. doi:10.1016/j.acap.2019.06. 008	Medical students reported an immersive virtual reality (VR) curriculum on respiratory distress as clinically accurate and likely to impact future patient assessment. VR training was rated as equally or more effective than high-fidelity mannequins and standardized patients but less effective than bedside teaching.





Zackoff MW, Real FJ, Sahay RD, et al. Impact of an Immersive Virtual Reality Curriculum on Medical Students' Clinical Assessment of Infants With Respiratory Distress. *Pediatr Crit Care Med*. 2020;21(5):477-485. doi:10.1097/PCC.00000000 0002249 **Objective:** To determine whether exposure to an immersive virtual reality curriculum on pediatric respiratory distress improves medical students' recognition of impending respiratory failure. **Design:** Randomized, controlled, prospective study conducted from July 2017 to June 2018. Evaluators blinded to student groupings. Setting: Academic, free-standing children's hospital. Participants: All third-year medical students (n = 168) were eligible. The standard curriculum was delivered to all students during their pediatric rotation with optional inclusion of research data per Institutional Review Board review. A randomized selection of students was exposed to the virtual reality curriculum. Intervention: All students received standard training on respiratory distress through didactics and high-fidelity mannequin simulation. Intervention students underwent an additional 30-minute immersive virtual reality curriculum, experienced through an OculusRift headset, with three simulations of an infant with 1) no distress, 2) respiratory distress, and 3) impending respiratory failure. Measurements and main results: The impact of the virtual reality curriculum on recognition/interpretation of key examination findings, assignment of an appropriate respiratory status assessment, and recognition of the need for escalation of care for patients in impending respiratory failure was assessed via a free response clinical assessment of video vignettes at the end of the pediatric rotation. Responses were scored on standardized rubrics by physician experts. All eligible students participated (78 intervention and 90 control). Significant differences between intervention and control were demonstrated for consideration/interpretation of mental status (p < 0.01), assignment of the appropriate respiratory status assessment (p < 0.01), and recognition of a need for escalation of care (p = 0.0004). **Conclusions:** Exposure to an immersive virtual reality curriculum led to improvement in objective competence at the assessment of respiratory distress and recognition of the need for escalation of care for patients with signs of impending respiratory failure. This study represents a novel application of immersive virtual reality and suggests that it may be effective for clinical assessment training.





Zackoff MW, Young D, Sahay RD, et al. Establishing Objective Measures of Clinical Competence in Undergraduate Medical Education Through Immersive Virtual Reality. *Acad Pediatr*. 2021;21(3):575-579. doi:10.1016/j.acap.2020.10. 010

Objective: The Association of American Medical Colleges defines recognition of the need for urgent or emergent escalation of care as a key Entrustable Professional Activity (EPA) for entering residency (EPA#10). This study pilots the use of an immersive virtual reality (VR) platform for defining objective observable behaviors as standards for evaluation of medical student recognition of impending respiratory failure. **Methods:** A cross-sectional observational study was conducted from July 2018 to December 2019, evaluating student performance during a VR scenario of an infant in impending respiratory failure using the OculusRift VR platform. Video recordings were rated by 2 pair of physician reviewers blinded to student identity. One pair provided a consensus global assessment of performance (not competent, borderline, or competent) while the other used a checklist of observable behaviors to rate performance. Binary discriminant analysis was used to identify the observable behaviors that predicted the global assessment rating. **Results:** Twenty-six fourth year medical students participated. Student performance of 8 observable behaviors was found to be most predictive of a rating of competent, with a 91% probability. Correctly stating that the patient required an escalation of care had the largest contribution toward predicting a rating of competent, followed by commenting on the patient's increased heart rate, low oxygen saturation, increased respiratory rate, and stating that the patient was in respiratory distress. Conclusions: This study demonstrates that VR can be used to establish objective and observable performance standards for assessment of EPA attainment - a key step in moving towards competency based medical education.





## Table 7: Medical Training

Citation	Abstract
Ail G, Freer F, Chan CS, et al.	Immersive virtual reality (i-VR) is a powerful tool that can be used to explore
A comparison of virtual	virtual models in three dimensions. It could therefore be a valuable tool to
reality anatomy models to	supplement anatomical teaching by providing opportunities to explore spatial
prosections in station-based	anatomical relationships in a virtual environment. However, there is a lack of
anatomy teaching. Anat Sci	consensus in the literature as to its effectiveness as a teaching modality when
Educ. Published online April	compared to the use of cadaveric material. The aim of our study was to compare
7, 2024.	the effectiveness of i-VR in facilitating understanding of different anatomical
doi:10.1002/ase.2419	regions when compared with cadaveric prosections for a cohort of first- and
	second-year undergraduate medical students. Students (n = 92) enrolled in the
	MBBS program at Queen Mary University of London undertook an assessment,
	answering questions using either Oculus i-VR headsets, the Human Anatomy
	VR™ application, or prosection materials. Utilizing ANOVA with Sidak's multiple
	comparison test, we found no significant difference between prosections and i-
	VR scores in the abdomen (p = 0.6745), upper limb (p = 0.8557), or lower limb
	groups (p = 0.9973), suggesting that i-VR may be a viable alternative to
	prosections in these regions. However, students scored significantly higher
	when using prosections when compared to i-VR for the thoracic region (p <
	0.0001). This may be due to a greater need for visuospatial understanding of 3D
	relationships when viewing anatomical cavities, which is challenged by a virtual
	environment. Our study supports the use of i-VR in anatomical teaching but
	highlights that there is significant variation in the efficacy of this tool for the
	study of different anatomical regions.





Alaraj A, Luciano CJ, Bailey DP, et al. Virtual reality cerebral aneurysm clipping simulation with real-time haptic feedback. *Neurosurgery*. 2015;11 Suppl 2(0 2):52-58. doi:10.1227/NEU.00000000 0000583 Background: With the decrease in the number of cerebral aneurysms treated surgically and the increase of complexity of those treated surgically, there is a need for simulation-based tools to teach future neurosurgeons the operative techniques of aneurysm clipping. **Objective:** To develop and evaluate the usefulness of a new haptic-based virtual reality simulator in the training of neurosurgical residents. Methods: A real-time sensory haptic feedback virtual reality aneurysm clipping simulator was developed using the ImmersiveTouch platform. A prototype middle cerebral artery aneurysm simulation was created from a computed tomographic angiogram. Aneurysm and vessel volume deformation and haptic feedback are provided in a 3-dimensional immersive virtual reality environment. Intraoperative aneurysm rupture was also simulated. Seventeen neurosurgery residents from 3 residency programs tested the simulator and provided feedback on its usefulness and resemblance to real aneurysm clipping surgery. **Results:** Residents thought that the simulation would be useful in preparing for real-life surgery. About two-thirds of the residents thought that the 3-dimensional immersive anatomic details provided a close resemblance to real operative anatomy and accurate guidance for deciding surgical approaches. They thought the simulation was useful for preoperative surgical rehearsal and neurosurgical training. A third of the residents thought that the technology in its current form provided realistic haptic feedback for aneurysm surgery. Conclusion: Neurosurgical residents thought that the novel immersive VR simulator is helpful in their training, especially because they do not get a chance to perform aneurysm clippings until late in their residency programs.





Amini H, Gregory ME, Abrams MA, et al. Feasibility and usability study of a pilot immersive virtual realitybased empathy training for dental providers. *J Dent Educ*. 2021;85(6):856-865. doi:10.1002/jdd.12566 Purpose: Social determinants of health (SDOH) significantly impact individuals' engagement with the healthcare system. To address SDOH-related oral health disparities, providers must be equipped with knowledge, skills, and attitudes (KSAs) to understand how SDOH affect patients and how to mitigate these effects. Traditional dental school curricula provide limited training on recognizing SDOH or developing empathy for those with SDOH-related access barriers. This study describes the design and evaluation of such a virtual reality (VR)-based simulation in dental training. We hypothesize the simulation will increase post-training KSAs. Methods: We developed "MPATHI" (Making Professionals Able THrough Immersion), a scripted VR simulation where participants take the role of an English-speaking caregiver with limited socioeconomic resources seeking dental care for a child in a Spanish-speaking country. The simulation is a combination of 360° video recording and virtual scenes delivered via VR headsets. A pilot was conducted with 29 dental residents/faculty, utilizing a pre-post design to evaluate effectiveness in improving immediate and retention of KSAs toward care delivery for families facing barriers. Results: MPATHI led to increased mean scores for cognitive (pre = 3.48 ± 0.80, post = 4.56 ± 0.51, p < 0.001), affective (pre = 4.20 ± 0.4, post =  $4.47 \pm 0.44$ , p < 0.001), and skill-based learning (pre =  $4.00 \pm 0.47$ , post =  $4.52 \pm$ 0.37, p < 0.001) immediately post-training. There was not a significant difference between skills measured immediately post-training and in the 1-month posttraining survey (p = 0.41). Participants reported high satisfaction with the content and methods used in this training. Conclusions: This pilot study supports using VR SDOH training in dental education. VR technology provides new opportunities for innovative content design.





Andersen AG, Rahmoui L, Dalsgaard TS, et al. Preparing for Reality: A Randomized Trial on Immersive Virtual Reality for Bronchoscopy Training. *Respiration*. 2023;102(4):316-323. doi:10.1159/000528319 **Background:** Bronchoscopy is an essential procedure in the diagnosis and treatment of pulmonary diseases. However, the literature suggests that distractions affect the quality of bronchoscopy and affect inexperienced doctors more than experienced. **Objectives:** The objective of the study was as follows: does simulation-based bronchoscopy training with immersive virtual reality (iVR) improve the doctors' ability to handle distractions and thereby increase the quality, measured in procedure time, structured progression score, diagnostic completeness (%), and hand motor movements of a diagnostic bronchoscopy in a simulated scenario. Exploratory outcomes were heart rate variability and a cognitive load questionnaire (Surg-TLX). Methods: Participants were randomized. The intervention group practiced in an iVR environment with a head-mounted display (HMD) while using the bronchoscopy simulator, while the control group trained without the HMD. Both groups were tested in the iVR environment using a scenario with distractions. Results: 34 participants completed the trial. The intervention group scored significantly higher in diagnostic completeness (100 i.q.r. 100-100 vs. 94 i.q.r. 89-100, p value = 0.03) and structured progress (16 i.q.r. 15-18 vs. 12 i.q.r. 11-15, p value 0.03) but not in procedure time (367 s standard deviation [SD] 149 vs. 445 s SD 219, p value = 0.06) or hand motor movements (-1.02 i.q.r. -1.03-[-1.02] versus -0.98 i.q.r. -1.02-[-0.98], p value = 0.27). The control group had a tendency toward a lower heart rate variability (5.76 i.q.r. 3.77-9.06 vs. 4.12 i.q.r. 2.68-6.27, p = 0.25). There was no significant difference in total Surg-TLX points between the two groups. **Conclusion:** iVR simulation training increases the quality of diagnostic bronchoscopy in a simulated scenario with distractions compared with conventional simulation-based training.





Andersen NL, Jensen RO, Konge L, et al. Immersive Virtual Reality in Basic Pointof-Care Ultrasound Training: A Randomized Controlled Trial. *Ultrasound Med Biol*. 2023;49(1):178-185. doi:10.1016/j.ultrasmedbio. 2022.08.012 This study was aimed at comparing the learning efficacy of a traditional instructor-led lesson with that of a completely virtual, self-directed lesson in immersive virtual reality (IVR) in teaching basic point-of-care ultrasound (PoCUS) skills. We conducted a blinded, non-inferiority, parallel-group, randomized controlled trial in which final-year medical students were randomized to an instructor-led (n = 53) or IVR (n = 51) lesson. Participants' learning efficacy was evaluated by blinded assessors, who rated each participant's performance using the Objective Structured Assessment of Ultrasound Skills (OSAUS) assessment tool. The mean total scores for participants were 11.0 points (95% confidence interval: 9.8-12.2) for the instructor-led lesson and 10.3 points (95% confidence interval: 9.0-11.5) for the IVR lesson. No significant differences were observed between the groups with respect to total score (p = 0.36) or subgroup objectives of the OSAUS score (p = 0.34 for familiarity, p = 0.45 for image optimization, p = 0.96 for systematic approach and p = 0.07 for interpretation). Maintenance costs for both courses were estimated at 400 euros each. Startup costs for the instructor-led course were estimated 16 times higher than those for the IVR course. The learning efficacy of an instructor-led lesson on basic US did not differ significantly from that of a self-directed lesson in IVR, as assessed using the OSAUS. The results suggest that IVR could be an equivalent alternative to instructor-led lessons in future basic US courses, but further research is warranted to clarify the role of IVR in PoCUS courses.





Andorson NIL Jonson BO	Introduction: Immersive virtual reality (IVP) based training is gaining ground as
Pooth S. Louroon CP	an advantianal tool in healthears. When combined with well established
Fostil S, Lauisell CB,	all educational tool in field file an estantially increase compateney and eutenemy
Jørgensen R, Graumann O.	educational methods, IVR can potentially increase competency and autonomy
leaching ultrasound-guided	In ultrasound (US)-guided peripheral venous cannulation. The aim of this study
peripheral venous catheter	was to examine the impact of adding IVR training to a course in US-guided
placement through	peripheral venous cannulation. <b>Methods:</b> Medical students (n = 19) from the
immersive virtual reality: An	University of Southern Denmark with no former standardized US education were
explorative pilot	recruited to voluntarily participate in a pilot study, designed as a randomized
study. Medicine (Baltimore).	controlled trial. The primary outcome was the proportion of successful
2021;100(27):e26394.	peripheral venous cannulations on a phantom. Secondary outcomes included
doi:10.1097/MD.00000000	the proportion of surface punctures on the phantom and procedure time.
0026394	Participants received e-learning on the basic US before randomization to either
	IVR (n = 10) or no further training (n = 9). The additional IVR training comprised 10
	virtual scenarios for US-guided peripheral venous catheter (PVC) placement.
	Students were subsequently evaluated in peripheral venous cannulation by a
	blinded assessor. <b>Results:</b> The proportion of successful peripheral venous
	cannulations was significantly higher in the IVR group ( $P \le .001$ ). The proportions
	of successful cannulations were significantly higher in the IVR group compared
	to the control group for the 1st and 2nd PV/C ( $P = 0.11$ , $P = 0.23$ ), but not for the
	3rd PV/C (P = 0.87) Similar results were found for the proportion of surface
	shuf ve ( $i = .007$ ). Similar results were round for the proportion of surface
	differences in procedure times were found between the groups
	<b>Conclusion:</b> This nilot study showed that adding an IVR-based training
	simulation to an existing e-learning curriculum significantly increased the
	learning efficacy of US-guided PVC placement for medical students
Baneriee S. Pham T	While radiological imaging is presented as two-dimensional images either on
Eastaway & Auffermann W/F	radiography or cross-sectional imaging it is important for interpreters to
Ouigley EP 3rd The Use of	understand three-dimensional anatomy and pathology. We hypothesized that
Virtual Reality in Teaching	virtual reality (VR) may serve as an engaging and effective way for trainees to
Three Dimensional Anatomy	loarn to ovtrapolato from two dimonsional images to an understanding of these
and Pathology on CT / Digit	three dimensional structures. We created a Coogle Cordboard Virtual Papility
Imaging 2022;26(2):1270	application that deniate intracranic lycaculature and anounyma. We then
1004 dei:10 1007/010070	application that depicts intracramat vasculature and aneurysms. We then
1284. doi:10.1007/\$10278-	recruited 12 medical students to voluntarily participate in our study. The
023-00784-2	performance of the students in identifying intracranial aneurysms before and
	after the virtual reality training was evaluated and compared to a control group.
	while the experimental group's performance in correctly identifying aneurysms
	after virtual reality educational intervention was better than the control's
	(experimental increased by 5.3%, control decreased by 2.1%), the difference
	was not statistically significant (p-value of 0.06). Significantly, survey data from
	the medical students was very positive with students noting they preferred the
	immersive virtual reality training over conventional education and believed that
	VR would be a helpful educational tool for them in the future. We believe virtual
	reality can serve as an important tool to help radiology trainees better
	understand three-dimensional anatomy and pathology.





Birrenbach T, Wespi R, Hautz	<b>Background:</b> Resuscitative endovascular balloon occlusion of the aorta
WE, et al. Development and	(REBOA) is a potentially life-saving procedure for bleeding trauma patients.
usability testing of a fully	Being a rare and complex procedure performed in extreme situations, repetitive
immersive VR simulation for	training of REBOA teams is critical. Evidence-based guidelines on how to train
REBOA training. Int J Emerg	REBOA are missing, although simulation-based training has been shown to be
Med. 2023;16(1):67.	effective but can be costly and complex. We aimed to determine the feasibility
Published 2023 Oct 6.	and acceptance of REBOA training using a fully immersive virtual reality (VR)
doi:10.1186/s12245-023-	REBOA simulation, as well as assess the confidence in conducting the REBOA
00545-6	procedure before and after the training. <b>Methods:</b> Prospective feasibility pilot
	study of prehospital emergency physicians and paramedics in Bern, Switzerland,
	from November 2020 until March 2021. Baseline characteristics of trainees,
	prior training and experience in REBOA and with VR, variables of media use
	(usability: system usability scale, immersion/presence: Slater-Usoh-Steed,
	workload: NASA-TLX, user satisfaction: USEQ) as well as confidence prior and
	after VR training were accessed. <b>Results:</b> REBOA training in VR was found to be
	feasible without relevant VR-specific side-effects. Usability (SUS median 77.5,
	IQR 71.3-85) and sense of presence and immersion (Slater-Usoh-Steed median
	4.8, IQR 3.8-5.5) were good, the workload without under-nor overstraining
	(NASA-TLX median 39, IQR 32.8-50.2) and user satisfaction high (USEQ median
	26, IQR 23-29). Confidence of trainees in conducting REBOA increased
	significantly after training (p < 0.001). <b>Conclusions:</b> Procedural training of the
	REBOA procedure in immersive virtual reality is possible with a good acceptance
	and high usability. REBOA VR training can be an important part of a training
	curriculum, with the virtual reality-specific advantages of a time- and instructor-
	independent learning.
Boedecker C, Huettl F,	<b>Purpose:</b> Three-dimensional (3D) surgical planning is widely accepted in liver
Saalfeld P, et al. Using virtual	surgery. Currently, the 3D reconstructions are usually presented as 3D PDF data
3D-models in surgical	on regular monitors. 3D-printed liver models are sometimes used for education
planning: workflow of an	and planning. <b>Methods:</b> We developed an immersive virtual reality (VR)
immersive virtual reality	application that enables the presentation of preoperative 3D models. The 3D
application in liver	reconstructions are exported as STL files and easily imported into the
surgery. Langenbecks Arch	application, which creates the virtual model automatically. The presentation is
Surg. 2021;406(3):911-915.	possible in "OpenVR"-ready VR headsets. To interact with the 3D liver model, VR
doi:10.1007/s00423-021-	controllers are used. Scaling is possible, as well as changing the opacity from
02127-7	invisible over transparent to fully opaque. In addition, the surgeon can draw
	potential resection lines on the surface of the liver. All these functions can be
	used in a single or multi-user mode. <b>Results:</b> Five highly experienced HPB
	surgeons of our department evaluated the VR application after using it for the
	very first time and considered it helpful according to the "System Usability Scale"
	(SUS) with a score of 76.6%. Especially with the subitem "necessary learning
	effort," it was shown that the application is easy to use. Conclusion: We
	introduce an immersive, interactive presentation of medical volume data for
	preoperative 3D liver surgery planning. The application is easy to use and may
	have advantages over 3D PDF and 3D print in preoperative liver surgery planning.
	Prospective trials are needed to evaluate the optimal presentation mode of 3D
	liver models.





Bögge L, Colás-Blanco I, Piolino P. Respiratory sinus arrhythmia during biofeedback is linked to persistent improvements in attention, short-term memory, and positive selfreferential episodic memory. *Front Neurosci*. 2022;16:791498. Published 2022 Sep 13. doi:10.3389/fnins.2022.7914 98 Background: Heart rate variability (HRV) biofeedback, an intervention based on the voluntary self-regulation of autonomic parameters, has been shown to affect prefrontal brain functioning and improve executive functions. The interest in using HRV biofeedback as cognitive training is typically ascribed to parasympathetic activation and optimized physiological functioning deriving from increased cardiac vagal control. However, the persistence of cognitive effects is poorly studied and their association with biofeedback-evoked autonomic changes has not yet been explored. In addition, no study has so far investigated the influence of HRV biofeedback in adults on long-term episodic memory, which is particularly concerned with self-referential encoding processing. Methods: In the present study, a novel training system was developed integrating HRV and respiratory biofeedback into an immersive virtual reality environment to enhance training efficacy. Twenty-two young healthy adults were subjected to a blinded randomized placebo-controlled experiment, including six self-regulation training sessions, to evaluate the effect of biofeedback on autonomic and cognitive changes. Cardiac vagal control was assessed before, during, and 5 min after each training session. Executive functions, episodic memory, and the self-referential encoding effect were evaluated 1 week before and after the training program using a set of validated tasks. Results: Linear mixed-effects models showed that HRV biofeedback greatly stimulated respiratory sinus arrhythmia during and after training. Moreover, it improved the attentional capabilities required for the identification and discrimination of stimuli ( $\eta_p^2 = 0.17$ ), auditory short-term memory ( $\eta_p^2 = 0.17$ ) 0.23), and self-referential episodic memory recollection of positive stimuli ( $\eta^2_p$  = 0.23). Episodic memory outcomes indicated that HRV biofeedback reinforced positive self-reference encoding processing. Cognitive changes were strongly dependent on the level of respiratory sinus arrhythmia evoked during selfregulation training. Conclusion: The present study provides evidence that biofeedback moderates respiration-related cardiac vagal control, which in turn mediates improvements in several cognitive processes crucial for everyday functioning including episodic memory, that are maintained beyond the training period. The results highlight the interest in HRV biofeedback as an innovative research tool and medication-free therapeutic approach to affect autonomic and neurocognitive functioning. Finally, a neurocognitive model of biofeedbacksupported autonomic self-regulation as a scaffolding for episodic memory is proposed.





Bonnin C, Pejoan D, Ranvial	Immersive virtual patient simulation could help medical students in clinical
E, et al. Immersive virtual	reasoning, but there is a lack of literature on the effectiveness of this method in
patient simulation compared	healthcare learning. A pilot randomised controlled study compared
with traditional education for	performance (exam score) on a clinical case in immersive virtual simulation to a
clinical reasoning: a pilot	text for physiotherapy students. In the experimental group, the clinical case was
randomised controlled	presented by an immersive 360° video that students watched with a standalone
study. J Vis Commun Med.	headset, whereas the control group used the text only. A survey investigated
2023;46(2):66-74.	students' perceptions of the clinical case, their experience of virtual reality, and
doi:10.1080/17453054.2023.	sense of presence. Twenty-three students in immersive virtual reality had a
2216243	significantly lower total score than 25 students with a text. This difference
	appeared in the assessment part of a clinical case. More precisely, it concerned
	patient history (including a few other elements of assessment and bio-psycho-
	social factors, $p = 0.007$ ). Satisfaction and motivation were strong in the
	experimental group. In conclusion, the performance was higher in text than in
	virtual reality situations. Nevertheless, immersive virtual patient simulation
	remains an interesting tool could train novices to follow history-taking skills of a
	new patient, as similar to a real-life situation.
Bowyer MW, Streete KA,	Advances in simulation technology are fueling a paradigmatic shift in how
Muniz GM, Liu AV. Immersive	medicine will be taught and practiced in the future. Current simulators range
Virtual Environments for	from simplified part task trainers to fully immersive virtual environments. We are
Medical Training. Seminars	on the verge of training platforms that provide realistic representations of
in Colon and Rectal Surgery.	medical and surgical scenarios that engage learners in a manner that
2008;19(2):90-97.	approximates reality. This article reviews the rationale for developing advanced
doi:10.1053/j.scrs.2008.02.0	virtual environments and details the technologies that are currently available.
05	Immersive environments using virtual reality, herein reviewed, include Cave
	Automated Virtual Environments, Distributive Virtual Environments for
	collaborative learning over the internet (Project TOUCH), Serious Games for
	medical education (PULSE and 3DiTeams), and a Wide Area Virtual Environment.
	The ultimate role of these technologies in surgical education remains to be
	determined but will undoubtedly play an important part in the future.





Brandín-De la Cruz N,	Introduction: Treadmill training is considered an effective intervention to
Secorro N, Calvo S,	improve gait ability in patients with Parkinson's disease (PD). In parallel, virtual
Benyoucef Y, Herrero P,	reality shows promising intervention with several applications in the inpatient
Bellosta-López P. Immersive	medical setting. <b>Aim:</b> To evaluate the feasibility and preliminary efficacy of
virtual reality and antigravity	mechanical gait assistance combined with immersive virtual reality in patients
treadmill training for gait	with PD. Patients and methods: This pilot and feasibility study followed a pre-
rehabilitation in Parkinson's	post study design. The intervention consisted of 12 sessions of 30 minutes,
disease: a pilot and	distributed regularly over four consecutive weeks. Participants walked on a
feasibility study.	treadmill with a body-weight support system set at approximately 20% of body
Entrenamiento	weight and equipped with a virtual reality helmet controlled by a two-handed
antigravitatorio e inmersivo	joystick. Feasibility and intervention outcomes were collected at baseline and
de realidad virtual para la	after four weeks of intervention. <b>Results:</b> Twelve participants of 60 patients were
rehabilitación de la marcha	finally enrolled. Nine of them (75%) completed the treatment intervention with
en la enfermedad de	an adherence rate of 97%. Two participants left the study, one of them due to
Parkinson: estudio piloto y	sickness associated with virtual reality and another because of a lack of
de viabilidad. Rev Neurol.	motivation. There were significant differences associated with small-medium
2020;71(12):447-454.	effect sizes when comparing the pre and post values for walk distance, walk
doi:10.33588/rn.7112.20203	speed, balance, and quality of life. <b>Conclusions:</b> The present study provided
52	preliminary evidence supporting the feasibility of the combination of antigravity
	treadmill and immersive virtual reality system for the rehabilitation of patients
	with PD.
Bun P, Gorski F, Grajewski D,	The Virtual Reality technology is nowadays dynamically developed, thanks to
Wichniarek R, Zawadzki P.	appearance of low-cost devices and interest by large companies related to
Low – Cost Devices Used in	entertainment, communication and visualization. It is especially important in
Virtual Reality Exposure	medicine, as it allows a much wider access to tools such as Virtual Reality
Therapy. Procedia Computer	Exposure Therapy. The paper presents possibilities of using low-cost VR devices
Science. 2017;104:445-451.	in curing phobias by exposure to a stress-generating factor in an immersive
doi:10.1016/j.procs.2017.01.	virtual environment. Several use scenarios are presented for a simple
158	application aimed at exposing a patient to fear of heights. A test group consisted
	of healthy individuals. To evaluate level of immersion and fear caused by the
	application, a heart rate monitor was used, to record heartbeat in real time.
Choi J, Thompson CE, Choi J,	<b>Background:</b> Digital education using immersive virtual reality (VR) technology is
Waddill CB, Choi S.	available in nursing. Evidence of its effectiveness is essential. <b>Purpose:</b> This
Effectiveness of Immersive	review analyzed the effectiveness of and barriers to using immersive VR in
Virtual Reality in Nursing	nursing education. <b>Methods:</b> A structured search was performed in PubMed,
Education: Systematic	Cumulative Index to Nursing and Allied Health Literature, EMBASE, PsycINFO,
Review. Nurse Educ.	Web of Science, and ProQuest Nursing & Allied Health Database. The Medical
2022;47(3):E57-E61.	Education Research Study Quality Instrument was used to assess the quality of
doi:10.1097/NNE.00000000	studies. <b>Results:</b> The final review was composed of 9 studies of moderate to
00001117	high quality published between 2018 and 2020. The review indicated that
	immersive VR increased learning, cognitive, and psychomotor performance.
	Most participants of the studies preferred using immersive VR in education and
	with a variety of experiential scenarios. Barriers were associated with
	technological hardware and software (eg, simulation sickness, lack of visual
	comfort). <b>Conclusion:</b> The review supports the viability of immersive VR
	technology in nursing education.





Couperus K, Young S, Walsh R, et al. Immersive Virtual Reality Medical Simulation: Autonomous Trauma Training Simulator. *Cureus*. 2020;12(5):e8062. Published 2020 May 11. doi:10.7759/cureus.8062 Background Medical and traumatic emergencies can be intimidating and stressful. This is especially true for early-career medical personnel. Training providers to respond effectively to medical emergencies before being confronted with a real scenario is limited by unnatural or high-cost training modalities that fail to realistically replicate the stress and gravity of real-world trauma management. Immersive virtual reality (IVR) may provide a unique training solution. Methods We created a working group of 10 active duty or former military emergency medicine physicians and two technical experts. We hosted 10 meetings to facilitate the development process. The program was developed with financial support from the Telemedicine and Advanced Technology Research Center (TATRC), through the primary vendor Exonicus, Inc, with support from Anatomy Next Inc, and Kitware, Inc. Development was completed using an agile project management style, which allowed our team to review progress and provide immediate feedback on previous milestones throughout its completion. The working group completed the resulting four simulation scenarios to evaluate perceived realism and training potential. Finally, testing of the technology platform off the network in a deployed role 3 was conducted. Results Upon completion, we created four IVR scenarios based on the highest mortality battlefield injuries: hemorrhage, tension pneumothorax, and airway obstruction. The working group unanimously indicated a high level of realism and potential training usefulness. Throughout this process, there have been a number of lessons learned and we present those here to show what we have created as well as provide guidance to others creating IVR training solutions. Conclusion Our team developed trauma scenarios that, to our knowledge, are the only IVR trauma scenarios to run autonomously without instructor input. Furthermore, we provide a potential template for the creation of future autonomous IVR training programs. This framework may offer a dynamic starting point as more teams seek to leverage the capabilities IVR offers.




Crockatt WK, Confino JE, Kopydlowski NJ, Jobin CM, Levine WN. Comparing Skill Acquisition and Validity of Immersive Virtual Reality with Cadaver Laboratory Sessions in Training for Reverse Total Shoulder Arthroplasty. *JB JS Open Access*. 2023;8(3):e22.00141. Published 2023 Jul 6. doi:10.2106/JBJS.OA.22.001 41 Immersive virtual reality (iVR) allows surgical trainees to practice skills without risking harm to patients or the need for cadaveric training resources. However, iVR has never been directly compared with cadaver training, the longtime gold standard for surgical skill training. We aimed to compare skill acquisition using cadaver laboratory and iVR training methods for augmented baseplate implantation during reverse total shoulder arthroplasty (rTSA). Methods: In a randomized controlled trial, junior orthopaedic surgery residents were assigned to a 1-hour training with either iVR or a cadaveric laboratory session with shoulder specimens. Before training, all participants viewed an overview lecture and technique video demonstrating key steps of augmented baseplate implantation for rTSA. Participants were assessed by a blinded evaluator using validated competency checklists during cadaveric glenoid baseplate implantation. Continuous and categorial variables were analyzed using the 2sample t test and Fisher exact test. Results: Fourteen junior residents (3 incoming matched postgraduate year [PGY1], 6 PGY1s, 1 PGY2, and 4 PGY3s) were randomized to training with either iVR (n = 6) or cadaver laboratory (n = 8). There were no significant differences in demographic data, previous experience with rTSA, or previous use of iVR (p > 0.05). There were no significant difference in total Objective Structured Assessment of Technical Skill score (91.2% [15.2] vs. 93.25% [6.32], -0.1406 to 0.1823, p = 0.763), Global Rating Scale score (4.708 [0.459] vs. 4.609 [0.465], -0.647 to 0.450, p = 0.699), or time to completion (546 seconds [158] vs. 591 seconds [192], -176.3 to 266.8, p = 0.655) in cadaveric glenoid baseplate implantation. Average cost of iVR hardware and a 1-year software license was \$4,900, and average cost of a single cadaver laboratory was \$1,268.20 per resident. Conclusions: Among junior orthopaedic residents, there is similar skill acquisition when training with either cadaver laboratory or iVR. Although additional research into this field is needed, iVR may provide an important and cost-effective tool in surgical education. Clinical relevance: Emerging simulation and iVR technology simulation in surgical training programs can increase access to effective and high-level surgical training across the globe and improve quality of care.





Drewett O, Hann G, Gillies M, et al. A Discussion of the Use of Virtual Reality for Training Healthcare Practitioners to Recognize Child Protection Issues. <i>Front Public Health</i> . 2019;7:255. Published 2019 Sep 13. doi:10.3389/fpubh.2019.002 55	<b>Background:</b> Virtual reality technology is a rapidly developing tool which has been shown to have exciting prospects in the field of medical education (1). In a recent, subsequent study, Pan et al. consider the potential of the same technology in the realm of child protection training and safeguarding issues (2). To build upon the Pan et al. (2) study, a panel discussion was held at The Centre for Behavior Change Annual Conference 2018 to discuss the question "Can a virtual reality communication scenario be used to teach General Practitioners and trainees how to recognize and manage child protection issues?" <b>Methodology:</b> The above study comprised an immersive virtual reality consultation, in which the ability of 63 doctors to pick up covert safeguarding cues was tested in the context of a consultation with an adult patient, where the patient's child happened to be present as well. The study and its findings were discussed at the Centre for Behavior Change 4th Annual Conference, and this paper summarizes the opinions of both the panel and the audience. <b>Viewpoint:</b> Safeguarding is a challenging area of practice where we must listen to the child, and tackle difficult conversations with parents. Within medical training, role play is the gold standard for teaching how to communicate in difficult scenarios. Given the ethical questions surrounding children being asked to role play such abuse, the use of virtual reality characters could have a key rela in undrading current practices in medical education on sofeduarding
Droc G. Isac S. Nita E. et al.	Background and Objectives: Impaired cognition and pain after surgery
Postoperative Cognitive	contribute to prolonged hospital stays and increased mortality rates. Thus, the
Impairment and Pain	development of preemptive algorithms for reducing their impact should be
Perception after Abdominal	prioritized. The main objectives of the present study were to evaluate the
Surgery-Could Immersive	efficiency of using virtual reality (VR) to treat postoperative cognitive decline and
Virtual Reality Bring More? A	pain perception. Materials and Methods: The study was a prospective,
Clinical Approach. Medicina	monocentric, clinical study that included 51 patients who have undergone major
(Kaunas). 2023;59(11):2034.	abdominal surgery. The patients were divided into two groups: Control (n = 25)
Published 2023 Nov 17.	and VR (n = 26). The VR sessions consisted of 5-8 min exposure at 24-48 h after
doi:10.3390/medicina59112	surgery. We considered the outcome variables, the mini-mental state
034	examination, and visual analogue scale at 24-48 h after surgery. The dependent
	variables were age, social status, educational level, and duration of
	surgery. <b>Results:</b> We did not observe any differences in postoperative cognition
	deficit with regard to VR. The VR, however, successfully reduced postoperative
	pain intensity. Moreover, the patients' age, surgery duration, level of education,
	and social status influenced the MMSE score at 24-48 h after
	surgery. <b>Conclusions:</b> Even if using VR does not alleviate short-term
	postoperative cognitive impairments, it could affect pain perception. Further
	studies are needed to support the use of VR in perioperative contexts.





Ekstrand C, Jamal A, Nguyen R, Kudryk A, Mann J, Mendez I. Immersive and interactive virtual reality to improve learning and retention of neuroanatomy in medical students: a randomized controlled study. *CMAJ Open*. 2018;6(1):E103-E109. doi:10.9778/cmajo.2017011 0 **Background:** Spatial 3-dimensional understanding of the brain is essential to learning neuroanatomy, and 3-dimensional learning techniques have been proposed as tools to enhance neuroanatomy training. The aim of this study was to examine the impact of immersive virtual-reality neuroanatomy training and compare it to traditional paper-based methods. Methods: In this randomized controlled study, participants consisted of first- or second-year medical students from the University of Saskatchewan recruited via email and posters displayed throughout the medical school. Participants were randomly assigned to the virtual-reality group or the paper-based group and studied the spatial relations between neural structures for 12 minutes after performing a neuroanatomy baseline test, with both test and control questions. A postintervention test was administered immediately after the study period and 5-9 days later. Satisfaction measures were obtained. Results: Of the 66 participants randomly assigned to the study groups, 64 were included in the final analysis, 31 in the virtual-reality group and 33 in the paper-based group. The 2 groups performed comparably on the baseline questions and showed significant performance improvement on the test questions following study. There were no significant differences between groups for the control questions, the postintervention test questions or the 7-day postintervention test questions. Satisfaction survey results indicated that neurophobia was decreased. Interpretation: Results from this study provide evidence that training in neuroanatomy in an immersive and interactive virtual-reality environment may be an effective neuroanatomy learning tool that warrants further study. They also suggest that integration of virtual-reality into neuroanatomy training may improve knowledge retention, increase study motivation and decrease neurophobia.





Eley CL, Palaniappan V, Carter A, et al. Randomized controlled trial of the CMR immersive virtual reality (IVR) headset training compared to e-learning for operating room configuration of the CMR versius robot. *J Robot Surg.* 2024;18(1):143. Published 2024 Mar 30. doi:10.1007/s11701-024-01885-y Robotic surgery offers potential advantages over laparoscopic procedures, but the training for configuring robotic systems in the operating room remains underexplored. This study seeks to validate immersive virtual reality (IVR) headset training for setting up the CMR Versius in the operating room. This single-blinded randomized control trial randomised medical students with no prior robotic experience using an online randomiser. The intervention group received IVR headset training, and the control group, e-learning modules. Assessors were blinded to participant group. Primary endpoint was overall score (OS): Likert-scale 1-5: 1 reflecting independent performance, with increasing verbal prompts to a maximum score of 5, requiring physical assistance to complete the task. Secondary endpoints included task scores, time, inter-rater reliability, and concordance with participant confidence scores. Statistical analysis was performed using IBM SPSS Version 27. Of 23 participants analysed, 11 received IVR and 12 received e-learning. The median OS was lower in the IVR group than the e-learning group 53.5 vs 84.5 (p < 0.001). VR recipients performed tasks independently more frequently and required less physical assistance than e-learning participants (p < 0.001). There was no significant difference in time to completion (p = 0.880). Self-assessed confidence scores and assessor scores differed for e-learning participants (p = 0.008), though not IVR participants (p =0.607). IVR learning is more effective than e-learning for preparing robot-naïve individuals in operating room set-up of the CMR Versius. It offers a feasible, realistic, and accessible option in resource-limited settings and changing dynamics of operating theatre teams. Ongoing deliberate practice, however, is still necessary for achieving optimal performance.





Evans E, Dass M, Muter WM, Tuthill C, Tan AQ, Trumbower RD. A Wearable Mixed Reality Platform to Augment Overground Walking: A Feasibility Study. *Front Hum Neurosci.* 2022;16:868074. Published 2022 Jun 9. doi:10.3389/fnhum.2022.86 8074 Humans routinely modify their walking speed to adapt to functional goals and physical demands. However, damage to the central nervous system (CNS) often results in abnormal modulation of walking speed and increased risk of falls. There is considerable interest in treatment modalities that can provide safe and salient training opportunities, feedback about walking performance, and that may augment less reliable sensory feedback within the CNS after injury or disease. Fully immersive virtual reality technologies show benefits in boosting training-related gains in walking performance; however, they lack views of the real world that may limit functional carryover. Augmented reality and mixed reality head-mount displays (MR-HMD) provide partially immersive environments to extend the virtual reality benefits of interacting with virtual objects but within an unobstructed view of the real world. Despite this potential advantage, the feasibility of using MR-HMD visual feedback to promote goaldirected changes in overground walking speed remains unclear. Thus, we developed and evaluated a novel mixed reality application using the Microsoft HoloLens MR-HMD that provided real-time walking speed targets and augmented visual feedback during overground walking. We tested the application in a group of adults not living with disability and examined if they could use the targets and visual feedback to walk at 85%, 100%, and 115% of each individual's self-selected speed. We examined whether individuals were able to meet each target gait speed and explored differences in accuracy across repeated trials and at the different speeds. Additionally, given the importance of task-specificity to therapeutic interventions, we examined if walking speed adjustment strategies were consistent with those observed during usual overground walking, and if walking with the MR-HMD resulted in increased variability in gait parameters. Overall, participants matched their overground walking speed to the target speed of the MR-HMD visual feedback conditions (all p-values > 0.05). The percent inaccuracy was approximately 5% across all speed matching conditions and remained consistent across walking trials after the first overall walking trial. Walking with the MR-HMD did not result in more variability in walking speed, however, we observed more variability in stride length and time when walking with feedback from the MR-HMD compared to walking without feedback. The findings offer support for mixed reality-based visual feedback as a method to provoke goal-specific changes in overground walking behavior. Further studies are necessary to determine the clinical safety and efficacy of this MR-HMD technology to provide extrinsic sensory feedback in combination with traditional treatments in rehabilitation.





Farcas M, Reynolds LF, Lee JY. Simulation-Based Percutaneous Renal Access Training: Evaluating a Novel 3D Immersive Virtual Reality Platform. *J Endourol*. 2021;35(5):695-699. doi:10.1089/end.2020.0674 Introduction: Percutaneous nephrolithotomy (PCNL) is the gold standard treatment for patients with a large stone burden. There are a variety of methods to teach this important endourologic procedure, including simulation. We evaluated three different PCNL simulation platforms for potential use in teaching and assessing percutaneous renal access skills. Materials and Methods: Urology residents, fellows, and faculty were recruited to participate in this study, which included completing standardized tasks on three PCNL simulation platforms: a virtual reality (VR) simulator (PercMentor, 3D Systems™), a porcine tissue simulator (Cook™ Medical), and a new 3D immersive VR simulator-Marion K181 (Marion Surgical™). Participants were asked to complete a standardized task-gaining prone percutaneous renal access using a fluoroscopic-guided technique. Participants were asked to rate the simulators, and performance data were recorded for analysis. Results: A total of 18 participants with varying levels of PCNL experience completed the study. The Marion K181 had higher ratings by participants in all domains (realism, tactile feedback, instrument movement, renal anatomy, fidelity of simulation, utility as teaching tool) compared with the PercMentor (p < 0.05) but did not differ in any domain when compared with the porcine PCNL model. Participants felt that the Marion K181 was comparable with the porcine PCNL model as a teaching tool, but had the advantage of not requiring radiation exposure. Fluoroscopy time was the variable that most consistently correlated with participant PCNL experience and level of training, across all three PCNL simulation platforms. **Conclusions:** There are a variety of PCNL simulation platforms available for teaching percutaneous renal access skills. Based on our initial comparative study, there is validity evidence to support the use of the novel Marion K181 PCNL simulator as a training tool rather than higher fidelity models requiring real radiation exposure. However, evidence is yet lacking for its use as an assessment tool.





Fealy S, Jones D, Hutton A, et al. The integration of immersive virtual reality in tertiary nursing and midwifery education: A scoping review. <i>Nurse Educ</i> <i>Today</i> . 2019;79:14-19. doi:10.1016/j.nedt.2019.05. 002	<b>Background:</b> Immersive virtual reality is an advancing technology that has the potential to change the traditional pedagogical approaches to teaching tertiary nursing and midwifery students. The application of immersive virtual reality in nursing and midwifery education may be a novel, accessible method for information provision and skill acquisition, however little is known of the extent of immersive virtual reality technology integration into tertiary nursing and midwifery programs. <b>Objectives:</b> The purpose of this review is to identify the application and integration of immersive virtual reality within nursing and midwifery tertiary education programs. <b>Design:</b> A scoping review based on the Joanna Briggs Institute methodology for scoping reviews was undertaken. An a priori review protocol and eligibility criterion was developed with the protocol subject to review a posteriori following first round screening. An electronic search of ten databases was conducted in January 2018. <b>Results:</b> A total of n = 506 non-duplicate records were identified and subjected to level one and level two screening. The search strategy and screening process identified n = 2 articles that were quality checked and included for review. <b>Conclusions:</b> There is currently a paucity of quality published literature on the application and/or integration of immersive virtual reality into nursing and midwifery tertiary education. Immersive virtual reality has the potential to increase competence and confidence for students providing accessible and repeatable learning opportunities in a fail-safe environment. There is a need for educators to be involved in the conceptualisation, design, integration and research of immersive
Ferrandini Price M.	<b>Objectives:</b> The main objective of the study is to determine the efficiency in the
Escribano Tortosa D, Nieto	execution of the START (Simple Triage and Rapid Treatment) triage, comparing
Fernandez-Pacheco A, et al.	Virtual Reality (VR) to Clinical Simulation (CS) in a Mass Casualty Incident (MCI).
Comparative study of a	The secondary objective is to determine the stress produced in the health
simulated incident with	professionals in the two situations described. Materials: A comparative study
multiple victims and	on the efficiency and the stress during triage in a MSI was conducted. The basal
immersive virtual	and post levels of salivary $\alpha$ -amylase (sAA) activity were measured in all the
reality. Nurse Educ Today.	participants before and after the simulation. <b>Results:</b> The percentage of victims
2018;71:48-53.	that were triaged correctly was $87.65\%$ (SD = $8.3$ ); $88.3\%$ (SD = $9.65$ ) for the
006	Cumical Simulation with Actors (CSA) group and $87.2\%$ (SD = 7.2) for the virtual Reality Simulation (VRG) group, without any significant differences (n = 0.612)
000	heavier both groups. The basal sAA was 103 26 (SD = 79 13) $U/L$ with a
	significant increase ( $p < 0.001$ ) with respect to the post-simulation levels
	(182.22, SD = 148.65 U/L). The increase of sAA was 80.70 (SD = 109.67) U/mL,
	being greater for the CSA group than the VRG group. Conclusion: The results
	show that virtual reality method is as efficient as clinical simulation for training
	on the execution of basic triage (START model). Also, based on the sAA results,
	we can attest that clinical simulation creates a more stressful training
	experience for the student, so that is should not be substituted by the use of
	virtual reality, although the latter could be used as a complementary activity.





Flores A, Linehan MM, Todd SR, Hoffman HG. The Use of Virtual Reality to Facilitate Mindfulness Skills Training in Dialectical Behavioral Therapy for Spinal Cord Injury: A Case Study. *Front Psychol.* 2018;9:531. Published 2018 Apr 23. doi:10.3389/fpsyg.2018.005 31 Introduction: Paralysis from a spinal cord injury (SCI) increases risk of psychological problems including suicide attempts, substance use disorder, negative emotions (e.g., anger), depression, anxiety, ASD/PTSD. Dialectical Behavioral Therapy<sup>®</sup> (DBT<sup>®</sup>) has been shown to be effective for treating similar psychological symptoms in non-SCI patient populations. The current study explored for the first time, the feasibility and clinical potential of using Immersive Virtual Reality (VR) enhanced DBT<sup>®</sup> Mindfulness skills training to help reduce psychological symptoms (negative emotions and anxiety, ASD/PTSD) of two patients with SCI. Patient 1 was a 39-year-old male patient suffering multiple spinal cord injuries, resulting in quadriplegia, after falling out of a four story building. Patient 1 had severe depression, and anxiety symptoms. Patient 2, was a 31 year old male with a C7 vertebral body fracture, leading to paresis, after suffering a blunt force trauma injury during an attempted suicide, jumping from a moving vehicle. Patient 2 had mild depression, and anxiety symptoms. **Methods:** Each patient looked into VR goggles, and had the illusion of slowly "floating down" a river in virtual reality while listening to DBT® Mindfulness Skills training instructions. Each patient filled out brief psychological ratings before and after each VR session, four VR DBT<sup>®</sup> sessions for patient 1, and two VR DBT<sup>®</sup> sessions for patient 2. **Results:** As predicted, patient 1 reported reductions in negative emotions after each VR DBT® Mindfulness session. Patient 2 had mixed results on some of the measures of negative emotions. And both patients reported feeling less depressed, less anxious, and less emotionally upset, after VR DBT® Mindfulness Skills learning. Patient 2 reported large reductions in short term ASD/PTSD symptoms after his first VR DBT<sup>®</sup> mindfulness skills training session. Conclusion: This study explored the feasibility of using VR DBT<sup>®</sup> with quadriplegic or paresis SCI patients. Both SCI patients accepted VR, the patients liked using VR, and, with assistance from the therapist, the patients were able to use the VR equipment, despite being paralyzed. Additional research and development will be needed to determine whether VR DBT® Mindfulness Skills training leads to any long term improvements in outcome.





Francis ER, Bernard S,	<b>Objective:</b> To assess the impact on self-efficacy for preclinical physician
Nowak ML, Daniel S, Bernard	assistant (PA) students through immersive virtual reality (VK) operating room
JA. Operating Room Virtual	simulation. <b>Design:</b> Randomized double-blinded controlled experiment
Reality Immersion Improves	measuring self-efficacy using Schwarzer and Jerusalem's general self-efficacy
Self-Efficacy Amongst	scale. An entirely novel operating room was created, casted, and filmed using VR
Preclinical Physician	software. Fifty-two preclinical PA students were randomly assigned to VR (n =
Assistant Students. <i>J Surg</i>	26) or traditional lecture (n = 26) and self-efficacy was measured in both
Educ. 2020;77(4):947-952.	conditions using a general self-efficacy scale given before and after the virtual
doi:10.1016/j.jsurg.2020.02.	experience. A mixed ANOVA, independent sample t tests, and paired samples t
013	tests were performed. Setting: Shenandoah University Physician Assistant
	program, Winchester, Virginia. <b>Results:</b> Exposure to VR training after the
	traditional lecture improves self-efficacy amongst PA students (p < 0.05).
	Exposure to VR improved self-efficacy compared to traditional methods (p <
	0.05). There was no difference in self-efficacy amongst PA students with the
	traditional model (p < 0.05). <b>Conclusions:</b> The introduction of VR simulation
	improved preclinical PA student self-efficacy in the operating room setting.
Frederiksen JG, Sørensen	Background: Virtual reality simulators combined with head-mounted displays
SMD, Konge L, et al.	enable highly immersive virtual reality (VR) for surgical skills training, potentially
Cognitive load and	bridging the gap between the simulation environment and real-life operating
performance in immersive	room conditions. However, the increased complexity of the learning situation in
virtual reality versus	immersive VR could potentially induce high cognitive load thereby inhibiting
conventional virtual reality	performance and learning. This study aims to compare cognitive load and
simulation training of	performance in immersive VR and conventional VR simulation training.
laparoscopic surgery: a	<b>Methods:</b> A randomized controlled trial of residents (n = 31) performing
randomized trial. Surg	laparoscopic salpingectomies with an ectopic pregnancy in either immersive VR
Endosc. 2020;34(3):1244-	or conventional VR simulation. Cognitive load was estimated by secondary-task
1252. doi:10.1007/s00464-	reaction time at baseline, and during nonstressor and stressor phases of the
019-06887-8	procedure. Simulator metrics were used to evaluate performance.
	<b>Results:</b> Cognitive load was increased by 66% and 58% during immersive VR
	and conventional VR simulation, respectively ( $p < 0.001$ ), compared to baseline.
	A light stressor induced a further increase in cognitive load by 15.2% and a
	severe stressor by 43.1% in the immersive VR group compared to 23% (severe
	stressor) in the conventional VR group. Immersive VR also caused a significantly
	worse performance on most simulator metrics. <b>Conclusion:</b> Immersive VR
	simulation training induces a higher cognitive load and results in a poorer
	performance than conventional VR simulation training in lanaroscopy. High
	extraneous load and element interactivity in the immersive VR are suggested as
	mechanisms explaining this finding. However, immersive VR offers some
	potential advantages over conventional VR such as more real-life conditions but
	we only recommend introducing immersive VR in surgical skills training after
	initial training in conventional VR.





Freeman D, Antley A, Ehlers	Presentation of social situations via immersive virtual reality (VR) has the
A, et al. The use of	potential to be an ecologically valid way of assessing psychiatric symptoms. In
immersive virtual reality (VR)	this study we assess the occurrence of paranoid thinking and of symptoms of
to predict the occurrence 6	posttraumatic stress disorder (PTSD) in response to a single neutral VR social
months later of paranoid	environment as predictors of later psychiatric symptoms assessed by standard
thinking and posttraumatic	methods. One hundred six people entered an immersive VR social environment
stress symptoms assessed	(a train ride), presented via a head-mounted display, 4 weeks after having
by self-report and	attended hospital because of a physical assault. Paranoid thinking about the
interviewer methods: a study	neutral computer-generated characters and the occurrence of PTSD symptoms
of individuals who have been	in VR were assessed. Reactions in VR were then used to predict the occurrence
physically	6 months later of symptoms of paranoia and PTSD, as assessed by standard
assaulted. Psychol Assess.	interviewer and self-report methods. Responses to VR predicted the severity of
2014;26(3):841-847.	paranoia and PTSD symptoms as assessed by standard measures 6 months
doi:10.1037/a0036240	later. The VR assessments also added predictive value to the baseline
	interviewer methods, especially for paranoia. Brief exposure to environments
	presented via virtual reality provides a symptom assessment with predictive
	ability over many months. VR assessment may be of particular benefit for
	difficult to assess problems, such as paranoia, that have no gold standard
	assessment method. In the future, VR environments may be used in the clinic to
	complement standard self-report and clinical interview methods.
Gandedkar NH, Wong MT,	Virtual Reality (VR), Augmented Reality (AR) and Artificial Intelligence (AI) are
Darendeliler MA. Role of	modern days technological phenomenon that are equipped with powerful ability
virtual reality (VR),	to revolutionize education and research. The present insight not only outlines
augmented reality (AR) and	the caveats of traditional teaching, but explores the current and potential
artificial intelligence (AI) in	applications of VR, AR, and AI in the field of orthodontic teaching and research.
tertiary education and	The digital technology world immersed in artificial intelligence not only enhances
research of orthodontics: An	the ability of both student and educator in assimilating and imparting
insight. Seminars in	knowledge, respectively, but also, helps to create a symbiotic relationship with
Orthodontics. 2021;27(2):69-	each other. Also, emphasis is laid on understanding and implementing the
77.	interaction of strategic framework, professionalism and patient care delivery in
doi:10.1053/j.sodo.2021.05.	the era of AI, VR, and AR in order to support dynamic engagements in a
003	pedagogical, ethically-appropriate, community-centred, culturally-sensitive and
	economically-feasible teaching and research milieu.





Gandsas A, Dorey T, Park A.	Background: Prior studies have demonstrated the value of live streamed
Immersive Live Streaming of	surgical procedures in surgical education and that learning is further enhanced
Surgery Using 360-Degree	with the use of 360-degree video. Emerging virtual reality (VR) technology now
Video to Head-Mounted	offers yet another advancement by placing learners in an immersive
Virtual Reality Devices: A	environment, which can improve both engagement and procedural learning.
New Paradigm in Surgical	Aims: The aim here is to test the feasibility of live streaming surgery in immersive
Education. Surg Innov.	virtual reality using consumer-level technology, including stream stability and
2023;30(4):486-492.	impacts on case duration. <b>Methodology:</b> Ten laparoscopic procedures were
doi:10.1177/1553350623116	live-streamed in a 360-degree immersive VR format over a 3-week period for
5828	viewing by surgical residents in a remote location wearing a head-mounted
	display. Stream quality, stability and latency were monitored, and operating
	room time was compared to non-streamed surgeries to quantify impacts on
	procedure times. <b>Conclusions:</b> This novel live streaming configuration was able
	to deliver high-quality, low-latency video directly to a VR platform, allowing
	complete immersion into the learning environment by remote learners. Live
	streaming surgical procedures in an immersive VR format provides an efficient,
	cost-effective, and reproducible way to teleport remote learners from any
	location directly into the operating room.
Goel T, Sharma N, Gehlot A,	<b>Objectives:</b> Spinal cord injury (SCI) is a disabling condition with physical,
Srivastav AK. Effectiveness	psychological, and financial consequences. The study's goal is to compare the
of immersive virtual reality	effectiveness of immersive virtual reality (VR) training in balance among
training to improve sitting	individuals with incomplete paraplegia to that of functional electrical
balance control among	stimulation (FES). <b>Design:</b> Two groups, randomized clinical trial.
individuals with acute and	Setting: Neurological Physiotherapy Out Patient Department, Tertiary Care
sub-acute paraplegia: A	Hospital. <b>Participants:</b> Eighteen people aged 18-60 years with incomplete SCI.
randomized clinical trial. J	Interventions: VR training along with conventional physical therapy (CPT) and
Spinal Cord Med.	FES for Rectus Abdominis and Erector Spinae with CPT five times a week for 4
2023;46(6):964-974.	weeks. <b>Outcome measures:</b> The outcome measures were Modified Functional
doi:10.1080/10790268.2021.	Reach Test (mFRT) and Function in Sitting Test (FIST) to assess sitting balance
2012053	and Spinal Cord Independence Measure III (SCIM III) for the level of
	independence. Assessments were taken before initiating treatment and at the
	end of the 2 and 4 weeks after treatment. Within-group analyses for the mFRT
	values were performed using Repeated Measures ANOVA test, and between-
	group analyses were performed using the independent <i>t</i> -test test. Friedman and
	Mann-Whitney U-tests were used for analyzing FIST and SCIM III. Results: All
	variables (mFRT and FIST) improved significantly in both groups (P < 0.05), with
	the VR + CPT group showing a more significant result than the FES + CPT group (P
	value < 0.05), except for SCIM III. <b>Conclusion:</b> VR as an adjunct to CPT
	demonstrated proved to be an effective treatment to improve balance among
	individuals with incomplete paraplegia.





Gomez J, Hoffman HG, Bistricky SL, et al. The Use of Virtual Reality Facilitates Dialectical Behavior Therapy® "Observing Sounds and Visuals" Mindfulness Skills Training Exercises for a Latino Patient with Severe Burns: A Case Study. *Front Psychol.* 2017;8:1611. Published 2017 Sep 25. doi:10.3389/fpsyg.2017.016 11 Sustaining a burn injury increases an individual's risk of developing psychological problems such as generalized anxiety, negative emotions, depression, acute stress disorder, or post-traumatic stress disorder. Despite the growing use of Dialectical Behavioral Therapy<sup>®</sup> (DBT<sup>®</sup>) by clinical psychologists, to date, there are no published studies using standard DBT<sup>®</sup> or DBT<sup>®</sup> skills learning for severe burn patients. The current study explored the feasibility and clinical potential of using Immersive Virtual Reality (VR) enhanced DBT® mindfulness skills training to reduce negative emotions and increase positive emotions of a patient with severe burn injuries. The participant was a hospitalized (in house) 21-year-old Spanish speaking Latino male patient being treated for a large (>35% TBSA) severe flame burn injury. **Methods:** The patient looked into a pair of Oculus Rift DK2 virtual reality goggles to perceive the computer-generated virtual reality illusion of floating down a river, with rocks, boulders, trees, mountains, and clouds, while listening to DBT<sup>®</sup> mindfulness training audios during 4 VR sessions over a 1 month period. Study measures were administered before and after each VR session. **Results:** As predicted, the patient reported increased positive emotions and decreased negative emotions. The patient also accepted the VR mindfulness treatment technique. He reported the sessions helped him become more comfortable with his emotions and he wanted to keep using mindfulness after returning home. Conclusions: Dialectical Behavioral Therapy is an empirically validated treatment approach that has proved effective with non-burn patient populations for treating many of the psychological problems experienced by severe burn patients. The current case study explored for the first time, the use of immersive virtual reality enhanced DBT<sup>®</sup> mindfulness skills training with a burn patient. The patient reported reductions in negative emotions and increases in positive emotions, after VR DBT<sup>®</sup> mindfulness skills training. Immersive Virtual Reality is becoming widely available to mainstream consumers, and thus has the potential to make this treatment available to a much wider number of patient

populations, including severe burn patients. Additional development, and

controlled studies are needed.





Heinrich F, Apilla V, Lawonn K, Hansen C, Preim B, Meuschke M. Estimating depth information of vascular models: A comparative user study between a virtual reality and a desktop application. *Computers & Graphics*. 2021;98:210-217. doi:10.1016/j.cag.2021.05.0 14

Vascular structures are assessed, e.g., in tumor surgery to understand the influence of a planned resection on the vascular supply and venous drainage. The understanding of complex branching vascular structures may benefit from immersive virtual reality (VR) visualization. Therefore, the estimation of distance, depth and shape information is a crucial task to support diagnosis and therapy decisions. Depending on the visualization techniques used, perceptual issues can influence this process and may thus lead to false conclusions. Many studies were carried out to study depth perception for different variants of vessel visualization. However, these studies are restricted to desktop applications. Since VR exhibits specific perceptual problems, we aim at an understanding of the appropriateness of vessel visualization techniques in VR. Therefore, this paper presents a user study that investigates the effects of three commonly used visualization techniques on depth perception. The set of visualization techniques comprises Phong shading, pseudo-chromadepth and fog shading. An immersive VR setup of the study using a head-mounted display (HMD) was compared to a traditional desktop setup. Results suggest that depth judgments are less error-prone and more certain in VR than in desktop environments. Moreover, depth-enhancing visualization techniques had greater effects in the desktop study compared to the VR study.





Hess SP, Levin M, Akram F, et al. The impact and feasibility of a brief, virtual, educational intervention for home healthcare professionals on Parkinson's Disease and Related Disorders: pilot study of I SEE PD Home. *BMC Med Educ*. 2022;22(1):506. Published 2022 Jun 28. doi:10.1186/s12909-022-03430-7 Background: Individuals with advanced Parkinson's Disease (PD) and Parkinson-related disorders (PRD) are frequently referred for home allied therapies and nursing care, yet home healthcare professionals have limited training in PD/PRD. While recognizing the need for such care, patients and families report home healthcare professionals are unfamiliar with these conditions, which may be driven by neurophobia and may contribute to suboptimal care and early termination of services. We sought to determine the feasibility and effects of a virtual, multimodal educational intervention on PD knowledge, confidence, and empathy among home health professionals. **Methods:** Home health nurses, occupational therapists, physical therapists and physical therapy assistants, and speech-language pathologists participated in a daylong, virtual symposium on advanced PD/PRD, combining focused lectures, discipline-specific breakout sessions, immersive virtual reality vignettes, and interactive panels with both patients and families, and movement disorders and home healthcare experts. Participants completed online pre- and postsymposium surveys including: demographics; PD/PRD knowledge (0-10 points possible); empathy (Interpersonal Reactivity Index); and 10-point scales of confidence with and attitudes towards individuals with PD/PRD, respectively. Pre-post intervention changes and effect sizes were evaluated with paired ttests and Cohen's d. We performed qualitative analyses of post-symposium free-text feedback using a grounded theory approach to identify participants' intentions to change their practice. **Results:** Participants had a mean improvement of 3.1 points on the PD/PRD knowledge test (p < 0.001, d = 1.97), and improvement in confidence managing individuals with PD/PRD (p = 0.0003, d = .36), and no change in empathy. The interactive, virtual format was rated as effective by 95%. Common themes regarding symposium-motivated practice change included: interdisciplinary collaboration; greater involvement and weighting of the patient and caregiver voice in care plans; attention to visit scheduling in relation to patient function; recognition and practical management of the causes of sudden change in PD/PRD, including infections and orthostatic hypotension. **Conclusions:** A virtual, multimodal, brief educational pilot intervention improved PD/PRD-specific knowledge and confidence among home healthcare nurses and allied health professionals. Future studies are necessary to test the short- and long-term effects of this intervention more broadly and to investigate the impact of this education on patient and caregiver outcomes.





Huber T, Paschold M,	Introduction: Immersive virtual reality (VR) laparoscopy simulation connects VR
Hansen C, Lang H, Kneist W.	simulation with head-mounted displays to increase presence during VR training.
Artificial Versus Video-Based	The goal of the present study was the comparison of 2 different surroundings
Immersive Virtual	according to performance and users' preference. <b>Methods:</b> With a custom
Surroundings: Analysis of	immersive virtual reality laparoscopy simulator, an artificially created VR
Performance and User's	operating room (AVR) and a highly immersive VR operating room (IVR) were
Preference. Surg Innov.	compared. Participants (n = 30) performed 3 tasks (peg transfer, fine dissection,
2018;25(3):280-285.	and cholecystectomy) in AVR and IVR in a crossover study design. <b>Results:</b> No
doi:10.1177/1553350618761	overall difference in virtual laparoscopic performance was obtained when
756	comparing results from AVR with IVR. Most participants preferred the IVR
	surrounding (n = 24). Experienced participants (n = 10) performed significantly
	better than novices (n = 10) in all tasks regardless of the surrounding ( $P < .05$ ).
	Participants with limited experience (n = 10) showed differing results. Presence,
	immersion, and exhilaration were significantly higher in IVR. Two thirds assumed
	that IVR would have a positive influence on their laparoscopic simulator use.
	<b>Conclusion:</b> This first study comparing AVR and IVR did not reveal differences in
	virtual laparoscopic performance. IVR is considered the more realistic
	surrounding and is therefore preferred by the participants.
Jacobsen N, Larsen JD,	Contrast-enhanced ultrasound (CEUS) is used in various medical specialties as
Falster C, et al. Using	a diagnostic imaging tool and for procedural guidance. Experience in the
Immersive Virtual Reality	procedure is currently attained via supervised clinical practice that is challenged
Simulation to Ensure	by patient availability and risks. Prior simulation-based training and subsequent
Competence in Contrast-	assessment could improve and ensure competence before performance on
Enhanced	patients, but no simulator currently exists. Immersive virtual reality (IVR) is a new
Ultrasound. Ultrasound Med	promising simulation tool that can replicate complex interactions and
Biol. 2022;48(5):912-923.	environments that are unfeasible to achieve by traditional simulators. This study
doi:10.1016/j.ultrasmedbio.	was aimed at developing an IVR simulation-based test for core CEUS
2022.01.015	competencies and gathering validity evidence for the test in accordance with
	Messick's framework. The test was developed by IVR software specialists and
	clinical experts in CEUS and medical education and imitated a CEUS
	examination of a patient with a focal liver lesion with emphasis on the pre-
	contrast preparations. Twenty-five medical doctors with varying CEUS
	experience were recruited as test participants, and their results were used to
	analyze test quality and to establish a pass/fail standard. The final test of 23 test
	items had good internal reliability (Cronbach's $\alpha$ = 0.85) and discriminatory
	abilities. The risks of false positives and negatives (9.1% and 23.6%,
	respectively) were acceptable for the test to be used as a certification tool prior
	to supervised clinical training in CEUS.





Javaid M, Haleem A, Singh RP, Khan S. Understanding roles of virtual reality in radiology. <i>Internet of Things</i> <i>and Cyber-Physical Systems</i> . 2022;2:91-98. doi:10.1016/j.iotcps.2022.06 .002	Radiology includes a wide range of imaging technologies that use different technologies to capture patients' data. Virtual Reality (VR) is an innovative technology that provides a clear virtual image of a patient. We see the vast potential of VR to provide a positive impact in radiology. Most relevant papers on Virtual reality in Healthcare/Radiology are identified from Scopus, ScienceDirect, Google Scholar and ResearchGate. Paper tries to technologically explore VR and its applications to improve radiological training and learners' participation levels. Paper briefs about Virtual reality and its working process steps for radiology based clinical treatments. Supportive features of virtual reality in the broad radiology domain are discussed diagrammatically. This paper's primary strength is identifying and discussing thirteen significant VR applications in radiology. VR is an important technology that is viable for healthcare. With the integration of various components and software, it provides a complete virtual display. In the starting years, this technology was for entertainment purposes. Nowadays, this technology is used to visualise the internal structure. The patient's internal or external parts are used to create more integrated interaction, providing a better procedure for guidance. A radiologist can benefit from this technology for trainees' procedural planning, in-process guidance, detection, diagnosis, and education.
Junge K, Larsen JD,	<b>Objective:</b> Focused assessment with sonography for trauma (FAST) is a valuable
Education in Focused	based education in EAST to ensure competencies. Immersive virtual reality (IVR)
Assessment With	is a progressive training modality gaining traction in the field of ultrasound
Sonography for Trauma	training. IVR holds several economic and practical advantages to the common
Using Immersive Virtual	instructor-led FAST courses using screen-based simulation (SBS). <b>Methods:</b>
Reality: A Prospective,	This prospective, interventional cohort study investigated whether training FAST
Interventional Cohort Study	using IVR unsupervised and out-of-hospital was non-inferior to a historical
and Non-inferiority Analysis	control group training at a 90 min SBS course in terms of developing FAST
With a Historical Control.	competencies in novices. Competencies were assessed in both groups using
Ultrasound in Medicine &	the same post-training simulation-based FAST test with validity evidence, and a
Biology. 2024;50(2):277-284.	non-inferiority margin of 2 points was chosen. <b>Results:</b> A total of 27 medical
doi:10.1016/j.ultrasmedbio.	students attended the IVR course, and 27 junior doctors attended the SBS
2023.10.013	course. The IVR group trained for a median time of 117 min and scored a mean
	14.2 ± 2.0 points, compared with a mean 13.7 ± 2.5 points in the SBS group. As
	the lower bound of the 95% confidence interval at 13.6 was within the range of
	the non-inferiority margin (11.7–13.7 points), training FAST in IVR for a median of
	117 min was found non-inferior to training at a 90 min SBS course. No significant
	correlation was found between time spent in IVR and test scores. <b>Conclusion:</b>
	Within the limitations of the use of a historical control group, the results suggest
	that IVR could be an alternative to SBS FAST training and suitable for
	unsupervised, out-of-hospital courses in basic FAST competencies.





Kang JM, Kim N, Lee SY, et al. Effect of Cognitive Training in Fully Immersive Virtual Reality on Visuospatial Function and Frontal-Occipital Functional Connectivity in Predementia: Randomized Controlled Trial. *J Med Internet Res.* 2021;23(5):e24526. Published 2021 May 6. doi:10.2196/24526 **Background:** Cognitive training can potentially prevent cognitive decline. However, the results of recent studies using semi-immersive virtual reality (VR)assisted cognitive training are inconsistent. **Objective:** We aimed to examine the hypothesis that cognitive training using fully immersive VR, which may facilitate visuospatial processes, could improve visuospatial functioning, comprehensive neuropsychological functioning, psychiatric symptoms, and functional connectivity in the visual brain network in predementia. **Methods:** Participants over 60 years old with subjective cognitive decline or mild cognitive impairment from a memory clinic were randomly allocated to the VR (n=23) or the control (n=18) group. The VR group participants received multidomain and neuropsychologist-assisted cognitive training in a fully immersive VR environment twice a week for 1 month. The control group participants did not undergo any additional intervention except for their usual therapy such as pharmacotherapy. Participants of both groups were evaluated for cognitive function using face-to-face comprehensive neuropsychological tests, including the Rey-Osterrieth Complex Figure Test (RCFT) copy task; for psychiatric symptoms such as depression, apathy, affect, and quality of life; as well as resting-state functional magnetic resonance imaging (rsfMRI) at baseline and after training. Repeated-measures analysis of variance was used to compare the effect of cognitive training between groups. Seed-to-voxel-based analyses were used to identify the cognitive improvement-related functional connectivity in the visual network of the brain. Results: After VR cognitive training, significant improvement was found in the total score ( $F_{1,39}$ =14.69, P=.001) and basic components score of the RCFT copy task (F<sub>1,39</sub>=9.27, P=.005) compared with those of the control group. The VR group also showed improvements, albeit not significant, in naming ability ( $F_{1.39}$ =3.55, P=.07), verbal memory delayed recall (F<sub>1,39</sub>=3.03, P=.09), and phonemic fluency (F<sub>1,39</sub>=3.08, P=.09). Improvements in psychiatric symptoms such as apathy ( $F_{1,39}$ =7.02, P=.01), affect ( $F_{1,39}$ =14.40, P=.001 for positive affect; F<sub>1.39</sub>=4.23, P=.047 for negative affect), and quality of life ( $F_{1,39}$ =4.49, P=.04) were found in the VR group compared to the control group. Improvement in the RCFT copy task was associated with a frontal-occipital functional connectivity increase revealed by rsfMRI in the VR group compared to the control group. **Conclusions:** Fully immersive VR cognitive training had positive effects on the visuospatial function, apathy, affect, quality of life, and increased frontal-occipital functional connectivity in older people in a predementia state. Future trials using VR cognitive training with larger sample sizes and more sophisticated designs over a longer duration may reveal greater improvements in cognition, psychiatric symptoms, and brain functional connectivity.





Katz D. Hvers B. Patten E.	<b>Background:</b> Virtual reality is emerging as an important component of medical
Sarte D. Loo M. Burnett GW.	education. Although the benefits of virtual reality are apparent, the optimal
Relationship between	strategy to orient to or differentiate learners in the virtual space have not been
demographic and social	delineated. The purpose of this study was to investigate the relationships
variables and performance	between demographic variables, social variables, and self-perceived comfort
in virtual reality among	with technology to performance on a standardized non-medical virtual reality
healthcare personnel: an	experience. <b>Methods:</b> This observational study was performed at the
observational study BMC	International Meeting on Simulation in Healthcare in 2022 This conference
Med Educ 2024:24(1):227	includes medical and non-medical attendees. Particinants provided
Published 2024 Mar 4	demographic information and participated in a scored non-medical VB
doi:10.1186/s12909-024-	experience due to the beterogeneity of the sample. Participants then completed
05180-0	a System Usability Index and NASA Task Load Index form. Participants were
	divided into low scoring medium scoring and high scoring groups according to
	their final game score for further analysis <b>Besults:</b> 05 participants were
	included in final analysis, 55 (57 0%) of participants had prior virtual reality
	experience. Higher scores were associated with younger age (11.09, $n < 0.001$ )
	identifying as male (11.00, $p < 0.001$ ) and a higher frequency of playing video
	$f_{a}$ and a higher frequency of playing video $f_{a}$ and a higher frequency of playing video $f_{a}$
	games in the past (10.50, $p < 0.001$ ). The high score group was more likely to
	report connort with virtual reality (6.29, $p = 0.005$ ) as well as connort with new technology (4.61, $n = 0.012$ ). NASA Technology approximately approxima
	Lectinology (4.61, $p = 0.012$ ). NASA Task Load index scores ireflated down and System Lipshility Index spores trended up with increasing spore. Being a pures
	System Osability muck scores trended up with increasing score. Being a nurse
	was a positive predictor of a higher score when compared to physicians in the
	multivariate analysis. <b>Conclusion:</b> Performance during an immersive virtual
	reality experience was most closely related to age, gender, and frequency of
	playing video games. Self-perceived comfort with virtual reality was more
	predictive of score than prior virtual reality experience.
Kim H, Hong JP, Kang JM, et	Background: Cognitive reserve (CR) is a concept proposed to account for
al. Cognitive reserve and the	discrepancies between the extent of brain pathology and clinical manifestations
effects of virtual reality-	of that pathology. This study aimed to explore the associations between CR and
based cognitive training on	the effects of cognitive training using fully immersive virtual reality (VR).
elderly individuals with mild	Methods: A total of 44 older adults (22 cognitively normal, 22 with mild cognitive
cognitive impairment and	impairment) underwent eight cognitive training sessions using VR for a period of
normal	4 weeks. CR was assessed using the Cognitive Reserve Index questionnaire
cognition. <i>Psychogeriatrics</i> .	(CRIq). To evaluate baseline cognitive function and the effects of VR training, the
2021;21(4):552-559.	Consortium to Establish a Registry for Alzheimer's Disease (CERAD)
doi:10.1111/psyg.12705	neuropsychological battery was administered to all participants before and after
	the training. <b>Results:</b> Greater improvement in the total CERAD score was seen
	for cognitively normal participants with higher versus lower scores on the
	Education subdomain of the CRIq. Among patients with mild cognitive
	impairment, none of the CRIq subdomain scores (Education, Working Activity,
	Leisure Time) were related to a change in CERAD total scores. The CRIq total
	score did not predict the improvement of global cognition in either group.
	<b>Conclusions:</b> This study revealed different impacts of CR on cognitive training
	according to the participants' cognitive status. It also suggests that employing
	three proxies of CR rather than using a composite score would provide a more
	accurate understanding of one's CR.





Kim HJ, Lee HK, Jang JY, et al. Immersive virtual reality simulation training for cesarean section: a randomized controlled trial. *Int J Surg*. 2024;110(1):194-201. Published 2024 Jan 1. doi:10.1097/JS9.000000000 000843 Background: Caesarean section (CS) is a complex surgical procedure that involves many steps and requires careful precision. Virtual reality (VR) simulation has emerged as a promising tool for medical education and training, providing a realistic and immersive environment for learners to practice clinical skills and decision-making. This study aimed to evaluate the educational effectiveness of a VR simulation program in training the management of patients with premature rupture of membranes (PROM) and CS. Materials and methods: A two-arm parallel randomized controlled trial was conducted with 105 eligible participants randomly assigned to the VR group (n =53) or the control group (n =52) in a 1:1 ratio. The VR group received VR simulation training focused on PROM management and CS practice, while the control group watched a video presentation with narrative of clinical scenario and recording of CS. Both groups completed questionnaires assessing their prior experiences with VR, experience in managing patients with PROM and performing CS, as well as their confidence levels. These questionnaires were administered before and after the intervention, along with a mini-test quiz. **Results:** Baseline characteristics and previous experiences were comparable between the two groups. After the intervention, the VR group had higher confidence scores in all four aspects, including managing patients with PROM, performing CS as an operator, and understanding the indications and complications of CS, compared to the control group. The VR group also achieved significantly higher scores on the mini-test quiz [median (interquartile range), 42 (37-48) in the VR group; 36 (32-40) in the control group, P < 0.001]. Conclusion: VR simulation program can be an effective educational tool for improving participants' knowledge and confidence in managing patients with PROM and performing CS.





Koucheki R, Lex JR, Morozova A, et al. Immersive Virtual Reality and Cadaveric Bone are Equally Effective in Skeletal Anatomy Education: A Randomized Crossover Noninferiority Trial. *J Surg Educ*. 2023;80(7):1028-1038. doi:10.1016/j.jsurg.2023.04. 005 **Objective:** Immersive virtual reality (IVR) technology is transforming medical education. Our aim was to compare the effectiveness of IVR with cadaveric bone models in teaching skeletal anatomy. Design: A randomized crossover noninferiority trial was conducted. Setting: Anatomy laboratory of a large medical school. Participants: Incoming first-year medical students. Participants were randomized to IVR or cadaveric groups studying upper limb skeletal anatomy, and then were crossed over to use the opposite tool, to study lower limb skeletal anatomy. Participants in both groups completed a pre-and postintervention knowledge test. The primary endpoint of the study was change in performance from the pre-to postintervention knowledge test. Surveys were completed to assess participant's impressions on IVR as an educational tool. **Results:** Fifty first-year medical students met inclusion criteria and were randomized. Among all students, the average score on the preintervention knowledge test was 14.6% (standard deviation (SD) = 18.2%) and 25.0% (SD = 17%) for upper and lower limbs, respectively. Percentage increase in scores between pre-and postintervention knowledge test, was 15.0% in the upper limb IVR group, and 16.7% for upper limb cadaveric bones (p = 0.286). For the lower limb, score increase was 22.6% in the IVR and 22.5% in the cadaveric bone group (p = 0.936). 79% of participants found that IVR was most valuable for teaching 3-dimensional orientation, anatomical relationships, and key landmarks. Majority of participants were favorable towards combination use of traditional methods and IVR technology for learning skeletal anatomy (LSM>3). Conclusions: In this randomized controlled trial, there was no significant difference in knowledge after using IVR or cadaveric bones for skeletal anatomy education. These findings have further implications for medical schools that face challenges in acquiring human cadavers and cadaveric parts.





Hospital acquired infections stemming from contaminated reusable medical devices are of increasing concern. This issue is exaggerated with the introduction of complex medical devices like endoscopes and robotic instrumentation. Although medical device manufacturers validate their cleaning instructions for use, evidence in the literature demonstrates that effective device processing is not being performed consistently within sterile processing departments in clinical settings. The result is increased risks to patient safety. As a solution to this problem, focused one-on-one training increases
compliance to the medical device manufacturer's processing instruction. However, often this is not a practical solution for the volume of healthcare staff responsible for device processing activities. This constitutes the first paper to
address the blended use of educational and digital technologies to address these challenges and as a result inform safety and sustainability for the medical device sector. Cognitive learning theory is an evidence-based framework for learning. It supports the use of immersive educational experiences using emerging extended reality technologies (e.g., virtual or augmented reality) to increase learning comprehension. The delivery of educational content via these technologies provides an innovative option for repeatable leaning and training outcomes. The motivation is to decrease patient risk of contaminated reusable medical devices. The proposed approach while primary motivated by safety can also enhance sustainability and efficiency enabled by artificial intelligence and robotic instrumentation.
The aim of this study was to investigate the effect of immersive three- dimensional (3D) interactive virtual reality (VR) on anatomy training in undergraduate physical therapy students. A total of 72 students were included in the study. The students were randomized into control (n = 36) and VR (n = 36) group according to the Kolb Learning Style Inventory, sex, and Purdue Spatial Visualization Test Rotations (PSVT-R). Each student completed a pre- intervention and post-intervention test, consisting of 15 multiple-choice questions. There was no significant difference between the two groups in terms of age, sex, Kolb Learning Style Inventory distribution, and the PSVT-R (P > 0.05). The post-test scores were significantly higher compared to pre-test scores in both the VR group (P < 0.001) and the control group (P < 0.001). The difference between the pre-test and post-test results was found to be significantly higher in favor of the VR group (P < 0.001). In this study, anatomy training with a 3D immersive VR system was found to be beneficial. These results suggest that VR systems can be used as an alternative method to the conventional anatomy





Lan L, Mao RQ, Qiu RY, Kay J,	Background: Immersive virtual reality (iVR) facilitates surgical decision-making
de Sa D. Immersive Virtual	by enabling surgeons to interact with complex anatomic structures in realistic 3-
Reality for Patient-Specific	dimensional environments. With emerging interest in its applications, its effects
Preoperative Planning: A	on patients and providers should be clarified. This systematic review examines
Systematic Review. Surg	the current literature on iVR for patient-specific preoperative planning. <b>Materials</b>
Innov. 2023;30(1):109-122.	and Methods: A literature search was performed on five databases for
doi:10.1177/1553350622114	publications from January 1, 2000 through March 21, 2021. Primary studies on
3235	the use of iVR simulators by surgeons at any level of training for patient-specific
	preoperative planning were eligible. Two reviewers independently screened
	titles, abstracts, and full texts, extracted data, and assessed quality using the
	Quality Assessment Tool for Studies with Diverse Designs (QATSDD). Results
	were qualitatively synthesized, and descriptive statistics were
	calculated. <b>Results:</b> The systematic search yielded 2,555 studies in total, with
	24 full-texts subsequently included for qualitative synthesis, representing 264
	medical personnel and 460 patients. Neurosurgery was the most frequently
	represented discipline (10/24; 42%). Preoperative IVR did not significantly
	Improve patient-specific outcomes of operative time, blood loss, complications,
	and length of stay, but may decrease fluoroscopy time. In contrast, IVR improved
	surgeon-specific outcomes of surgical strategy, anatomy visualization, and
	confidence. Validity, reliability, and reasibility of patient-specific fVR models
	22.0% Conclusions: Immersive VP improves surgeen experiences of
	sz. 3%. <b>Conclusions.</b> Initial sive via inproves surgeon experiences of
	outcomes. Future work should focus on high-quality studies investigating long-
	term natient outcomes, and utility of preoperative iVR for trainees
Lan L Sikov L Leieune L et	<b>Objective:</b> Immersive virtual reality (VB) and augmented reality (AB) have the
al. A Systematic Review of	potential to improve the treatment and diagnosis of individuals experiencing
using Virtual and Augmented	psychosis. Although commonly used in creative industries, emerging evidence
Reality for the Diagnosis and	reveals that VR is a valuable tool to potentially improve clinical outcomes.
Treatment of Psychotic	including medication adherence, motivation, and rehabilitation. However, the
Disorders. Curr Treat	efficacy and future directions of this novel intervention require further study. The
Options Psychiatry.	aim of this review is to search for evidence of efficacy in enhancing existing
Published online June 14,	psychosis treatment and diagnosis with AR/VR. <b>Methods:</b> 2069 studies involving
2023. doi:10.1007/s40501-	AR/VR as a diagnostic and treatment option were reviewed via PRISMA
023-00287-5	guidelines in five databases: PubMed, PsychInfo, Embase, and CINAHL.
	Results: Of the initial 2069 articles, 23 original articles were eligible for
	inclusion. One study applied VR to the diagnosis of schizophrenia. Most studies
	demonstrated that the addition of VR therapies and rehabilitation methods to
	treatment-as-usual (medication, psychotherapy, social skills training) was more
	effective than traditional methods alone in treating psychosis disorders. Studies
	also support the feasibility, safety, and acceptability of VR to patients. No
	articles using AR as a diagnostic or treatment option were found.
	Conclusions: VR is efficacious in diagnosing and treating individuals
	experiencing psychosis and is a valuable augmentation of evidence-based
	treatments.





Larsen JD, Jensen RO, Pietersen PI, et al. Education in Focused Lung Ultrasound Using Gamified Immersive Virtual Reality: A Randomized Controlled Study. <i>Ultrasound Med Biol</i> . 2023;49(3):841-852. doi:10.1016/j.ultrasmedbio. 2022.11.011	Focused lung ultrasound (FLUS) has high diagnostic accuracy in many common conditions seen in a variety of emergency settings. Competencies are essential for diagnostic success and patient safety but can be challenging to acquire in clinical environments. Immersive virtual reality (IVR) offers an interactive risk-free learning environment and is progressing as an educational tool. First, this study explored the educational impact of novice FLUS users participating in a gamified or non-gamified IVR training module in FLUS by comparing test scores using a test with proven validity evidence. Second, the learning effect was assessed by comparing scores of each group with known test scores of novices, intermediates and experienced users in FLUS. A total of 48 participants were included: 24 received gamified and 24 received non-gamified IVR training. No significant difference was found between gamified (mean = 15.5 points) and non-gamified (mean = 15.2 points), indicating that chosen gamification elements for our setup did not affect learning outcome (p = 0.66). The mean scores of both groups did not significantly differ from those of known intermediate users in FLUS (gamified p = 0.63, non-gamified p = 0.24), indicating that both IVR modules could be used as unsupervised out-of-hospital training for novice trainees in FLUS.
Lau ST, Liaw SY, Loh WL, et al. Mid-career switch nursing students' perceptions and experiences of using immersive virtual reality for clinical skills learning: A mixed methods study. <i>Nurse Educ Today</i> . 2023;124:105760. doi:10.1016/j.nedt.2023.105 760	<b>Background:</b> There has been an increase of mid-career professionals joining nursing. These adult students possess significant expertise in other areas and may benefit substantially in deliberate practice to acquire skills competency using immersive virtual reality (IVR) for clinical procedures before they practise in actual clinical settings. <b>Objectives:</b> This study aims to (1) examine the impact of IVR clinical procedures on mid-career switch students in knowledge, game perception and user reaction; (2) to explore the mid-career switch students' perceptions and experiences in using the IVR clinical procedures. <b>Design:</b> A mixed methods feasibility study was used. <b>Setting and participants:</b> This study was conducted at a university in Singapore with 34 first-year mid-career switch students. <b>Methods:</b> This study is a single-group pre-test and post-test experimental study on learning clinical procedures using IVR in the home setting. The study took place from September to November 2021. Focus group discussions were conducted and analysed verbatim using thematic analysis. <b>Results:</b> The students demonstrated significant improvement of knowledge for subcutaneous insulin, but overall, the increase in combined scores for both intravenous therapy and subcutaneous insulin were not statistically significant. Three overarching themes included: 1) Learning and practice, 2) Challenges and barriers, and 3) Personal attributes. Most of the participants found the experiences to be engaging, relevant, and satisfying. Some reported experiencing giddiness, headache, and lack of familiarity with technologies. <b>Conclusions:</b> IVR simulation can potentially be used as a supplementary learning tool to improve knowledge of clinical procedures in mid-career switch students.





Lee SH, Jung HY, Yun SJ, Oh Background: Rehabilitation therapy using a virtual reality (VR) system for stroke BM, Seo HG. Upper patients has gained attention. However, few studies have investigated fully **Extremity Rehabilitation** immersive VR using a head-mount display (HMD) for upper extremity Using Fully Immersive Virtual rehabilitation in stroke patients. **Objective:** To investigate the feasibility, Reality Games With a Head preliminary efficacy, and usability of a fully immersive VR rehabilitation program Mount Display: A Feasibility using a commercially available HMD for upper-limb rehabilitation in stroke patients. Design: A feasibility study. Setting: Two rehabilitation centers. Study. PM R. 2020;12(3):257-262. doi:10.1002/pmrj.12206 **Participants:** Twelve stroke patients with upper extremity weakness. Interventions: Five upper extremity rehabilitation tasks were implemented in a virtual environment, and the participants wore an HMD (HTC Vive) and trained with appropriate tasks. Participants received a total of 10 sessions two to three times a week, consisting of 30 minutes per session. Main outcome measures: Both patient participation and adverse effects of VR training were monitored. Primary efficacy was assessed using functional outcomes (Action Research Arm Test, Box and Block Test, and modified Barthel Index), before and after the intervention. Usability was assessed using a self-reported questionnaire. **Results:** Three patients discontinued VR training, and nine patients completed the entire training sessions and there were no adverse effects due to motion sickness. The patients who received all sessions showed significant functional improvement in all outcome measures after training (P < .05 for all measures). The overall satisfaction was 6.3 ± 0.8 on a 7-point Likert scale in all participants. **Conclusions:** A fully immersive VR rehabilitation program using an HMD for rehabilitation of the upper extremities following stroke is feasible and, in this small study, no serious adverse effects were identified.





Li S. Immersive technologies	Immersive technologies are playing an increasingly crucial role in revolutionizing
in health professions	health professions education, as they provide students with realistic and
education: A bibliometric	interactive learning experiences. These experiences better prepare them for the
analysis. Computers &	complexities and challenges they will encounter in real-world healthcare
Education: X Reality.	practice. To comprehensively explore the growth, trends, and patterns at the
2024;4:100051.	intersection of immersive technologies and health professions education, a
doi:10.1016/j.cexr.2024.100	bibliometric analysis was conducted in May 2023 using the Clarivate Analytics -
051	Web of Science Core Collection database. Specifically, we conducted a
	thorough descriptive examination of various facets within the dataset of 956
	bibliographic records, obtained through a systematic literature search. We
	presented descriptive insights from this scientific literature at multiple levels.
	including the article (e.g., most frequent words, important themes, trends of
	keywords), journal (most productive, and most cited journals), affiliation (most
	productive affiliations), and country (most productive, and most cited countries)
	levels Furthermore we explored the concentual intellectual and social
	structures of this field of study represented by the co-occurrence network co-
	word network and collaboration network respectively. These analyses
	collectively painted a comprehensive picture of the research landscape within
	the realm of immersive technologies in health professions education. This study
	not only contributes to the identification of trends and gaps in the literature but
	also provides actionable inside for educators, researchers, and policymakers
	regarding influential players, resource allocation, researchers, and policymakers
Lim DV Hwang DM Cha KH	<b>Objective:</b> To determine whether a fully immersive virtual reality (VP)
Moon CW/ Abn SV A Fully	intervention combined with conventional rehabilitation (CP) can improve upper
Immorphy Virtual Papility	limb function more than CP clone in patients with anigol pard injury (SCI) we
Mothed for Upper Limb	and unction more than CK atome in patients with spinal cord injury (SCI), we
Republication in Chinal Card	Methode: Derticinente were renderely assigned to either the central group (CC)
Renabilitation in Spinal Cord	<b>Methods:</b> Participants were randomly assigned to either the control group (CG;
Injury. Ann Renabil Med.	n=10) or experimental group (EG; n=10). The participants in the CG received 60
2020;44(4):311-319.	minutes of conventional therapy per day, 4 days per week for 4 weeks, whereas
doi:10.5535/arm.19181	those in the EG received 30 minutes of VR training and 30 minutes of
	conventional therapy per day, 4 days per week for 4 weeks. The clinical outcome
	measures included Medical Research Council grade, the American Spinal Injury
	Association upper extremity motor score (ASIA-UEMS), and scores in the Hand
	Strength Test, Box and Block Test, Nine-Hole Peg Test, Action Research Arm
	Test, and Korean version of the Spinal Cord Independence Measure (K-SCIM).
	The assessments were performed at the beginning (T0) and end of the
	intervention (T1). <b>Results:</b> Grip power and K-SCIM score significantly improved
	in the EG after the intervention. When comparing differences between the
	groups, elbow extensor, wrist extensor, ASIA-UEMS, grip power, lateral pinch
	power, and palmar pinch power were all significantly improved. <b>Conclusion:</b> VR
	training of upper limb function after SCI can provide an acceptable adjunctive
	rehabilitation method without significant adverse effects.





Lim I, Cha B, Cho DR, Park E, Lee KS, Kim M. Safety and Potential Usability of Immersive Virtual Reality for Brain Rehabilitation: A Pilot Study. <i>Games Health J</i> . 2023;12(1):34-41. doi:10.1089/g4h.2022.0048	<b>Objective:</b> This study was conducted to demonstrate the safety and usability of an immersive virtual reality (VR) game as a rehabilitative training by assessing adverse events (AEs), adherence, and satisfaction in patients with brain injury who had free optional opportunities. <b>Materials and Methods:</b> The results were analyzed retrospectively. Seventy-eight patients with brain injury, undergoing rehabilitation treatment for motor impairment, were recruited. Among them, 51 were available for postintervention survey. The immersive type of VR training was programmed to facilitate use of the paralyzed upper extremity through a fishing simulation game. The Oculus Rift was used as head-mounted display device. Patients were observed for any AEs as defined in the Common Terminology Criteria for AEs during and after each VR training session. A postintervention telephone survey was done to investigate adherence-related factors and safety. <b>Results:</b> The results were analyzed after dividing the patients into nonadherence (patients participated <3 times) and high-adherence (≥3 times) groups. No serious AEs were reported during and after the VR training, and several patients reported other AEs, predominantly dizziness, with one case requiring cessation of VR training. Overall, the satisfaction rate was 54%. Compared with the nonadherence group, the high-adherence group expressed higher satisfaction with VR training, regarded it as effective for recovery from upper limb paralysis, accepted VR as comprehensible, and considered the level of difficulty to be appropriate ( $P < 0.05$ ). <b>Conclusion:</b> Immersive VR training appeared to be safe for patients with brain injury.
Lin Q, Xu Z, Li B, et al. Immersive Virtual Reality for Visualization of Abdominal CT. <i>Proc SPIE Int Soc Opt</i> <i>Eng.</i> 2013;8673:10.1117/12.2008 050. doi:10.1117/12.2008050	Immersive virtual environments use a stereoscopic head-mounted display and data glove to create high fidelity virtual experiences in which users can interact with three-dimensional models and perceive relationships at their true scale. This stands in stark contrast to traditional PACS-based infrastructure in which images are viewed as stacks of two-dimensional slices, or, at best, disembodied renderings. Although there has substantial innovation in immersive virtual environments for entertainment and consumer media, these technologies have not been widely applied in clinical applications. Here, we consider potential applications of immersive virtual environments for ventral hernia patients with abdominal computed tomography imaging data. Nearly a half million ventral hernias occur in the United States each year, and hernia repair is the most commonly performed general surgery operation worldwide. A significant problem in these conditions is communicating the urgency, degree of severity, and impact of a hernia (and potential repair) on patient quality of life. Hernias are defined by ruptures in the abdominal wall (i.e., the absence of healthy tissues) rather than a growth (e.g., cancer); therefore, understanding a hernia necessitates understanding the entire abdomen. Our environment allows surgeons and patients to view body scans at scale and interact with these virtual models using a data glove. This visualization and interact medical imaging data. The system provides close integration of PACS-based CT data with immersive virtual environments and creates opportunities to study and optimize interfaces for patient communication, operative planning, and medical education.





Liu JYW, Yin YH, Kor PPK, et al. The Effects of Immersive Virtual Reality Applications on Enhancing the Learning Outcomes of Undergraduate Health Care Students: Systematic Review With Meta-synthesis. *J Med Internet Res*. 2023;25:e39989. Published 2023 Mar 6. doi:10.2196/39989 Background: Immersive virtual reality (IVR) applications are gaining popularity in health care education. They provide an uninterrupted, scaled environment capable of simulating the full magnitude of sensory stimuli present in busy health care settings and increase students' competence and confidence by providing them with accessible and repeatable learning opportunities in a failsafe environment. Objective: This systematic review aimed to evaluate the effects of IVR teaching on the learning outcomes and experiences of undergraduate health care students compared with other teaching methods. Methods: MEDLINE, Embase, PubMed, and Scopus were searched (last search on May 2022) for randomized controlled trials (RCTs) or quasi-experimental studies published in English between January 2000 and March 2022. The inclusion criteria were studies involving undergraduate students majoring in health care, IVR teaching, and evaluations of students' learning outcomes and experiences. The methodological validity of the studies was examined using the Joanna Briggs Institute standard critical appraisal instruments for RCTs or quasiexperimental studies. The findings were synthesized without a meta-analysis using vote counting as the synthesis metric. A binomial test with P<.05 was used to test for statistical significance using SPSS (version 28; IBM Corp). The overall quality of evidence was evaluated using the Grading of Recommendations Assessment, Development, and Evaluation tool. Results: A total of 17 articles from 16 studies totaling 1787 participants conducted between 2007 and 2021 were included. The undergraduate students in the studies majored in medicine, nursing, rehabilitation, pharmacy, biomedicine, radiography, audiology, or stomatology. The IVR teaching domains included procedural training (13/16, 81%), anatomical knowledge (2/16, 12%), and orientation to the operating room setting (1/16, 6%). The quality of the 75% (12/16) of RCT studies was poor, with unclear descriptions of randomization, allocation concealment, and outcome assessor blinding procedures. The overall risk of bias was relatively low in the 25% (4/16) of quasi-experimental studies. A vote count showed that 60% (9/15; 95% CI 16.3%-67.7%; P=.61) of the studies identified similar learning outcomes between IVR teaching and other teaching approaches regardless of teaching domains. The vote count showed that 62% (8/13) of the studies favored using IVR as a teaching medium. The results of the binomial test (95% CI 34.9%-90%; P=.59) did not show a statistically significant difference. Low-level evidence was identified based on the Grading of Recommendations Assessment, Development, and Evaluation tool. Conclusions: This review found that undergraduate students had positive learning outcomes and experiences after engaging with IVR teaching, although the effects may be similar to those of other forms of virtual reality or conventional teaching methods. Given the identification of risk of bias and low level of the overall evidence, more studies with a larger sample size and robust study design are required to evaluate the effects of IVR teaching.





Liu Z, He Z, Yuan J, et al. Application of Immersive Virtual-Reality-Based Puzzle Games in Elderly Patients with Post-Stroke Cognitive Impairment: A Pilot Study. *Brain Sci*. 2022;13(1):79. Published 2022 Dec 31. doi:10.3390/brainsci130100 79 **Background:** The society is aging in China, and the cognitive level of elderly post-stroke patients gradually declines. Face-to-face cognitive functional training is no longer sufficient. Immersive virtual reality (IVR) is a promising rehabilitation training device. In this study, we developed an IVR-based puzzle game to explore its effectiveness, feasibility, and safety in elderly stroke patients with cognitive dysfunction. Methods: A total of 30 patients with mild post-stroke cognitive impairment after stroke were randomly assigned to a control or IVR group. Patients in both groups received routine rehabilitation therapy. Patients in the control group received traditional cognitive training, and those in the IVR group received IVR-based puzzle game therapy. Before and after treatment, Montreal cognitive assessment (MOCA), trail-making test-A (TMT-A), digit symbol substitution test (DSST), digital span test (DST), verbal fluency test (VFT), and modified Barthel index (MBI) were evaluated in both groups. In addition, the IVR group was administered a self-report questionnaire to obtain feedback on user experience. **Results:** There was no significant difference in the baseline data between the two groups. After six weeks of treatment, the cognitive assessment scores were improved in both groups. Moreover, the IVR group showed more improvements than the control group in the DSST (Z = 2.203, p =0.028 < 0.05, n2 = 0.16); MOCA (T = 1.186, p = 0.246 > 0.05, d = 0.44), TMT-A (T = 1.791, p = 0.084 > 0.05, d = 0.65), MBI (T = 0.783, p = 0.44 > 0.05, d = 0.28), FDST (Z = 0.78, p = 0.435 > 0.05, n2 = 0.02), BDST (Z = 0.347, p = 0.728 > 0.05, n2 = 0.004), and VFT(Z = 1.087, p = 0.277 > 0.05,  $\eta 2 = 0.039$ ) did not significantly improve. The significant difference in DSST represents an improvement in executive function and visual-spatial cognitive characteristics. The other assessment scores did not show such features. Therefore, we did not observe significant differences through this measure. According to the results of the selfreport questionnaire, most of the patients were satisfied with the equipment stability and training content. Several individuals reported mild adverse reactions. **Conclusions:** This pilot study suggests that IVR-based puzzle games are a promising approach to improve post-stroke cognitive function, especially executive cognitive function, and visual-spatial attention in older adults.





Lo YT, Yang CC, Yeh TF, Tu HY, Chang YC. Effectiveness of immersive virtual reality training in nasogastric tube feeding education: A randomized controlled trial. *Nurse Educ Today*. 2022;119:105601. doi:10.1016/j.nedt.2022.105 601 Background: Given rapidly aging societies worldwide, improving the quality of long-term care through the cultivation of immense nursing assistants is critical. Accordingly, developing a satisfactory learning model to improve the learning outcomes of nursing assistant students is imperative. Objective: This study tested the hypothesis that students in long-term care departments who underwent immersive virtual reality (IVR) training would have significantly (1) higher levels of knowledge about the skills of nasogastric tube feeding, (2) higher learning motivations (i.e., intrinsic and extrinsic motivations, task values, and self-efficacy), (3) lower cognitive load, and (4) higher satisfaction than a control group. **Design:** A randomized controlled trial with pretest and posttest design. Settings and participants: We randomly assigned 107 students from the longterm care departments of two universities in central Taiwan to the IVR group (n = 54) or the control group (n = 53). Methods: The IVR group learned the procedure of nasogastric tube feeding through IVR, whereas the control group watched a 15-min 2D video. The participants filled pretest and posttest questionnaires on nasogastric tube feeding knowledge. After the experiment was completed, the participants answered another questionnaire on their learning motivations, cognitive load, and learning satisfaction. **Results:** The nasogastric tube feeding knowledge improved significantly in the IVR and control groups after the intervention, with no significant between-group differences. The IVR group scored significantly higher than the control group on extrinsic goals, task value, and satisfaction; nevertheless, they also experienced a significantly higher cognitive load. Conclusions: Both the IVR training and the traditional 2D video improved the learning outcomes of the nursing assistant students. The students were more satisfied with IVR than with the conventional learning model and indicated that IVR inspired their extrinsic learning motivations and perceived task value. However, IVR incurred a high cognitive load, which must be addressed in future course designs.





Lohre R, Bois AJ, Pollock JW, et al. Effectiveness of Immersive Virtual Reality on Orthopedic Surgical Skills and Knowledge Acquisition Among Senior Surgical Residents: A Randomized Clinical Trial. JAMA Netw Open. 2020;3(12):e2031217. Published 2020 Dec 1. doi:10.1001/jamanetworkop en.2020.31217 Importance: Video learning prior to surgery is common practice for trainees and surgeons, and immersive virtual reality (IVR) simulators are of increasing interest for surgical training. The training effectiveness of IVR compared with video training in complex skill acquisition should be studied. **Objectives:** To evaluate whether IVR improves learning effectiveness for surgical trainees and to validate a VR rating scale through correlation to real-world performance. Design, setting, and participants: This block randomized, intervention-controlled clinical trial included senior (ie, postgraduate year 4 and 5) orthopedic surgery residents from multiple institutions in Canada during a single training course. An intention-to-treat analysis was performed. Data were collected from January 30 to February 1, 2020. Intervention: An IVR training platform providing a casebased module for reverse shoulder arthroplasty (RSA) for advanced rotator cuff tear arthropathy. Participants were permitted to repeat the module indefinitely. Main outcomes and measures: The primary outcome measure was a validated performance metric for both the intervention and control groups (Objective Structured Assessment of Technical Skills [OSATS]). Secondary measures included transfer of training (ToT), transfer effectiveness ratio (TER), and costeffectiveness (CER) ratios of IVR training compared with control. Additional secondary measures included IVR performance metrics measured on a novel rating scale compared with real-world performance. Results: A total of 18 senior surgical residents participated; 9 (50%) were randomized to the IVR group and 9 (50%) to the control group. Participant demographic characteristics were not different for age (mean [SD] age: IVR group, 31.1 [2.8] years; control group, 31.0 [2.7] years), gender (IVR group, 8 [89%] men; control group, 6 [67%] men), surgical experience (mean [SD] experience with RSA: IVR group, 3.3 [0.9]; control group, 3.2 [0.4]), or prior simulator use (had experience: IVR group 6 [67%]; control group, 4 [44%]). The IVR group completed training 387% faster considering a single repetition (mean [SD] time for IVR group: 4.1 [2.5] minutes; mean [SD] time for control group: 16.1 [2.6] minutes; difference, 12.0 minutes; 95% CI, 8.8-14.0 minutes; P < .001). The IVR group had significantly better mean (SD) OSATS scores than the control group (15.9 [2.5] vs 9.4 [3.2]; difference, 6.9; 95% CI, 3.3-9.7; P < .001). The IVR group also demonstrated higher mean (SD) verbal questioning scores (4.1 [1.0] vs 2.2 [1.7]; difference, 1.9; 95% CI, 0.1-3.3; P = .03). The IVR score (ie, Precision Score) had a strong correlation to real-world OSATS scores (r = 0.74) and final implant position (r = 0.73). The ToT was 59.4%, based on the OSATS score. The TER was 0.79, and the system was 34 times more cost-effective than control, based on CER. Conclusions and relevance: In this study, surgical training with IVR demonstrated superior learning efficiency, knowledge, and skill transfer. The TER of 0.79 substituted for 47.4 minutes of operating room time when IVR was used for 60 minutes.





Lohre R, Warner JJP, Morrey BR, et al. Mitigating Surgical Skill Decay in Orthopaedics Using Virtual Simulation Learning. <i>J Am Acad Orthop</i> <i>Surg Glob Res Rev.</i> 2021;5(10):10.5435/JAAOSGl obal-D-21-00193. Published 2021 Oct 12. doi:10.5435/JAAOSGlobal-D- 21-00193	<b>Background:</b> The COVID-19 pandemic has interrupted orthopaedic training structures for both surgeons and trainees. The concept of skill decay must be considered during inactivity of elective practice. The purpose of this study was to provide an evidence-based curriculum in association with immersive virtual reality (iVR) to prevent skill decay during periods of training cessation and beyond. <b>Methods:</b> A review of pertinent literature for orthopaedic surgical skill decay was performed. Early experience by faculty instructors and residency and fellowship program directors was gathered from multiple institutions with experience in virtual training methods including iVR. A proposed curriculum for cognitive and manual skill acquisition during COVID-19 was produced from qualitative narrative group opinion. <b>Results:</b> Skill decay can occur on the order of days to months and is dependent on the initial skill level. A novel curriculum for structured continuing medical education during and after periods of surgical disruption including e-learning, virtual meetings, and iVR simulators was produced from expert opinion and based on competency-based curriculum standards. <b>Conclusion:</b> Skill decay mitigation strategies should use best available evidence technologies and course structures that satisfy advanced learning concepts. The virtual curriculum including iVR simulators may provide cost-effective solutions to training.
López Chávez O, Rodríguez LF, Gutierrez-Garcia JO. A comparative case study of 2D, 3D and immersive- virtual-reality applications for healthcare education. <i>Int J Med Inform</i> . 2020;141:104226. doi:10.1016/j.ijmedinf.2020. 104226	<b>Background and objective:</b> The workings of medical educational tools are implemented using a myriad of approaches ranging from presenting static content to immersing students in gamified virtual-reality environments. The objective of this paper is to explore whether and how different approaches for designing medical educational tools affect students' learning performance. <b>Materials and methods:</b> Four versions of an educational tool for the study of clinical cases were implemented: a 2D version, a gamified 2D version, a gamified 3D version, and a gamified immersive-virtual-reality version. All complying with the same functional requirements. Each version was used and evaluated by an independent group of students. The participants (n = 78) evaluated the applications regarding usefulness, usability, and gamification. Afterward, the students took an exam to assess the retention of information on the clinical cases presented. <b>Results:</b> One-sample Wilcoxon signed-rank tests confirmed that the participants perceived that it was at least quite likely that gamification helped improved their learning. In addition, based on the participants' perception, the gamification of the immersive-virtual-reality version helped the most to improve their learning performance in comparison with the gamified 2D and 3D versions. <b>Conclusions:</b> Regardless of whether different versions of a medical educational tool (complying with the same functional requirements) are perceived as equally useful and usable, the design approach
	students' retention of information on clinical cases.





Lu J, Leng A, Zhou Y, et al. An innovative virtual reality training tool for the pre- hospital treatment of cranialmaxillofacial trauma. <i>Comput Assist Surg</i> <i>(Abingdon)</i> . 2023;28(1):2189047. doi:10.1080/24699322.2023. 2189047	Virtual reality (VR) surgery using the High Technology Computer Corporation Very Immersive Virtual Experience professional 2(HTC VIVE Pro2) suite is a multi- sensory, holistic surgical training experience. A multimedia combination including videos and three-dimensional interaction in VR has been developed to enable trainees to experience a realistic battlefield environment. The innovation allows trainees to interact with the individual components of the cranialmaxillofacial(CMF) anatomy and apply surgical instruments while watching close-up stereoscopic three-dimensional videos of the surgery. In this study, a novel training tool for the pre-hospital treatment of CMF trauma based on immersive virtual reality (iVR) was developed and validated. Twenty-five CMF surgeons evaluated the application for face and content validity. Using a structured assessment process, the surgeons commented on the content of the developed training tool, its realism and usability and the applicability of VR surgery for CMF trauma rescue simulation training. The results confirmed the applicability of VR for delivering training in the pre-hospital treatment of CMF trauma. Modifications were suggested to improve the user experience and interactions with the surgical instruments. This training tool is ready for testing with surgical trainees.
Lülsdorff K, Junker FB, Studer B, Wittenberg H, Pickenbrock H, Schmidt- Wilcke T. Neurorehabilitation of the upper extremity - immersive virtual reality vs. electromechanically assisted training. A comparative study. <i>Front</i> <i>Neurol</i> . 2023;14:1290637. Published 2023 Dec 21. doi:10.3389/fneur.2023.1290 637	<ul> <li>Background: Severe paresis of the contralesional upper extremity is one of the most common and debilitating post-stroke impairments. The need for cost-effective high-intensity training is driving the development of new technologies, which can complement and extent conventional therapies. Apart from established methods using electromechanical devices, immersive virtual reality (iVR) systems hold promise to provide cost-efficient high-intensity arm training. Objective: We investigated whether iVR-based arm training yields at least equivalent effects on upper extremity function as compared to an electromechanically assisted training in stroke patients with severe arm paresis. Methods: 52 stroke patients with severe arm paresis received a total of ten daily group therapy sessions over a period of three weeks, which consisted of 20 min of conventional therapy and 20 min of either electromechanically assisted (ARMEOSpring<sup>*</sup>) or iVR-based (CUREO<sup>*</sup>) arm training. Changes in upper extremity function was assessed using the Action Research Arm Test (ARAT) and user acceptance was measured with the User Experience Questionnaire (UEQ).</li> <li>Results: iVR-based training was not inferior to electromechanically assisted training. We found that 84% of patients treated with iVR and 50% of patients treated with electromechanically assisted arm training showed a clinically relevant improvement of upper extremity function. This difference could neither be attributed to differences between the groups regarding age, gender, duration after stroke, affected body side or ARAT scores at baseline, nor to differences in the total amount of therapy provided. Conclusion: The present study results show that iVR-based arm training seems to be a promising addition to conventional therapy. Potential mechanisms by which iVR unfolds its effects are discussed.</li> </ul>





Maeng S, Hong JP, Kim WH, et al. Effects of Virtual Reality-Based Cognitive Training in the Elderly with and without Mild Cognitive Impairment. <i>Psychiatry</i> <i>Investig</i> . 2021;18(7):619- 627. doi:10.30773/pi.2020.0446	<b>Objective:</b> This study aimed to introduce a 4-week long fully immersive virtual reality-based cognitive training (VRCT) program that could be applied for both a cognitively normal elderly population and patients with mild cognitive impairment (MCI). In addition, we attempted to investigate the neuropsychological effects of the VRCT program in each group. <b>Methods:</b> A total of 56 participants, 31 in the MCI group and 25 in the cognitively normal elderly group, underwent eight sessions of VRCT for 4 weeks. In order to evaluate the effects of the VRCT, the Korean version of the Consortium to Establish a Registry for Alzheimer's Disease Assessment Packet was administered before and after the program. The program's safety was assessed using a simulator sickness questionnaire (SSQ), and availability was assessed using the presence questionnaire. <b>Results:</b> After the eighth session of the VRCT program, cognitive improvement was observed in the ability to learn new information, visuospatial constructional ability, and frontal lobe function in both groups. At the baseline evaluation, based on the SSQ, the MCI group complained of disorientation and nausea significantly more than the cognitively normal elderly group did. However, both groups showed a reduction in discomfort as the VRCT program progressed. <b>Conclusion:</b> We conclude that our VRCT program helps improve cognition in both the MCI group and cognitively normal elderly group. Therefore, the VRCT is expected to help improve cognitive function in elderly populations with and without MCI.
Mandal P, Ambade R.	A range of extended reality technology integration, including immersive virtual
Surgery Training and	reality (IVR), augmented reality (AR), as well as mixed reality, has lately acquired
Simulation Using Virtual and	favour in orthopaedics. The utilization of extended reality machinery in knee
Augmented Reality for Knee	arthroplasty is examined in this review study. Virtual reality (VR) and AR are
Arthroplasty. Cureus.	usually exercised together in orthopaedic surgical training as alluring training
2022;14(9):e28823.	outside of the operation theatre is acknowledged as a good surgical training tool.
Published 2022 Sep 6.	The use of this technology, its consequences for orthopaedic surgeons and their
doi:10.7759/cureus.28823	patients, and its moral and practical issues are also covered. Head-mounted
	displays (HMDs) are a potential addition directed toward improving surgical
	precision along with instruction. Although the hardware is cutting-edge,
	substantial effort needs to be done to develop software that enables seamless,
	rehabilitation has drawn increasing attention in recent years, and its significance
	has increased in light of the recent outbreak of the COVID-19 enidemic
	Numerous medical sectors have shown the benefits of telerebabilitation
	gamification, VR, and AR. Given the rising demand for orthopaedic therapy and
	its rising costs, this is a requirement. A remote surgeon can impart knowledge
	without being present, by virtually placing his or her hands in the visual field of a
	local surgeon using AR technology. With the use of this innovation, orthopaedic
	surgery seems to have been able to participate in the telemedicine revolution.
	This technology may also have an impact on how surgeons collaborate and train
	for orthopaedic residencies in the future. Volatility in the HMD market will
	probably stall improvements in surgical education.





Mao RQ, Lan L, Kay J, et al.	Background: Immersive virtual reality (iVR) simulators provide accessible, low
Immersive Virtual Reality for	cost, realistic training adjuncts in time and financially constrained systems. With
Surgical Training: A	increasing evidence and utilization of this technology by training programs,
Systematic Review. J Surg	clarity on the effect of global skill training should be provided. This systematic
Res. 2021;268:40-58.	review examines the current literature on the effectiveness of iVR for surgical
doi:10.1016/j.jss.2021.06.04	skills acquisition in medical students, residents, and staff surgeons. <b>Methods:</b> A
5	literature search was performed on MEDLINE, EMBASE, CENTRAL, Web of
	Science and PsycInfo for primary studies published between January 1, 2000
	and January 26, 2021. Two reviewers independently screened titles, abstracts,
	and full texts, extracted data, and assessed quality and strength of evidence
	using the Medical Education Research Quality Instrument (MERSOI) and
	Cochrane methodology. Results were qualitatively synthesized, and descriptive
	statistics were calculated. <b>Results:</b> The literature search vielded 9650 citations.
	with 17 articles included for qualitative synthesis. The mean (SD) MERSOI score
	was 11.7 (1.9) out of 18. In total, 307 participants completed training in four
	disciplines. Immersive VR-trained groups performed 18% to 43% faster on
	procedural time to completion compared to control (pooled standardized mean
	difference = -0.90 [95% CI=-1.33 to -047, I <sup>2</sup> =1%, P < 0.0001]), Immersive VR
	trainees also demonstrated greater post-intervention scores on procedural
	checklists and greater implant placement accuracy compared to control.
	<b>Conclusions:</b> Immersive VR incorporation into surgical training programs is
	supported by high-quality, albeit heterogeneous, studies demonstrating
	improved procedural times, task completion, and accuracy, positive user
	ratings, and cost-effectiveness.
Marek K. Zubrycki I. Miller E.	Immersive virtual therapy technology is a new method that uses head-mounted
Immersion Therapy with	displays for rehabilitation purposes. It offers a realistic experience that puts the
Head-Mounted Display for	user in a virtual reality. This new type of therapy is used in the rehabilitation of
Rehabilitation of the Upper	stroke patients. Many patients after this disease have complications related to
Limb after Stroke-	the upper extremities that limit independence in their everyday life, which
Review. Sensors (Basel).	affects the functioning of society. Conventional neurological rehabilitation can
2022:22(24):9962. Published	be supplemented by the use of immersive virtual therapy. The system allows
2022 Dec 17.	patients with upper limb dysfunction to perform a motor and task-oriented
doi:10.3390/s22249962	training in virtual reality that is individually tailored to their performance. The
	complete immersion therapy itself is researched and evaluated by medical
	teams to determine the suitability for rehabilitation of the upper limb after a
	stroke. The purpose of this article is to provide an overview of the latest research
	(2019-2022) on immersive virtual reality with head-mounted displays using in
	rehabilitation of the upper extremities of stroke patients.





Matthews T, Tian F, Dolby T. Interaction design for paediatric emergency VR training. *Virtual Reality & Intelligent Hardware*. 2020;2(4):330-344. doi:10.1016/j.vrih.2020.07.0 06

Background: Virtual reality (VR) in healthcare training has increased adoption and support, but efforts are still required to mitigate usability concerns. **Methods:** This study conducted a usability study of an in-use emergency medicine VR training application, available on commercially available VR hardware and with a standard interaction design. Nine users without prior VR experience but with relevant medical expertise completed two simulation scenarios for a total of 18 recorded sessions. They completed NASA Task Load Index and System Usability Scale questionnaires after each session, and their performance was recorded for the tracking of user errors. Results and **Conclusion:** Our results showed a medium (and potentially optimal) Workload and an above average System Usability Score. There was significant improvement in several factors between users' first and second sessions, notably increased Performance evaluation. User errors with the strongest correlation to usability were not directly tied to interaction design, however, but to a limited 'possibility space'. Suggestions for closing this 'gulf of execution' were presented, including 'voice control' and 'hand-tracking', which are only feasible for this commercial product now with the availability of the Oculus Quest headset. Moreover, wider implications for VR medical training were outlined, and potential next steps towards a standardized design identified.





McKinney B, Dbeis A, Lamb	<b>Objective:</b> The objective of this study was to evaluate the effectiveness of
A, Frousiakis P, Sweet S.	immersive virtual reality training in orthopedic surgery education in comparison
Virtual Reality Training in	to the standard technique guide for fixed-bearing medial unicompartmental
Unicompartmental Knee	knee arthroplasty <b>Design:</b> Participants included 22 orthopedic surgery residents
Arthroplasty: A Randomized,	who were randomized to undergo fixed-bearing medial unicompartmental knee
Blinded Trial. J Surg Educ.	arthroplasty (UKA) surgical training with either an immersive virtual reality
2022;79(6):1526-1535.	technology or by studying the traditional technique guide. Participants were
doi:10.1016/j.jsurg.2022.06.	randomized within their training year via block randomization. Participants then
008	performed a medial UKA on a SawBone model using standard industry system
	surgical trays and equipment. Proficiency, timing, number of errors made, and
	subjective data were obtained during and after the SawBone procedure. A
	blinded observer was utilized to obtain objective data. Setting: Community
	Memorial Health System, a primary clinical care institution in Ventura,
	California. Participants: Twenty-two orthopedic surgery residents were
	randomly selected. There were 7 PGY-1 residents (3 TG, 4 VR), 7 PGY-2s (4 TG, 3
	VR), 3 PGY-3s (1 TG, 2 VR), 3 PGY-4s (2 TG, 1 VR), and 2 PGY-5s (1 TG, 1 VR) in
	total. Eligibility criteria were 1) an active orthopedic surgery resident, 2) no prior
	immersive VR surgical training, and 3) no prior experience with the Zimmer PPK
	implants or its technique guide. All participants completed the study.
	<b>Results:</b> Residents were randomized evenly in the virtual reality (n = 11) and
	technique guide groups (n = 11). Analysis showed that residents who trained
	with the immersive VR executed significantly more steps correctly (33 vs. 27, p <
	0.01) and completed their procedure in significantly faster time (26.7 vs. 35.4
	minutes, p < 0.01). They also scored higher in all global assessment categories
	reaching significance in 4 of 5 categories. Subjective questionnaire responses
	demonstrated positive feedback within both groups with a trend toward virtual
	reality. No adverse events were recorded. <b>Conclusions:</b> Immersive virtual reality
	was more effective than traditional training for the participants of this study.
	There are numerous potential applications of this technology and it provides an
	alternative learning modality to accommodate different learning styles.
Medical Readiness Trainer	The Medical Readiness Trainer (MRT) integrates fully immersive Virtual Reality
Team. Immersive virtual	(VR), highly advanced medical simulation technologies, and medical data to
reality platform for medical	enable unprecedented medical education and training. The flexibility offered by
training: a "killer-	the MRT environment serves as a practical teaching tool today and in the near
application". Stud Health	future the will serve as an ideal vehicle for facilitating the transition to the next
Technol Inform.	level of medical practice, i.e., telepresence and next generation Internet-based
2000;70:207-213.	collaborative learning.




Mekbib DB, Debeli DK, Zhang L, et al. A novel fully immersive virtual reality environment for upper extremity rehabilitation in patients with stroke. <i>Ann N Y</i> <i>Acad Sci.</i> 2021;1493(1):75- 89. doi:10.1111/nyas.14554	Given the rising incidence of stroke, several technology-driven methods for rehabilitation have recently been developed. Virtual reality (VR) is a promising therapeutic technology among them. We recently developed a neuroscientifically grounded VR system to aid recovery of motor function poststroke. The developed system provides unilateral and bilateral upper extremity (UE) training in a fully immersive virtual environment that may stimulate and activate mirror neurons (MNs) in the brain necessary for UE rehabilitation. Twenty-three participants were randomized to a VR group (n = 12) to receive VR intervention (8 h within 2 weeks) plus 8-h occupational therapy (OT) or a control group (n = 11) to receive time-matched OT alone. Treatment effects on motor recovery and cortical reorganization were investigated using the Barthel Index (BI), Fugl-Meyer Upper Extremity (FM-UE), and resting-state fMRI. Both groups significantly improved BI (P < 0.05), reflecting the recovery of UE motor function. The VR group revealed significant improvements on FM-UE scores (P < 0.05) than the control group. Neural activity increased after the
	intervention, particularly in the brain areas implicating MNs, such as in the
	primary motor cortex. Overall, results suggested that using a neuroscientifically
	grounded VR system might offer additional benefits for UE rehabilitation in
Mekhih DB Zhao Z Wang L	Virtual reality (VP) is considered to be a promising therepoultie technology for the
et al Proactive Motor	rehabilitation of upper extremities (LEs) post-stroke. Recently, we designed and
Functional Recovery	then implemented a neuroscientifically grounded VR protocol for the
Following Immersive Virtual	rehabilitation of natients with stroke. The system provides unilateral and
Reality-Based Limb Mirroring	bilateral limb mirroring exercises in a fully immersive virtual environment that
Therapy in Patients with	may stimulate and activate the mirror neuron system in the brain to help
Subacute	patients for their rehabilitation. Twelve patients with subacute stroke underwent
Stroke. Neurotherapeutics.	the newly implemented VR treatment in addition to conventional rehabilitation
2020;17(4):1919-1930.	for 8 consecutive weekdays. The treatment effect on brain reorganization and
doi:10.1007/s13311-020-	motor function was investigated using resting-state fMRI (rs-fMRI) and the Fugl-
00882-x	Meyer assessment for Upper Extremity (FM-UE), respectively. Fifteen healthy
	controls (HCs) also underwent rs-fMRI scanning one time. The study finally
	obtained usable data from 8 patients and 13 HCs. After the intervention, patients
	demonstrated significant improvement in their FM-UE scores (p values < 0.042).
	Voxel-wise functional connectivity (FC) analysis based on the rs-fMRI data found
	that HCs showed widespread bilateral FC patterns associated with the
	dominant hemispheric primary motor cortex (M1). However, the FC patterns in
	patients revealed intra-hemispheric association with the ipsilesional M1 seed
	and this association became visible in the contra-hemisphere after the
	Intervention. Moreover, the change of FC values between the bilateral M1 was
	significantly correlated with the changes in FM-UE scores (p values < 0.037). We
	virtual anvironment may enhance particul reargenization and load to improved
	motor function
	motor function.





Mondellini M, Arlati S, Gapeyeva H, et al. User Experience during an Immersive Virtual Reality-Based Cognitive Task: A Comparison between Estonian and Italian Older Adults with MCI. *Sensors (Basel)*. 2022;22(21):8249. Published 2022 Oct 27. doi:10.3390/s22218249 Mild cognitive impairment (MCI) is an early stage of cognitive abilities loss and puts older adults at higher risk of developing dementia. Virtual reality (VR) could represent a tool for the early assessment of this pathological condition and for administering cognitive training. This work presents a study evaluating the acceptance and the user experience of an immersive VR application representing a supermarket. As the same application had already been assessed in Italy, we aimed to perform the same study in Estonia in order to compare the outcomes in the two populations. Fifteen older adults with MCI were enrolled in one Rehabilitation Center of Estonia and tried the supermarket once. Afterwards, they were administered questionnaires aimed at evaluating their technology acceptance, sense of presence, and cybersickness. Estonian participants reported low side effects and discrete enjoyment, and a sense of presence. Nonetheless, their intention to use the technology decreased after the experience. The comparison between Italian and Estonian older adults showed that cybersickness was comparable, but technology acceptance and sense of presence were significantly lower in the Estonian group. Thus, we argue that: (i) cultural and social backgrounds influence technology acceptance; (ii) technology acceptance was rather mediated by the absence of positive feelings rather than cybersickness.





Napa S, Moore M, Bardyn T. Advancing Cardiac Surgery Case Planning and Case Review Conferences Using Virtual Reality in Medical Libraries: Evaluation of the Usability of Two Virtual Reality Apps. *JMIR Hum Factors*. 2019;6(1):e12008. Published 2019 Jan 16. doi:10.2196/12008 Background: Care providers and surgeons prepare for cardiac surgery using case conferences to review, discuss, and run through the surgical procedure. Surgeons visualize a patient's anatomy to decide the right surgical approach using magnetic resonance imaging and echocardiograms in a presurgical case planning session. Previous studies have shown that surgical errors can be reduced through the effective use of immersive virtual reality (VR) to visualize patient anatomy. However, inconsistent user interfaces, delegation of view control, and insufficient depth information cause user disorientation and interaction difficulties in using VR apps for case planning. Objective: The objective of the study was to evaluate and compare the usability of 2 commercially available VR apps-Bosc (Pyrus Medical systems) and Medical Holodeck (Nooon Web & IT GmbH)-using the Vive VR headset (HTC Corporation) to evaluate ease of use, physician attitudes toward VR technology, and viability for presurgical case planning. The role of medical libraries in advancing case planning is also explored. Methods: After screening a convenience sample of surgeons, fellows, and residents, ethnographic interviews were conducted to understand physician attitudes and experience with VR. Gaps in current case planning methods were also examined. We ran a usability study, employing a concurrent think-aloud protocol. To evaluate user satisfaction, we used the system usability scale (SUS) and the National Aeronautics and Space Administration-Task Load Index (NASA-TLX). A poststudy questionnaire was used to evaluate the VR experience and explore the role of medical libraries in advancing presurgical case planning. Semistructured interview data were analyzed using content analysis with feedback categorization. Results: Participants were residents, fellows, and surgeons from the University of Washington with a mean age of 41.5 (SD 11.67) years. A total of 8 surgeons participated in the usability study, 3 of whom had prior exposure to VR. Users found Medical Holodeck easier to use than Bosc. Mean adjusted NASA-TLX score for Medical Holodeck was 62.71 (SD 18.25) versus Bosc's 40.87 (SD 13.90). Neither app passed the mean SUS score of 68 for an app to be considered usable, though Medical Holodeck (66.25 [SD 12.87]) scored a higher mean SUS than Bosc (37.19 [SD 22.41]). One user rated the Bosc usable, whereas 3 users rated Medical Holodeck usable. **Conclusions:** Interviews highlighted the importance of precise anatomical conceptualization in presurgical case planning and teaching, identifying it as the top reason for modifying a surgical procedure. The importance of standardized user interaction features such as labeling is justified. The study also sheds light on the new roles medical librarians can play in curating VR content and promoting interdisciplinary collaboration.





Nielsen AB, Dragsbæk J, Jacobsen N, et al. Assessment of Basic Thoracic Ultrasound Skills in Immersive Virtual Reality: Gathering Validity Evidence. <i>Ultrasound Med Biol</i> . 2024;50(4):467-473. doi:10.1016/j.ultrasmedbio. 2023.12.002	<b>Objective:</b> Operator skills are essential for thoracic ultrasound (TUS) to ensure diagnostic accuracy. Immersive virtual reality (IVR) has shown potential within medical education but never for assessment of TUS skills. This study was aimed at developing an IVR test for assessing TUS skills, gathering validity evidence and establishing a pass/fail score. <b>Methods:</b> An expert panel developed a test based on the TUS protocol by the European Respiratory Society (ERS), including a tutorial and two clinical cases (pleural effusion and interstitial syndrome), using an IVR platform (VitaSim, Odense, Denmark). Four anterior, four lateral and six posterior zones were available for examination and decision of diagnosis. Each correct examination equaled one point. The contrasting groups' method was used to set a pass/fail score. <b>Results:</b> Data were collected during the 2022 ERS Congress. We included 13 novices (N, experience: 0 TUS), 22 intermediates (I, 1-50 TUS) and 11 experienced clinicians (E, >50 TUS). Cronbach's a was 0.86. The total mean point scores in case 1 (C1) were (N) $5.0 \pm 2.7$ , (I) $7.3 \pm 2.4$ and (E) $8.7 \pm 1.3$ , and the scores in case 2 (C2) were (N) $4.5 \pm 1.8$ , (I) $6.7 \pm 2.3$ and (E) $8.5 \pm 2.1$ . Significant differences were found between N and I for C1 (p = 0.007) and C2 (p = 0.02), I and E for C1 (p = 0.04) and C2 (p = 0.019) and N and E for C1 (p < 0.001) and C2 (p < 0.001). The pass/fail score was 7 points in each case.
Nunnerley J, Gupta S, Snell	<b>Purpose:</b> A user-centred design was used to develop and test the feasibility of
D, King M. Training	an immersive 3D virtual reality wheelchair training tool for people with spinal
wheelchair navigation in	cord injury (SCI). Method: A Wheelchair Training System was designed and
immersive virtual	modelled using the Oculus Rift headset and a Dynamic Control wheelchair
environments for patients	joystick. The system was tested by clinicians and expert wheelchair users with
with spinal cord injury - end-	SCI. Data from focus groups and individual interviews were analysed using a
user input to design an	general inductive approach to thematic analysis. <b>Results:</b> Four themes
effective system. Disabil	emerged: Realistic System, which described the advantages of a realistic virtual
Rehabil Assist Technol.	environment; a Wheelchair Training System, which described participants'
2017;12(4):417-423.	thoughts on the wheelchair training applications; Overcoming Resistance to
doi:10.1080/17483107.2016.	Technology, the obstacles to introducing technology within the clinical setting;
1176259	and Working outside the Rehabilitation Bubble which described the protective
	hospital environment. <b>Conclusions:</b> The Oculus Rift Wheelchair Training System
	has the potential to provide a virtual rehabilitation setting which could allow
	wheelchair users to learn valuable community wheelchair use in a safe
	environment. Nausea appears to be a side effect of the system, which will need
	to be resolved before this can be a viable clinical tool. Implications for
	kenapilitation immersive virtual reality snows promising benefit for wheelchair
	training in a renabilitation setting. Early engagement with consumers can
	Improve product development.





Omlor AJ, Schwärzel LS, Bewarder M, et al. Comparison of immersive and non-immersive virtual reality videos as substitute for in-hospital teaching during coronavirus lockdown: a survey with graduate medical students in Germany. <i>Med Educ</i> <i>Online</i> . 2022;27(1):2101417. doi:10.1080/10872981.2022. 2101417	As a consequence of the continued Covid-19 lockdown in Germany, in-hospital teaching for medical students was impossible. While lectures and other theoretical training were relatively easily converted into online sessions using platforms such as Moodle, Zoom and Microsoft Teams, this was not the case for practical skills and clinical interventions, such as bronchoscopy or colonoscopy. This study describes a workaround that was implemented at the Saarland University Hospital utilizing virtual reality equipment to convey the impressions of shadowing clinical procedures to the students without physical presence. To achieve this, 3D 180° videos of key clinical interventions of various internal medicine specialities were recorded, cut, and censored. The videos were uploaded to the e-learning YouTube channel of our institution and shared with the students via the private share function. The students could choose whether to use a VR-viewer to watch the videos immersively or to watch them without a viewer on a screen non-immersively. At the end of the course after 1 week, the students completed a questionnaire anonymously focusing on learning-success regarding the presented topics, a self-assessment, and an evaluation of the course. A total of 27 students watched the videos with a VR-Viewer and 74 watched non-immersively. Although the VR-viewer group self-assessed their expertise higher, there was no significant difference between the two groups in the learning atmosphere, comprehensibility, and overall recommendation of the course significantly higher. They also agreed significantly more to the statement, that they gained a better conception of the presented procedures, and that virtual reality might be an appropriate tool for online teaching. Video-assisted teaching facilitates learning and might be a
Pais-Vieira C, Gaspar P, Matos D, et al. Embodiment Comfort Levels During Motor Imagery Training Combined With Immersive Virtual Reality in a Spinal Cord Injury Patient. <i>Front Hum</i> <i>Neurosci</i> . 2022;16:909112. Published 2022 May 20. doi:10.3389/fnhum.2022.90 9112	Brain-machine interfaces combining visual, auditory, and tactile feedback have been previously used to generate embodiment experiences during spinal cord injury (SCI) rehabilitation. It is not known if adding temperature to these modalities can result in discomfort with embodiment experiences. Here, comfort levels with the embodiment experiences were investigated in an intervention that required a chronic pain SCI patient to generate lower limb motor imagery commands in an immersive environment combining visual (virtual reality -VR), auditory, tactile, and thermal feedback. Assessments were made pre-/ post-, throughout the intervention (Weeks 0-5), and at 7 weeks follow up. Overall, high levels of embodiment in the adapted three-domain scale of embodiment were found throughout the sessions. No significant adverse effects of VR were reported. Although sessions induced only a modest reduction in pain levels, an overall reduction occurred in all pain scales (Faces, Intensity, and Verbal) at follow up. A high degree of comfort in the comfort scale for the thermal-tactile sleeve, in both the thermal and tactile feedback components of the sleeve was reported. This study supports the feasibility of combining multimodal stimulation involving visual (VR), auditory, tactile, and thermal feedback to generate embodiment experiences in neurorehabilitation programs.





Pal S, Benson R, Duvall P, Taylor-Jones V. Do innovative immersive virtual reality simulation videos have a role to play in teaching nontechnical skills and increasing preparedness for clinical placements for medical students?. *MedEdPublish* (2016). 2021;9:164. Published 2021 Sep 29. doi:10.15694/mep.2020.000 164.2 Background: Teaching non-technical skills (NTS) is an important part of the undergraduate medical curriculum. Resource intensive high-fidelity simulation has an established role in this. Alternative methods of delivering large scale simulation-based education should be considered to help further improve NTS and preparedness for clinical placements of medical students. Emerging technologies such as immersive virtual reality (VR) may have a role in this. **Aim:** To assess if a VR simulation-based teaching programme enhances understanding of NTS and preparedness for clinical placements in medical students at the University of Liverpool. Methods: A VR simulation-based teaching programme, consisting of 4 sessions of lecture-based simulation and a hi-fidelity simulation session was delivered to 3 <sup>rd</sup> year medical students. The lecture-based sessions used pre-recorded, immersive clinical scenarios developed by the School of Medicine, with a focus on NTS. The hi-fidelity simulation session was delivered by local hospital trusts. A survey was sent to all students to assess their understanding of key NTS: decision making, task prioritisation and delegation and how the clinical environment works. Preparedness for clinical placement and confidence in the clinical environment was also assessed. A focus group further explored how students felt towards these NTS, with subsequent thematic analysis. Results: 101/281 students responded to the survey reporting a greater understanding in all NTS assessed. Students also described feeling better prepared for clinical placements. The focus group reported the programme provided a 'safe space' for learning alongside increasing understanding of role modelling and self-awareness. **Discussion:** Utilising emerging technology alongside hi-fidelity simulation increased students' exposure to the clinical environment and enabled exploration of NTS by students. Additional work with larger focus groups will be required to further validate our results. Whilst restrictions are limiting clinical exposure due to the COVID-19 pandemic, we propose that VR simulation-based teaching programmes could provide an alternative educational tool.





Pan X, Collingwoode-The art of picking up signs that a child may be suffering from abuse at home is Williams T, Antley A, et al. A one of those skills that cannot easily be taught, given its dependence on a range Study of Professional of non-cognitive abilities. It is also difficult to study, given the number of factors Awareness Using Immersive that may interfere with this skill in a real-life, professional setting. An immersive Virtual Reality: The virtual reality environment provides a way round these difficulties. In this study, we recruited 64 general practitioners (GPs), with different levels of experience. Responses of General Practitioners to Child Would this level of experience have any impact on general practitioners' ability Safeguarding to pick up child-safeguarding concerns? Would more experienced GPs find it Concerns. Front Robot AI. easier to pick up subtle (rather than obvious) signs of child-safeguarding 2018:5:80. Published 2018 concerns? Our main measurement was the quality of the note left by the GP at Jul 12. the end of the virtual consultation: we had a panel of 10 (all experienced in doi:10.3389/frobt.2018.0008 safeguarding) rate the note according to the extent to which they were able to identify and take the necessary steps required in relation to the child 0 safeguarding concerns. While the level of professional experience was not shown to make any difference to a GP's ability to pick up those concerns, the parent's level of aggressive behavior toward the child did. We also manipulated the level of cognitive load (reflected in a complex presentation of the patient's medical condition): while cognitive load did have some impact upon GPs in the "obvious cue" condition (parent behaving particularly aggressively), this effect fell short of significance. Furthermore, our results also suggest that GPs who are less stressed, less neurotic, more agreeable and extroverted tend to be better at raising potential child abuse issues in their notes. These results not only point at the considerable potential of virtual reality as a training tool, they also highlight fruitful avenues for further research, as well as potential strategies to support GP's in their dealing with highly sensitive, emotionally charged situations.





Pan X, Slater M, Beacco A, et al. The Responses of Medical General Practitioners to Unreasonable Patient Demand for Antibiotics--A Study of Medical Ethics Using Immersive Virtual Reality. *PLoS One*. 2016;11(2):e0146837. Published 2016 Feb 18. doi:10.1371/journal.pone.01 46837 Background: Dealing with insistent patient demand for antibiotics is an all too common part of a General Practitioner's daily routine. This study explores the extent to which portable Immersive Virtual Reality technology can help us gain an accurate understanding of the factors that influence a doctor's response to the ethical challenge underlying such tenacious requests for antibiotics (given the threat posed by growing anti-bacterial resistance worldwide). It also considers the potential of such technology to train doctors to face such dilemmas. Experiment: Twelve experienced GPs and nine trainees were confronted with an increasingly angry demand by a woman to prescribe antibiotics to her mother in the face of inconclusive evidence that such antibiotic prescription is necessary. The daughter and mother were virtual characters displayed in immersive virtual reality. The specific purposes of the study were twofold: first, whether experienced GPs would be more resistant to patient demands than the trainees, and second, to investigate whether medical doctors would take the virtual situation seriously. Results: Eight out of the 9 trainees prescribed the antibiotics, whereas 7 out of the 12 GPs did so. On the basis of a Bayesian analysis, these results yield reasonable statistical evidence in favor of the notion that experienced GPs are more likely to withstand the pressure to prescribe antibiotics than trainee doctors, thus answering our first question positively. As for the second question, a post experience questionnaire assessing the participants' level of presence (together with participants' feedback and body language) suggested that overall participants did tend towards the illusion of being in the consultation room depicted in the virtual reality and that the virtual consultation taking place was really happening.





Park W, Kim J, Kim M. Efficacy of virtual reality therapy in ideomotor apraxia rehabilitation: A case report. *Medicine (Baltimore)*. 2021;100(28):e26657. doi:10.1097/MD.00000000 0026657 Rationale: We report the possible therapeutic efficacy of immersive virtual reality (VR) rehabilitation for the treatment of ideomotor apraxia in a patient with stroke. Patient concerns: A 56-year-old man with sudden weakness of his left side caused by right frontal, parietal, and corpus callosal infarction was transferred to rehabilitation medicine center for intensive rehabilitation. Although his left-sided weakness had almost subsided 10 days after the onset of symptoms, he presented difficulty using his left hand and required assistance in most activities of daily living. Diagnoses: Ideomotor apraxia in a patient with right hemispheric infarction. Interventions: VR content was displayed to the study participants using a head-mounted display that involved catching of moving fish in the sea by grasping. Before and after of rehabilitative intervention including VR, functional measurements incorporating the Test of Upper Limb Apraxia (TULIA) were conducted. To directly compare therapeutic potencies under different conditions, success rates of consecutive grasping gesture performance were observed in VR, conventional occupational therapy setting, and augmented reality intervention. Outcomes: The patient demonstrated remarkable amelioration of apraxic symptoms while performing the task in the VR environment. At 1 and 3 months after the training, he showed significant improvement in most functions, and the TULIA score increased to 176 from 121 at the initiation of therapy. The number of successful grasps during 30 trials of each grasp trial was 28 in VR, 8 in the occupational therapy setting, and 20 in augmented reality. Lessons: This case report suggests the possible therapeutic efficacy of immersive VR training as a rehabilitative measure for ideomotor apraxia.





Parkhomenko E, O'Leary M, Safiullah S, et al. Pilot Assessment of Immersive Virtual Reality Renal Models as an Educational and Preoperative Planning Tool for Percutaneous Nephrolithotomy. *J Endourol*. 2019;33(4):283-288. doi:10.1089/end.2018.0626 Background: Percutaneous nephrolithotomy (PCNL) requires the urologist to have detailed knowledge of the stone and its relationship with the renal anatomy. Immersive virtual reality (iVR) provides patient-specific threedimensional models that might be beneficial in this regard. Our objective is to present the initial experience with iVR in surgeon planning and patient preoperative education for PCNL. Materials and methods: From 2017 to 2018 four surgeons, each of whom had varying expertise in PCNL, used iVR models to acquaint themselves with the renal anatomy before PCNL among 25 patients. iVR renderings were also viewed by patients using the same head-mounted Oculus rift display. Surgeons rated their understanding of the anatomy with CT alone and then after CT+iVR; patients also recorded their experience with iVR. To assess the impact on outcomes, the 25 iVR study patients were compared with 25 retrospective matched-paired non-iVR patients. Student's t-test was used to analyze collected data. Results: iVR improved surgeons' understanding of the optimal calix of entry and the stone's location, size, and orientation (p < 0.01). iVR altered the surgical approach in 10 (40%) cases. Patients strongly agreed that iVR improved their understanding of their stone disease and reduced their preoperative anxiety. In the retrospective matched-paired analysis, the iVR group had a statistically significant decrease in fluoroscopy time and blood loss as well as a trend toward fewer nephrostomy tracts and a higher stone-free rate. Conclusions: iVR improved urologists' understanding of the renal anatomy and altered the operative approach in 40% of cases. In addition, iVR improved patient comprehension of their surgery. Clinically, iVR had benefits with regard to decreased fluoroscopy time and less blood loss along with a trend toward fewer access tracts and higher stone-free rates.





Pau M, Arippa F, Leban B, et al. Cybersickness in People with Multiple Sclerosis Exposed to Immersive Virtual Reality. *Bioengineering (Basel)*. 2024;11(2):115. Published 2024 Jan 24. doi:10.3390/bioengineering1 1020115 Together with the wide range of possible benefits for the rehabilitation/training of people with multiple sclerosis (pwMS) and other neurologic conditions, exposure to immersive virtual reality (VR) has often been associated with unpleasant symptoms, such as transient dizziness, headache, nausea, disorientation and impaired postural control (i.e., cybersickness). Since these symptoms can significantly impact the safety and tolerability of the treatment, it appears important to correctly estimate their presence and magnitude. Given the existing data scarcity, this study aims to assess the existence and severity of possible adverse effects associated with exposure to immersive VR in a cohort of pwMS using both objective measurements of postural control effectiveness and subjective evaluations of perceived symptoms. To this aim, postural sway under upright quiet posture (in the presence and absence of visual input) of 56 pwMS with an Expanded Disability Status Scale score (EDSS) in the range of 0-6.5 (mean EDSS 2.3) and 33 unaffected individuals was measured before and after a 10-min immersive VR session and at 10 min follow-up on the basis of center of pressure (COP) trajectories. The severity of cybersickness symptoms associated with VR exposure was also self-rated by the participants using the Italian version of the Simulator Sickness Questionnaire (SSQ). Temporary impairments of postural control in terms of significantly increased sway area were observed after the VR session only in pwMS with mild-moderate disability (i.e., EDSS in the range of 2.5-6.5) in the presence of visual input. No changes were observed in pwMS with low disability (EDSS 0-2) and unaffected individuals. In contrast, when the visual input was removed, there was a decrease in sway area (pwMS with mild-moderate disability) and COP path length relating to the use of VR (pwMS with mild-moderate disability and unaffected individuals), thus suggesting a sort of "balance training effect". Even in this case, the baseline values were restored at follow-up. All participants, regardless of their status, experienced significant post-VR side effects, especially in terms of blurred vision and nausea. Taken together, the findings of the present study suggest that a short immersive VR session negatively (eyes open) and positively (eyes closed) impacts the postural control of pwMS and causes significant disorientation. However, such effects are of limited duration. While it is reasonable to state that immersive VR is sufficiently safe and tolerable to not be contraindicated in the rehabilitation/training of pwMS, in order to reduce possible negative effects and maximize the efficacy, safety and comfort of the treatment, it appears necessary to develop specific guidelines that consider important factors like individual susceptibility, maximum exposure time according to the specific features of the simulation, posture to adopt and protocols to assess objective and perceived effects on participants.





Pau M, Porta M, Bertoni R, Background: Although the use of Virtual Reality (VR) has received inc	reasing
Mattos FGM, Cocco E, interest as an add-on treatment in neurorehabilitation programs in the	e last
Cattaneo D. Effect of fifteen years, there is scarce information about the effectiveness of fu	lly
immersive virtual reality immersive VR-based treatments on upper limb (UL) motor function in	people
training on hand-to-mouth with Multiple Sclerosis (PwMS). <b>Methods:</b> In this bicentric 2-period	
task performance in people interventional crossover study, 19 PwMS with moderate to severe disa	ability
with Multiple Sclerosis: A (mean EDSS score 5.5) and relevant UL impairment underwent 12 imr	nersive-VR
quantitative kinematic sessions over a period of 4 weeks, using commercially available VR pl	atform
study. <i>Mult Scler Relat</i> (Oculus Quest) and games (Fruit Ninja, Beat Saber and Creed - Rise to	o Glory).
<i>Disord</i> . 2023;69:104455. Possible changes associated with the treatment were objectively associated with the treatment	essed
doi:10.1016/j.msard.2022.1 through instrumental kinematic analysis of the "hand-to-mouth" (HTM	1)
04455 movement by means of optical motion capture system. Clinical tests	to assess
gross and fine manual dexterity (i.e., the Box and Blocks and Nine Hol	e Peg Test)
were also administered. Results: The results of the kinematic analysi	s suggest
that the VR training positively impacted the ability of the tested PwMS	to perform
the HTM task. In particular, a significant reduction of the overall time i	required to
complete the task of approximately 20% for both most and least affect	ted limb,
and an improved degree of precision and stability of the movement, a	s indicated
by the reduced value of adjusting sway, especially for the most affect	ed limb (-
60%). <b>Conclusion:</b> Based on the results of the quantitative analysis, a	a 4-week
treatment with immersive VR is able to improve speed and stability of	the HTM
movement in PwMS. This suggests that such an approach might be co	onsidered
suitable to facilitate an immediate transfer of the possible positive eff	ects
associated with the training to common activities of daily living.	
Pierce J, Gutiérrez F, Vergara Virtual reality (VR) simulation provides a means of making experientia	l learning
VM, et al. Comparative reproducible and reusable. This study was designed to determine the	efficiency
usability studies of full vs. and satisfaction components of usability. Previously, it was found that	t first year
partial immersive virtual medical students using a VR simulation for medical education demor	strated
reality simulation for effectiveness in learning as measured by knowledge structure improv	ements
medical education and both with and without a head mounted display (HMD) but students us	ing a HMD
training. Stud Health Technol showed statistically greater improvement in knowledge structures co	mpared to
Inform. 2008;132:372-377. those not using a HMD. However, in this current analysis of other com	ponents of
usability, there were no overall significance differences in efficiency (	ease of
use), nor in satisfaction, within this same group of randomized subjec	ts
comparing students using a HMD to those not using a HMD. These typ	oes of
studies may be important in determining the most appropriate, cost e	ffective VR
simulation technology needed to achieve specific learning goals and	objectives.





Pinter C, Lasso A, Choueib S,	Virtual reality (VR) provides immersive visualization that has proved to be useful
et al. SlicerVR for Medical	in a variety of medical applications. Currently, however, no free open-source
Intervention Training and	software platform exists that would provide comprehensive support for
Planning in Immersive Virtual	translational clinical researchers in prototyping experimental VR scenarios in
Reality. IEEE Trans Med	training, planning or guiding medical interventions. By integrating VR functions in
Robot Bionics.	3D Slicer, an established medical image analysis and visualization platform,
2020;2(2):108-117.	SlicerVR enables virtual reality experience by a single click. It provides functions
doi:10.1109/tmrb.2020.2983	to navigate and manipulate the virtual scene, as well as various settings to abate
199	the feeling of motion sickness. SlicerVR allows for shared collaborative VR
	experience both locally and remotely. We present illustrative scenarios created
	with SlicerVR in a wide spectrum of applications, including echocardiography,
	neurosurgery, spine surgery, brachytherapy, intervention training and
	personalized patient education. SlicerVR is freely available under BSD type
	license as an extension to 3D Slicer and it has been downloaded over 7,800
	times at the time of writing this article.
Pulijala Y, Ma M, Pears M,	Virtual reality (VR) surgery using Oculus Rift and Leap Motion devices is a multi-
Peebles D, Ayoub A. An	sensory, holistic surgical training experience. A multimedia combination
innovative virtual reality	including 360° videos, three-dimensional interaction, and stereoscopic videos in
training tool for orthognathic	VR has been developed to enable trainees to experience a realistic surgery
surgery. Int J Oral Maxillofac	environment. The innovation allows trainees to interact with the individual
Surg. 2018;47(9):1199-1205.	components of the maxillofacial anatomy and apply surgical instruments while
doi:10.1016/j.ijom.2018.01.0	watching close-up stereoscopic three-dimensional videos of the surgery. In this
05	study, a novel training tool for Le Fort I osteotomy based on immersive virtual
	reality (iVR) was developed and validated. Seven consultant oral and
	maxillofacial surgeons evaluated the application for face and content validity.
	Using a structured assessment process, the surgeons commented on the
	content of the developed training tool, its realism and usability, and the
	applicability of VR surgery for orthognathic surgical training. The results
	confirmed the clinical applicability of VR for delivering training in orthognathic
	surgery. Modifications were suggested to improve the user experience and
	interactions with the surgical instruments. This training tool is ready for testing
	with surgical trainees.





Raab DL, Ely K, Israel K, et al. Impact of Virtual Reality Simulation on New Nurses' Assessment of Pediatric Respiratory Distress. <i>Am J</i> <i>Crit Care</i> . 2024;33(2):115- 124. doi:10.4037/ajcc2024878	<b>Background:</b> Children often experience respiratory illnesses requiring bedside nurses skilled in recognizing respiratory decompensation. Historically, recognizing respiratory distress has relied on teaching during direct patient care. Virtual reality simulation may accelerate such recognition among novice nurses. <b>Objective:</b> To determine whether a virtual reality curriculum improved new nurses' recognition of respiratory distress and impending respiratory failure in pediatric patients based on assessment of physical examination findings and appropriate escalation of care. <b>Methods:</b> New nurses (n = 168) were randomly assigned to complete either an immersive virtual reality curriculum on recognition of respiratory distress (intervention) or the usual orientation curriculum (control). Group differences and changes from 3 months to 6 months after the intervention were examined. <b>Results:</b> Nurses in the intervention group were significantly more likely to correctly recognize impending respiratory failure at both 3 months (23.4% vs 3.0%, P < .001) and 6 months (31.9% vs 2.6%, P < .001), identify respiratory distress without impending respiratory failure at 3 months (57.8% vs 29.6%, P = .002) and 6 months (57.9% vs 17.8%, P < .001), and recognize patients' altered mental status at 3 months (51.4% vs 18.2%, P < .001) and 6 months (46.8% vs 18.4%, P = .006). <b>Conclusions:</b> Implementation of a virtual reality-based training curriculum was associated with improved recognition of pediatric respiratory distress, impending respiratory failure, and altered mental status at 3 and 6 months compared with standard training
	approaches. Virtual reality may offer a new approach to nurse orientation to
	enhance training in pediatrics-specific assessment skills.
Real FJ, DeBlasio D, Beck AF, et al. A Virtual Reality Curriculum for Pediatric Residents Decreases Rates of Influenza Vaccine Refusal. <i>Acad Pediatr</i> . 2017;17(4):431-435. doi:10.1016/j.acap.2017.01. 010	<b>Objective:</b> Influenza vaccine hesitancy is common in the primary care setting. Though physicians can affect caregivers' attitudes toward vaccination, physicians report uneasiness discussing vaccine hesitancy. Few studies have targeted physician-patient communication training as a means to decrease vaccination refusal. <b>Methods:</b> An immersive virtual reality (VR) curriculum was created to teach pediatric residents communication skills when discussing influenza vaccine hesitancy. This pilot curriculum consisted of 3 VR simulations during which residents counseled graphical character representatives (avatars) who expressed vaccine hesitancy. Participants were randomized to the intervention (n = 24) or control (n = 21) group. Only residents in the intervention group underwent the VR curriculum. Impact of the curriculum was assessed through difference in influenza vaccine refusal rates between the intervention and control groups in the 3 months after the VR curriculum. <b>Results:</b> Participants included postgraduate level (PL) 2 and PL3 pediatric residents. All eligible residents (n = 45) participated; the survey response rate was 100%. In patients aged 6 to 59 months, residents in the intervention group had a decreased rate of influenza vaccination refusal in the postcurriculum period compared to the control group (27.8% vs 37.1%; P = .03).
	<b>Conclusions:</b> Immersive VR may be an effective modality to teach communication skills to medical trainees. Next steps include evaluation of the curriculum in a larger, multisite trial.





Real FJ, DeBlasio D,	<b>Background:</b> Communication skills can be difficult to teach and assess in busy
Ollberding NJ, et al. Resident	outpatient settings. These skills are important for effective counseling such as in
perspectives on	cases of influenza vaccine hesitancy. It is critical to consider novel educational
communication training that	methods to supplement current strategies aimed at teaching relational skills.
utilizes immersive virtual	Methods: An immersive virtual reality (VR) curriculum on addressing influenza
reality. Educ Health	vaccine hesitancy was developed using Kern's six-step approach to curriculum
(Abingdon). 2017;30(3):228-	design. The curriculum was meant to teach best-practice communication skills
231.	in cases of influenza vaccine hesitancy. Eligible participants included
doi:10.4103/efh.EfH 9 17	postgraduate level (PL) 2 and PL-3 pediatric residents (n = 24). Immediately
	following the curriculum, a survey was administered to assess residents'
	attitudes toward the VR curriculum and perceptions regarding the effectiveness
	of VR in comparison to other educational modalities. A survey was administered
	1 month following the VB curriculum to assess trainee-perceived impact of the
	curriculum on clinical practice <b>Besults:</b> All eligible residents ( $n = 24$ ) completed
	the curriculum Ninety-two percent ( $n = 22$ ) agreed or strongly agreed that VB
	simulations were like real-life nations encounters. Seventy-five percent ( $n = 18$ )
	folt that VP was aqually offactive to standardized patient (SP) oncounters and
	The contrast is the product of the contrast o
	tess effective than bedside teaching ( $r < 0.001$ ). At 1-month follow-up, 67% of
	he with a second of for all of strongly agreed that the VR experience improved
	now they counseled families in cases of influenza vaccine nesitancy.
	Discussion: An immersive VR curriculum at our institution was well-received by
	learners, and residents rated VR as equally effective as SP encounters. As such,
	immersive VR may be a promising modality for communication training.
Real FJ, Hood AM, Davis D, et	Although hydroxyurea (HU) is an effective treatment for sickle cell anemia,
al. An Immersive Virtual	uptake remains low. Shared decision-making (SDM) is a recommended strategy
Reality Curriculum for	for HU initiation to elicit family preferences; however, clinicians lack SDM
Pediatric Hematology	training. We implemented an immersive virtual reality (VR) curriculum at 8
Clinicians on Shared	pediatric institutions to train clinicians on SDM that included counseling virtual
Decision-making for	patients. Clinicians' self-reported confidence significantly improved following
Hydroxyurea in Sickle Cell	the VR simulations on all communication skills assessed, including asking open-
Anemia. J Pediatr Hematol	ended questions, eliciting specific concerns, and confirming understanding
Oncol. 2022;44(3):e799-	(Ps≤0.01 for all). VR may be an effective method for educating clinicians to
e803.	engage in SDM for HU.
doi:10.1097/MPH.00000000	
00002289	





Robison RA, Liu CY, Apuzzo	Objective: To review virtual reality in neurosurgery, including the history of
MLJ. Man, Mind, and	simulation and virtual reality and some of the current implementations; to
Machine: The Past and	examine some of the technical challenges involved; and to propose a potential
Future of Virtual Reality	paradigm for the development of virtual reality in neurosurgery going forward.
Simulation in Neurologic	Methods: A search was made on PubMed using key words surgical simulation,
Surgery. World	virtual reality, haptics, collision detection, and volumetric modeling to assess
Neurosurgery.	the current status of virtual reality in neurosurgery. Based on previous results,
2011;76(5):419-430.	investigators extrapolated the possible integration of existing efforts and
doi:10.1016/j.wneu.2011.07.	potential future directions. <b>Results:</b> Simulation has a rich history in surgical
008	training, and there are numerous currently existing applications and systems
	that involve virtual reality. All existing applications are limited to specific task-
	oriented functions and typically sacrifice visual realism for real-time interactivity
	or vice versa, owing to numerous technical challenges in rendering a virtual
	space in real time, including graphic and tissue modeling, collision detection.
	and direction of the haptic interface. <b>Conclusions:</b> With ongoing technical
	advancements in computer hardware and graphic and physical rendering
	incremental or modular development of a fully immersive multipurpose virtual
	reality neurosurgical simulator is feasible. The use of virtual reality in
	neurosurgery is predicted to change the nature of neurosurgical education, and
	to play an increased role in surgical rehearsal and the continuing education and
	credentialing of surgical practitioners
Ros M. Debien B. Cyteval C	<b>Objective:</b> The medical world is continuously evolving with techniques being
Ros M, Debien B, Cyteval C, Molinari N, Gatto E Lonion	<b>Objective:</b> The medical world is continuously evolving, with techniques being created or improved almost daily. Immersive virtual reality (VR) is a technology
Ros M, Debien B, Cyteval C, Molinari N, Gatto F, Lonjon	<b>Objective:</b> The medical world is continuously evolving, with techniques being created or improved almost daily. Immersive virtual reality (VR) is a technology that could be barnessed to develop tools that meet the educational challenges
Ros M, Debien B, Cyteval C, Molinari N, Gatto F, Lonjon N. Applying an immersive	<b>Objective:</b> The medical world is continuously evolving, with techniques being created or improved almost daily. Immersive virtual reality (VR) is a technology that could be harnessed to develop tools that meet the educational challenges of this changing environment. We previously described the immersive tutorial a
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Ros M, Debien B, Cyteval C, Molinari N, Gatto F, Lonjon N. Applying an immersive tutorial in virtual reality to learning a new technique. <i>Neurochirurgie</i> .	<b>Objective:</b> The medical world is continuously evolving, with techniques being created or improved almost daily. Immersive virtual reality (VR) is a technology that could be harnessed to develop tools that meet the educational challenges of this changing environment. We previously described the immersive tutorial, a 3D video (filmed from the first-person point of view), displayed on a VR application. This tool offers access to supplementary educational data in addition to the video. Here we attempt to assess improvement in learning a
Ros M, Debien B, Cyteval C, Molinari N, Gatto F, Lonjon N. Applying an immersive tutorial in virtual reality to learning a new technique. <i>Neurochirurgie</i> . 2020;66(4):212-218. doi:10.1016/i.neuchi.2020.0	<b>Objective:</b> The medical world is continuously evolving, with techniques being created or improved almost daily. Immersive virtual reality (VR) is a technology that could be harnessed to develop tools that meet the educational challenges of this changing environment. We previously described the immersive tutorial, a 3D video (filmed from the first-person point of view), displayed on a VR application. This tool offers access to supplementary educational data in addition to the video. Here we attempt to assess improvement in learning a technique using this new educational format.
Ros M, Debien B, Cyteval C, Molinari N, Gatto F, Lonjon N. Applying an immersive tutorial in virtual reality to learning a new technique. <i>Neurochirurgie</i> . 2020;66(4):212-218. doi:10.1016/j.neuchi.2020.0	<b>Objective:</b> The medical world is continuously evolving, with techniques being created or improved almost daily. Immersive virtual reality (VR) is a technology that could be harnessed to develop tools that meet the educational challenges of this changing environment. We previously described the immersive tutorial, a 3D video (filmed from the first-person point of view), displayed on a VR application. This tool offers access to supplementary educational data in addition to the video. Here we attempt to assess improvement in learning a technique using this new educational format. <b>Material and methods:</b> We
Ros M, Debien B, Cyteval C, Molinari N, Gatto F, Lonjon N. Applying an immersive tutorial in virtual reality to learning a new technique. <i>Neurochirurgie</i> . 2020;66(4):212-218. doi:10.1016/j.neuchi.2020.0 5.006	<b>Objective:</b> The medical world is continuously evolving, with techniques being created or improved almost daily. Immersive virtual reality (VR) is a technology that could be harnessed to develop tools that meet the educational challenges of this changing environment. We previously described the immersive tutorial, a 3D video (filmed from the first-person point of view), displayed on a VR application. This tool offers access to supplementary educational data in addition to the video. Here we attempt to assess improvement in learning a technique using this new educational format. <b>Material and methods:</b> We selected a single neurosurgical technique for the study: external ventricular drainage. We wrote a technical note describing this procedure and produced the
Ros M, Debien B, Cyteval C, Molinari N, Gatto F, Lonjon N. Applying an immersive tutorial in virtual reality to learning a new technique. <i>Neurochirurgie</i> . 2020;66(4):212-218. doi:10.1016/j.neuchi.2020.0 5.006	<b>Objective:</b> The medical world is continuously evolving, with techniques being created or improved almost daily. Immersive virtual reality (VR) is a technology that could be harnessed to develop tools that meet the educational challenges of this changing environment. We previously described the immersive tutorial, a 3D video (filmed from the first-person point of view), displayed on a VR application. This tool offers access to supplementary educational data in addition to the video. Here we attempt to assess improvement in learning a technique using this new educational format. <b>Material and methods:</b> We selected a single neurosurgical technique for the study: external ventricular drainage. We wrote a technical note describing this procedure and produced the
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Ros M, Debien B, Cyteval C, Molinari N, Gatto F, Lonjon N. Applying an immersive tutorial in virtual reality to learning a new technique. <i>Neurochirurgie</i> . 2020;66(4):212-218. doi:10.1016/j.neuchi.2020.0 5.006	<b>Objective:</b> The medical world is continuously evolving, with techniques being created or improved almost daily. Immersive virtual reality (VR) is a technology that could be harnessed to develop tools that meet the educational challenges of this changing environment. We previously described the immersive tutorial, a 3D video (filmed from the first-person point of view), displayed on a VR application. This tool offers access to supplementary educational data in addition to the video. Here we attempt to assess improvement in learning a technique using this new educational format. <b>Material and methods:</b> We selected a single neurosurgical technique for the study: external ventricular drainage. We wrote a technical note describing this procedure and produced the corresponding immersive tutorial. All participants read the technical note, and one group used the immersive tutorial as a teaching supplement. The students completed a multiple-choice questionnaire immediately after the training and
Ros M, Debien B, Cyteval C, Molinari N, Gatto F, Lonjon N. Applying an immersive tutorial in virtual reality to learning a new technique. <i>Neurochirurgie</i> . 2020;66(4):212-218. doi:10.1016/j.neuchi.2020.0 5.006	<b>Objective:</b> The medical world is continuously evolving, with techniques being created or improved almost daily. Immersive virtual reality (VR) is a technology that could be harnessed to develop tools that meet the educational challenges of this changing environment. We previously described the immersive tutorial, a 3D video (filmed from the first-person point of view), displayed on a VR application. This tool offers access to supplementary educational data in addition to the video. Here we attempt to assess improvement in learning a technique using this new educational format. <b>Material and methods:</b> We selected a single neurosurgical technique for the study: external ventricular drainage. We wrote a technical note describing this procedure and produced the corresponding immersive tutorial. We conducted a prospective randomized comparative study with students. All participants read the technical note, and one group used the immersive tutorial as a teaching supplement. The students completed a multiple-choice questionnaire immediately after the training and again at six months. <b>Results:</b> One hundred seventy-six fourth-year medical
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Ros M, Debien B, Cyteval C, Molinari N, Gatto F, Lonjon N. Applying an immersive tutorial in virtual reality to learning a new technique. <i>Neurochirurgie</i> . 2020;66(4):212-218. doi:10.1016/j.neuchi.2020.0 5.006	<b>Objective:</b> The medical world is continuously evolving, with techniques being created or improved almost daily. Immersive virtual reality (VR) is a technology that could be harnessed to develop tools that meet the educational challenges of this changing environment. We previously described the immersive tutorial, a 3D video (filmed from the first-person point of view), displayed on a VR application. This tool offers access to supplementary educational data in addition to the video. Here we attempt to assess improvement in learning a technique using this new educational format. <b>Material and methods:</b> We selected a single neurosurgical technique for the study: external ventricular drainage. We wrote a technical note describing this procedure and produced the corresponding immersive tutorial. We conducted a prospective randomized comparative study with students. All participants read the technical note, and one group used the immersive tutorial as a teaching supplement. The students completed a multiple-choice questionnaire immediately after the training and again at six months. <b>Results:</b> One hundred seventy-six fourth-year medical students participated in the study; 173 were included in assessing the immediate learning outcomes and 72 were included at the six-month follow-up. The VR group demonstrated significantly better short-term results than the
Ros M, Debien B, Cyteval C, Molinari N, Gatto F, Lonjon N. Applying an immersive tutorial in virtual reality to learning a new technique. <i>Neurochirurgie</i> . 2020;66(4):212-218. doi:10.1016/j.neuchi.2020.0 5.006	<b>Objective:</b> The medical world is continuously evolving, with techniques being created or improved almost daily. Immersive virtual reality (VR) is a technology that could be harnessed to develop tools that meet the educational challenges of this changing environment. We previously described the immersive tutorial, a 3D video (filmed from the first-person point of view), displayed on a VR application. This tool offers access to supplementary educational data in addition to the video. Here we attempt to assess improvement in learning a technique using this new educational format. <b>Material and methods:</b> We selected a single neurosurgical technique for the study: external ventricular drainage. We wrote a technical note describing this procedure and produced the corresponding immersive tutorial. We conducted a prospective randomized comparative study with students. All participants read the technical note, and one group used the immersive tutorial as a teaching supplement. The students completed a multiple-choice questionnaire immediately after the training and again at six months. <b>Results:</b> One hundred seventy-six fourth-year medical students participated in the study; 173 were included in assessing the immediate learning outcomes and 72 were included at the six-month follow-up. The VR group demonstrated significantly better short-term results than the control group (P=0.01). The same trend was seen at six months. <b>Conclusion:</b> To
Ros M, Debien B, Cyteval C, Molinari N, Gatto F, Lonjon N. Applying an immersive tutorial in virtual reality to learning a new technique. <i>Neurochirurgie</i> . 2020;66(4):212-218. doi:10.1016/j.neuchi.2020.0 5.006	<b>Objective:</b> The medical world is continuously evolving, with techniques being created or improved almost daily. Immersive virtual reality (VR) is a technology that could be harnessed to develop tools that meet the educational challenges of this changing environment. We previously described the immersive tutorial, a 3D video (filmed from the first-person point of view), displayed on a VR application. This tool offers access to supplementary educational data in addition to the video. Here we attempt to assess improvement in learning a technique using this new educational format. <b>Material and methods:</b> We selected a single neurosurgical technique for the study: external ventricular drainage. We wrote a technical note describing this procedure and produced the corresponding immersive tutorial. We conducted a prospective randomized comparative study with students. All participants read the technical note, and one group used the immersive tutorial as a teaching supplement. The students completed a multiple-choice questionnaire immediately after the training and again at six months. <b>Results:</b> One hundred seventy-six fourth-year medical students participated in the study; 173 were included in assessing the immediate learning outcomes and 72 were included at the six-month follow-up. The VR group demonstrated significantly better short-term results than the control group (P=0.01). The same trend was seen at six months. <b>Conclusion:</b> To our knowledge, this study presents one of the largest cohorts for VR. The use of
Ros M, Debien B, Cyteval C, Molinari N, Gatto F, Lonjon N. Applying an immersive tutorial in virtual reality to learning a new technique. <i>Neurochirurgie</i> . 2020;66(4):212-218. doi:10.1016/j.neuchi.2020.0 5.006	<b>Objective:</b> The medical world is continuously evolving, with techniques being created or improved almost daily. Immersive virtual reality (VR) is a technology that could be harnessed to develop tools that meet the educational challenges of this changing environment. We previously described the immersive tutorial, a 3D video (filmed from the first-person point of view), displayed on a VR application. This tool offers access to supplementary educational data in addition to the video. Here we attempt to assess improvement in learning a technique using this new educational format. <b>Material and methods:</b> We selected a single neurosurgical technique for the study: external ventricular drainage. We wrote a technical note describing this procedure and produced the corresponding immersive tutorial. We conducted a prospective randomized comparative study with students. All participants read the technical note, and one group used the immersive tutorial as a teaching supplement. The students completed a multiple-choice questionnaire immediately after the training and again at six months. <b>Results:</b> One hundred seventy-six fourth-year medical students participated in the study; 173 were included in assessing the immediate learning outcomes and 72 were included at the six-month follow-up. The VR group demonstrated significantly better short-term results than the control group (P=0.01). The same trend was seen at six months. <b>Conclusion:</b> To our knowledge, this study presents one of the largest cohorts for VR. The use of the immersive tutorial could enable a large number of healthcare professionals





Rosenfeldt Nielsen M, Kristensen EQ, Jensen RO, Mollerup AM, Pfeiffer T, Graumann O. Clinical Ultrasound Education for Medical Students: Virtual Reality Versus e-Learning, a Randomized Controlled Pilot Trial. <i>Ultrasound Q</i> . 2021;37(3):292-296. doi:10.1097/RUQ.0000000 00000558	The primary aim was to evaluate the effect of immersive virtual reality learning for training medical students in basic clinical ultrasound. Secondary outcomes were to explore if virtual reality learning had an effect on hand-eye coordination skills and if the medical students wanted more virtual reality learning. This pilot study was a double-blind, parallel-group, block-randomized, controlled trial. Participants (n = 20) were blinded and randomized to virtual reality or e-learning for basic ultrasound education. Medical students with no previous ultrasound education were recruited voluntarily from the University of Southern Denmark. Data were collected during introductory courses on ultrasound from March to May 2019. Participants were assessed with Objective Structured Assessment on Ultrasound Skills. Assessing supervisors were blinded. The virtual reality group (n = 11) scored a significantly higher Objective Structured Assessment on Ultrasound Skills score (143 [95% confidence interval {Cl}, 135 to 151]) compared with the e-learning group (n = 9; 126 [95% Cl, 113 to 138]; mean difference, 17 points [95% Cl, 4 to 30]; P < 0.01). No significant effect on the hand-eye score was found (mean difference, 3 points [95 % Cl, -3 to 9]; P = 0.32). Ninety-one percent of the virtual reality group wanted more virtual reality learning. Immersive virtual reality learning improved medical students' ultrasound skills significantly compared with e-learning. The hand-eye score was higher in the virtual reality group, although not at a significant level. Students wanted more virtual reality learning. Further research is needed to clarify immersion virtual reality learning. Further research is needed to clarify
Rutkowski S, Szary P, Sacha J, Casaburi R. Immersive Virtual Reality Influences Physiologic Responses to Submaximal Exercise: A Randomized, Crossover Trial. <i>Front Physiol</i> . 2021;12:702266. Published 2021 Sep 30. doi:10.3389/fphys.2021.702 266	<b>Objectives:</b> This cross-sectional, randomly assigned study aimed to assess the influence of immersive virtual reality (VR) on exercise tolerance expressed as the duration of a submaximal exercise test (ET) on a cycle ergometer. <b>Methods:</b> The study enrolled 70 healthy volunteers aged 22-25years. Each participant performed an ET with and without VR. Time- and frequency-domain heart rate variability (HRV) parameters were analyzed for the first 3min (T1), the last 3min (T2), and the time at which the shorter of the two tests terminated (Tiso). In the time domain, a SD of R-R intervals (SDNN) and a root mean square of successive R-R interval differences (RMSSD) in milliseconds were computed. The following spectral components were considered: low frequency (LF), high frequency (HF), total power (TP), and LF/HF ratio. The study was registered in ClinicalTrials.gov (NCT04197024). <b>Results:</b> Compared to standard ET, tests in immersive VR lasted significantly longer (694 vs. 591s, <i>p</i> <0.00001) and were associated with lower HR response across the range of corresponding exercise levels, averaging 5-8 beats/min. In the multiple regression analysis, the ET duration was positively determined by male sex, immersion in VR, and negatively determined by HRT1 and RMSSDT1. <b>Conclusion:</b> Exercising in VR is associated with lower HR which allowed subjects to exercise for a longer time before reaching target heart rate (HR). In addition, the increase in exercise duration was found to be related to an adjustment in autonomic nervous activity at a given work rate favoring narsaympathetic predominance.





Sankaranarayanan G, Li B, Manser K, et al. Face and construct validation of a next generation virtual reality (Gen2-VR) surgical simulator. *Surg Endosc*. 2016;30(3):979-985. doi:10.1007/s00464-015-4278-7 **Introduction:** Surgical performance is affected by distractors and interruptions to surgical workflow that exist in the operating room. However, traditional surgical simulators are used to train surgeons in a skills laboratory that does not recreate these conditions. To overcome this limitation, we have developed a novel, immersive virtual reality (Gen2-VR) system to train surgeons in these environments. This study was to establish face and construct validity of our system. Methods and procedures: The study was a within-subjects design, with subjects repeating a virtual peg transfer task under three different conditions: Case I: traditional VR; Case II: Gen2-VR with no distractions and Case III: Gen2-VR with distractions and interruptions. In Case III, to simulate the effects of distractions and interruptions, music was played intermittently, the camera lens was fogged for 10 s and tools malfunctioned for 15 s at random points in time during the simulation. At the completion of the study subjects filled in a 5-point Likert scale feedback questionnaire. A total of sixteen subjects participated in this study. **Results:** Friedman test showed significant difference in scores between the three conditions (p < 0.0001). Post hoc analysis using Wilcoxon signed-rank tests with Bonferroni correction further showed that all the three conditions were significantly different from each other (Case I, Case II, p < (0.0001), (Case I, Case III, p < 0.0001) and (Case II, Case III, p = 0.009). Subjects rated that fog (mean 4.18) and tool malfunction (median 4.56) significantly hindered their performance. Conclusion: The results showed that Gen2-VR simulator has both face and construct validity and that it can accurately and realistically present distractions and interruptions in a simulated OR, in spite of limitations of the current HMD hardware technology.





Sankaranarayanan G,	Background: SAGES FUSE curriculum provides didactic knowledge on OR fire
Wooley L, Hogg D, et al.	prevention. The objective of this study is to evaluate the impact of an immersive
Immersive virtual reality-	virtual reality (VR)-based OR fire training simulation system in combination with
based training improves	FUSE didactics. <b>Methods:</b> The study compared a control with a simulation
response in a simulated	group. After a pre-test questionnaire that assessed the baseline knowledge,
operating room fire	both groups were given didactic material that consists of a 10-min presentation
scenario. Surg Endosc.	and reading materials about precautions and stopping an OR fire from the FUSE
2018;32(8):3439-3449.	manual. The simulation group practiced on the OR fire simulation for one
doi:10.1007/s00464-018-	session that consisted of five trials within a week from the pre-test. One week
6063-x	later, both groups were reassessed using a questionnaire. A week after the post-
	test both groups also participated in a simulated OR fire scenario while their
	performance was videotaped for assessment. <b>Results:</b> A total of 20 subjects
	(ten per group) participated in this IRB approved study. Median test scores for
	the control group increased from 5.5 to 9.00 ( $p = 0.011$ ) and for the simulation
	group it increased from 5.0 to 8.5 ( $p = 0.005$ ). Both groups started at the same
	baseline (pre-test, $p = 0.529$ ) and reached similar level in cognitive knowledge
	(post-test, $p = 0.853$ ). However, when tested in the mock OB fire scenario, 70%
	of the simulation group subjects were able to perform the correct sequence of
	stens in extinguishing the simulated fire whereas only 20% subjects in the
	control group were able to do so $(n = 0.003)$ . The simulation group was better
	than control group in correctly identifying the oxidizer $(n = 0.03)$ and ignition
	source ( $p = 0.014$ ) <b>Conclusions:</b> Interactive VB-based bands-on training was
	found to be a relatively inexpensive and effective mode for teaching OR fire
	nevention and management scenarios
Sankaroski D. Baird M	Introduction: An immersive virtual reality (V/P) simulation clinic with dynamic
McInerney I Dimmock MB	national interaction and communication was developed to facilitate the training
The implementation of a	of medical radiation science students. The software "CETSOL VR Clinic" was
haptic foodback virtual	integrated into the Medical Imaging programme at Manash I Iniversity in 2016 in
reality simulation clinic with	arder to benchmark student experiences against existing simulation to chaigues
dynamia national interaction	(Shadarwara <sup>™</sup> ) Methoda: An iterative approach to development, based on two
and communication for	(Shaderware). Methods: An iterative approach to development, based on two
and communication for	cycles of user reeuback, was used to develop and refine the simulated clinical
Med Dedict Cai	environment. This environment uses realistic 3D models, embedded clinical
Med Radiat Sci.	scenarios, dynamic communication, 3D hand gesture interaction, gaze and
2018;65(3):218-225.	positional stereoscopic tracking and online user capabilities using the Unity"
doi:10.1002/jmrs.288	game and physics engines. Students' perceptions of educational enhancement
	of their positioning skills following the use of the simulation tools were analysed
	via a 5-point Likert scale questionnaire. <b>Results:</b> Student perception scores
	indicated a significant difference between simulation modalities in favour of the
	immersive CETSOL VR Clinic, $\chi^2$ (4, N = 92) = 9.5, P-value <0.001.
	<b>Conclusion:</b> Student perception scores on improvement of their clinical and
	technical skills were higher for the hand-positioning tasks performed with the
	CETSOL VR Clinic <sup>™</sup> than with the comparative benchmark simulation that did
	not provide dynamic patient interaction and communication.





Sapkaroski D, Baird M, Mundy M, Dimmock MR. Quantification of Student Radiographic Patient Positioning Using an Immersive Virtual Reality Simulation. *Simul Healthc*. 2019;14(4):258-263. doi:10.1097/SIH.00000000 0000380 Introduction: Immersive virtual reality (VR) simulation environments facilitate novel ways for users to visualize anatomy and quantify performance relative to expert users. The ability of software to provide positional feedback before a practitioner progresses with subsequent stages of examinations has broad implications for primary and allied healthcare professionals, particularly with respect to health and safety (eg, exposing to x-rays). The effect of training student-radiographers (radiology technicians), with a VR simulation environment was quantitatively assessed. Methods: Year 1 radiography students (N = 76) were randomly split into 2 cohorts, each of which were trained at performing the same tasks relating to optimal hand positioning for projection x-ray imaging; group 1 was trained using the CETSOL VR Clinic software, whereas group 2 was trained using conventional simulated role-play in a real clinical environment. All participants completed an examination 3 weeks after training. The examination required both posterior-anterior and oblique hand x-ray positioning tasks to be performed on a real patient model. The analysis of images from the examination enabled quantification of the students' performance. The results were contextualized through a comparison with 4 expert radiographers. **Results:** Students in group 1 performed on average 36% (P < 0.001) better in relation to digit separation, 11% (P  $\leq$  0.001) better in terms of palm flatness and 23% (P < 0.05) better in terms of central ray positioning onto the third metacarpal. **Conclusion:** A significant difference in patient positioning was evident between the groups; the VR clinic cohort demonstrated improved patient positioning outcomes. The observed improvement is attributed to the inherent task deconstruction and variety of visualization mechanisms available in immersive VR environments.





Sapkaroski D, Mundy M, Dimmock MR. Immersive virtual reality simulated learning environment versus role-play for empathic clinical communication training. *J Med Radiat Sci.* 2022;69(1):56-65. doi:10.1002/jmrs.555 Introduction: The use of immersive virtual reality simulated learning environments (VR SLEs) for improving clinical communication can offer desirable qualities including repetition and determinism in a safe environment. The aim of this study was to establish whether the mode of delivery, VR SLE versus clinical role-play, could have a measurable effect on clinical empathic communication skills for MRI scenarios. Methods: A split-cohort study was performed with trainee practitioners (n = 70) and qualified practitioners (n = 9). Participants were randomly assigned to four groups: clinician VR (CVR), clinician role-play (CRP), trainee VR (TVR), and trainee RP (TRP). Clinical communication skills were assessed using two methods: firstly, a self-reported measure - the SE-12 communication questionnaire and, secondly, a training and assessment tool developed by a panel of experts. **Results:** Participants in the VR trainee (TVR) and clinician (CVR) groups reported 11% (P < 0.05) and 7.2% (P < 0.05) improvements in communication confidence post training, whereas trainees assigned to the role-play (TRP) intervention reported a 4.3% (P < 0.05) improvement. Empirical assessment of communication training scores assessing a participant's ability to select empathic statements showed the TVR group performed 5% better on average than their role-play counterparts (P < 0.05). **Conclusion:** The accuracy of participant's selection of appropriate empathic responses was shown to differ significantly following the training intervention designed to improve interactions with patients that present for an MRI scan. The results may demonstrate the capacity for immersion into an emotional narrative in a VR environment to increase the user's susceptibility for recalling and selecting empathic terminology.





Schöbel T, Schuschke L, Youssef Y, Rotzoll D, Theopold J, Osterhoff G. Immersive virtual reality in orthopedic surgery as elective subject for medical students : First experiences in curricular teaching. Immersive virtuelle Realität in der Orthopädie und Unfallchirurgie als Wahlfach für Medizinstudierende : Erste Erfahrungen in der curricularen Lehre. Orthopadie (Heidelb). Published online April 4, 2024. doi:10.1007/s00132-024-04491-w

Background: Virtual reality (VR) simulators have been introduced for skills training in various medical disciplines to create an approximately realistic environment without the risk of patient harm and have improved to more immersive VR (iVR) simulators at affordable costs. There is evidence that training on VR simulators improves technical skills but its use in orthopedic training programs and especially in curricular teaching sessions for medical students are currently not well established. The aim of this study was to describe the implementation of a VR operating theater as an elective course for undergraduate medical students and to evaluate its effect on student learning. Methods: An elective course for 12 students was implemented during the summer semester of 2023. Using Oculus Quest 2 headsets (Reality Labs, Meta Platforms, USA) and controllers and the PrecisionOS platform, they were able to train five different surgical procedures. The courses were accompanied by weekly topic discussions and instructional videos. Students were assigned to two groups: group VR vs. group non-VR. The groups were switched after 5 weeks. User feedback and performance development (theoretical and procedural surgical knowledge) after VR training were assessed using three questionnaires. **Results:** The students highly appreciated the implementation of VR training into their curriculum and 91% stated that they would opt for further VR training. All students stated that VR training improved their understanding of surgical procedures and that it should be obligatory in surgical training for undergraduate medical students. After 5 weeks of training, students in the VR group achieved significantly better results (100 out of maximum 180 points) than the non-VR group (70 points, p = 0.0495) in procedural surgical knowledge. After completion of the VR training the VR group achieved 106 points and the non-VR group 104 points (p = 0.8564). The procedural knowledge for non-VR group after 5 weeks significantly improved after VR training from 70 to 106 points (p = 0.0087). **Conclusion:** The iVR can be easily integrated into the curriculum of medical students and is highly appreciated by the participants. The iVR statistically improves the procedural knowledge of surgical steps compared to conventional teaching methods. Further implementation of iVR training in curricular teaching of medical students should be considered.





Shin HT, Kim DY, Bae CR, et	Background: The purpose of this study was to confirm whether fully-immersive
al. Fully-immersive virtual	virtual reality instrumental activities of daily living training is safe and feasible for
reality instrumental activities	people with mild dementia. Methods: The virtual reality program contents
of daily living training for mild	include simulation of instrumental activities of daily living training. Feasibility
dementia: a feasibility	was assessed by means of responses to a self-report satisfaction questionnaire
study. Ann Palliat Med.	and the Simulator Sickness Questionnaire; and by analyzing the level of
2023;12(2):280-290.	participants' immersion. Researchers assessed the instrumental activities of
doi:10.21037/apm-22-847	daily living scores, cognitive functioning, and mood changes pre- and post-
	intervention. <b>Results:</b> A total of seven participants with mild dementia were
	recruited. The mean immersion score was 50.42±7.89 points, and the mean
	adherence was 83.71±6.10 points. Overall, the participants found the activities
	satisfying. Six participants experienced negligible side effects and one exhibited
	moderate side effects. After the training, the instrumental activities of daily living
	scores improved significantly ( $P=0.042$ ) Performance on the Word List Delayed
	Recall test and Trail Making Test B showed improvements in all participants
	<b>Conclusions:</b> Fully-immersive virtual reality-based instrumental activities of
	daily living training is feasible for people with mild dementia and provides them
	with a high level of satisfaction and immersion. This program can beln improve
	their capacities to carry out activities of daily living their cognitive functioning
	and mood. However, further research is peopled for fully immersive virtual reality
	instrumental activities of daily living training before it can be considered as a
	treatment ention in people with mild demontio
Sprangel II Scalfold D Stabl	<b>Burpage:</b> The treatment of intragrapial arteriovenous malfermations (A)(M) is
Sprenger O, Saatietu P, Stant	challenging due to their complex enotomy. For this vessel nothelegy, exterios are
for treatment support of	directly linked to voine without a confiltent had in botween. For endoween uler
intrograpial AVMa using an	treatment embelization is carried out, where the arterios that supply the AVM
interactive desisten and VD	are consecutively blocked. A virtual embediaction could support the mediael
Interactive desktop and VR	are consecutively blocked. A virtual embolization could support the medical
Application. Int J Comput	expert in treatment planning. <b>Method:</b> we designed and implemented an
Assist Radiol Surg.	I immorelive via annucation that allowe the vielialization of the elmiliated blood
2021;16(12):2119-2127.	flow here discrete silling as for extinction. For the many the second second states the
	flow by displaying millions of particles. Furthermore, the user can interactively
doi:10.1007/s11548-021-	flow by displaying millions of particles. Furthermore, the user can interactively block or unblock arteries that supply the AVM and analyze the altered blood flow
doi:10.1007/s11548-021- 02532-9	flow by displaying millions of particles. Furthermore, the user can interactively block or unblock arteries that supply the AVM and analyze the altered blood flow based on pre-computed simulations. <b>Results:</b> In a pilot study, the application
doi:10.1007/s11548-021- 02532-9	flow by displaying millions of particles. Furthermore, the user can interactively block or unblock arteries that supply the AVM and analyze the altered blood flow based on pre-computed simulations. <b>Results:</b> In a pilot study, the application was successfully adapted to three patient-specific cases. We performed a
doi:10.1007/s11548-021- 02532-9	flow by displaying millions of particles. Furthermore, the user can interactively block or unblock arteries that supply the AVM and analyze the altered blood flow based on pre-computed simulations. <b>Results:</b> In a pilot study, the application was successfully adapted to three patient-specific cases. We performed a qualitative evaluation with two experienced neuroradiologist who regularly
doi:10.1007/s11548-021- 02532-9	flow by displaying millions of particles. Furthermore, the user can interactively block or unblock arteries that supply the AVM and analyze the altered blood flow based on pre-computed simulations. <b>Results:</b> In a pilot study, the application was successfully adapted to three patient-specific cases. We performed a qualitative evaluation with two experienced neuroradiologist who regularly conduct AVM embolizations. The feature of virtually blocking or unblocking
doi:10.1007/s11548-021- 02532-9	flow by displaying millions of particles. Furthermore, the user can interactively block or unblock arteries that supply the AVM and analyze the altered blood flow based on pre-computed simulations. <b>Results:</b> In a pilot study, the application was successfully adapted to three patient-specific cases. We performed a qualitative evaluation with two experienced neuroradiologist who regularly conduct AVM embolizations. The feature of virtually blocking or unblocking feeders was rated highly beneficial, and a desire for the inclusion of quantitative
doi:10.1007/s11548-021- 02532-9	flow by displaying millions of particles. Furthermore, the user can interactively block or unblock arteries that supply the AVM and analyze the altered blood flow based on pre-computed simulations. <b>Results:</b> In a pilot study, the application was successfully adapted to three patient-specific cases. We performed a qualitative evaluation with two experienced neuroradiologist who regularly conduct AVM embolizations. The feature of virtually blocking or unblocking feeders was rated highly beneficial, and a desire for the inclusion of quantitative information was formulated. <b>Conclusion:</b> The presented application allows for
doi:10.1007/s11548-021- 02532-9	flow by displaying millions of particles. Furthermore, the user can interactively block or unblock arteries that supply the AVM and analyze the altered blood flow based on pre-computed simulations. <b>Results:</b> In a pilot study, the application was successfully adapted to three patient-specific cases. We performed a qualitative evaluation with two experienced neuroradiologist who regularly conduct AVM embolizations. The feature of virtually blocking or unblocking feeders was rated highly beneficial, and a desire for the inclusion of quantitative information was formulated. <b>Conclusion:</b> The presented application allows for virtual embolization and interactive blood flow visualization in an immersive
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Stepan K, Zeiger J, Hanchuk S, et al. Immersive virtual reality as a teaching tool for neuroanatomy. *Int Forum Allergy Rhinol*. 2017;7(10):1006-1013. doi:10.1002/alr.21986 Background: Three-dimensional (3D) computer modeling and interactive virtual reality (VR) simulation are validated teaching techniques used throughout medical disciplines. Little objective data exists supporting its use in teaching clinical anatomy. Learner motivation is thought to limit the rate of utilization of such novel technologies. The purpose of this study is to evaluate the effectiveness, satisfaction, and motivation associated with immersive VR simulation in teaching medical students neuroanatomy. Methods: Images of normal cerebral anatomy were reconstructed from human Digital Imaging and Communications in Medicine (DICOM) computed tomography (CT) imaging and magnetic resonance imaging (MRI) into 3D VR formats compatible with the Oculus Rift VR System, a head-mounted display with tracking capabilities allowing for an immersive VR experience. The ventricular system and cerebral vasculature were highlighted and labeled to create a focused interactive model. We conducted a randomized controlled study with 66 medical students (33 in both the control and experimental groups). Pertinent neuroanatomical structures were studied using either online textbooks or the VR interactive model, respectively. We then evaluated the students' anatomy knowledge, educational experience, and motivation (using the Instructional Materials Motivation Survey [IMMS], a previously validated assessment). Results: There was no significant difference in anatomy knowledge between the 2 groups on preintervention, postintervention, or retention quizzes. The VR group found the learning experience to be significantly more engaging, enjoyable, and useful (all p < 0.01) and scored significantly higher on the motivation assessment (p < 0.01). **Conclusion:** Immersive VR educational tools awarded a more positive learner experience and enhanced student motivation. However, the technology was equally as effective as the traditional text books in teaching neuroanatomy.





Taylor B, McLean G, Sim J. Immersive virtual reality for pre-registration computed tomography education of radiographers: A narrative review. *J Med Radiat Sci*. 2023;70(2):171-182. doi:10.1002/jmrs.657 To be registered as a medical radiation practitioner, The Medical Radiation Practice Board of Australia (MRPBA) requires radiographers to be capable of performing computed tomography (CT) imaging examinations safely and effectively. Universities meet this requirement by offering practical CT training to radiography students on-campus and during clinical placements. However, institutions face challenges when facilitating on-campus CT practicum. Virtual reality (VR) has been suggested as a possible solution for radiography students to gain CT scanning experience. This narrative review explored relevant literature to investigate the potential for immersive VR to be incorporated into CT practicum. Benefits and limitations of this education technology are examined with resultant recommendations made for integration into the CT curriculum. Results found that VR enhances CT learning for students, increases confidence and raises motivation for the simulated CT task. CT simulation provides a viable alternative in the context of pandemic-imposed restrictions and reduced CT placement duration. However, it remains debatable as to whether immersive VR truly enhances student learning compared with other VR modalities, such as computer-based CT simulation. In addition, a lack of staff training, availability of resources and technical problems were flagged as limitations. We concluded that before immersive VR is integrated into CT education, significant optimisation of the simulation is needed. This includes ensuring VR scenarios are based on learning paradigms and feedback is integrated as part of simulation learning. Engaging clinical partners during the CT VR rollout is imperative to ensure successful transition of students from university learning to clinical placement.





Tene T, Vique López DF, Valverde Aguirre PE, Orna Puente LM, Vacacela Gomez C. Virtual reality and augmented reality in medical education: an umbrella review. *Front Digit Health*. 2024;6:1365345. Published 2024 Mar 14. doi:10.3389/fdgth.2024.136 5345 Objective: This umbrella review aims to ascertain the extent to which immersive Virtual Reality (VR) and Augmented Reality (AR) technologies improve specific competencies in healthcare professionals within medical education and training, in contrast to traditional educational methods or no intervention. Methods: Adhering to PRISMA guidelines and the PICOS approach, a systematic literature search was conducted across major databases to identify studies examining the use of VR and AR in medical education. Eligible studies were screened and categorized based on the PICOS criteria. Descriptive statistics and chi-square tests were employed to analyze the data, supplemented by the Fisher test for small sample sizes or specific conditions. Analysis: The analysis involved cross-tabulating the stages of work (Development and Testing, Results, Evaluated) and variables of interest (Performance, Engagement, Performance and Engagement, Effectiveness, no evaluated) against the types of technologies used. Chi-square tests assessed the associations between these categorical variables. Results: A total of 28 studies were included, with the majority reporting increased or positive effects from the use of immersive technologies. VR was the most frequently studied technology, particularly in the "Performance" and "Results" stages. The chi-square analysis, with a Pearson value close to significance (p = 0.052), suggested a non-significant trend toward the association of VR with improved outcomes. **Conclusions:** The results indicate that VR is a prevalent tool in the research landscape of medical education technologies, with a positive trend toward enhancing educational outcomes. However, the statistical analysis did not reveal a significant association, suggesting the need for further research with larger sample sizes. This review underscores the potential of immersive technologies to enhance medical training yet calls for more rigorous studies to establish definitive evidence of their efficacy.





Tsai HP, Lin CW, Lin YJ, Yeh CS, Shan YS. Novel Software for High-level Virological Testing: Self-Designed Immersive Virtual Reality Training Approach. *J Med Internet Res*. 2023;25:e44538. Published 2023 Jun 21. doi:10.2196/44538 Background: To ensure the timely diagnosis of emerging infectious diseases, high-tech molecular biotechnology is often used to detect pathogens and has gradually become the gold standard for virological testing. However, beginners and students are often unable to practice their skills due to the higher costs associated with high-level virological testing, the increasing complexity of the equipment, and the limited number of specimens from patients. Therefore, a new training program is necessary to increase training and reduce the risk of test failure. **Objective:** The aim of the study is to (1) develop and implement a virtual reality (VR) software for simulated and interactive high-level virological testing that can be applied in clinical practice and skills building or training settings and (2) evaluate the VR simulation's effectiveness on reaction, learning, and behavior of the students (trainees). Methods: Viral nucleic acid tests on a BD MAX instrument were selected for our VR project because it is a high-tech automatic detection system. There was cooperation between teachers of medical technology and biomedical engineering. Medical technology teachers were responsible for designing the lesson plan, and the biomedical engineering personnel developed the VR software. We designed a novel VR teaching software to simulate cognitive learning via various procedure scenarios and interactive models. The VR software contains 2D VR "cognitive test and learning" lessons and 3D VR "practical skills training" lessons. We evaluated students' learning effectiveness pre- and posttraining and then recorded their behavior patterns when answering questions, performing repeated exercises, and engaging in clinical practice. **Results:** The results showed that the use of the VR software met participants' needs and enhanced their interest in learning. The average posttraining scores of participants exposed to 2D and 3D VR training were significantly higher than participants who were exposed solely to traditional demonstration teaching (P<.001). Behavioral assessments of students pre- and posttraining showed that students exposed to VR-based training to acquire relevant knowledge of advanced virological testing exhibited significantly improved knowledge of specific items posttraining (P<.01). A higher participant score led to fewer attempts when responding to each item in a matching task. Thus, VR can enhance students' understanding of difficult topics. **Conclusions:** The VR program designed for this study can reduce the costs associated with virological testing training, thus, increasing their accessibility for students and beginners. It can also reduce the risk of viral infections particularly during disease outbreaks (eg, the COVID-19 pandemic) and also enhance students' learning motivation to strengthen their practical skills.





Varela-Aldás J, Palacios- Navarro G, Amariglio R, García-Magariño I. Head- Mounted Display-Based Application for Cognitive Training. <i>Sensors (Basel)</i> . 2020;20(22):6552. Published 2020 Nov 17. doi:10.3390/s20226552	Virtual Reality (VR) has had significant advances in rehabilitation, due to the gamification of cognitive activities that facilitate treatment. On the other hand, Immersive Virtual Reality (IVR) produces outstanding results due to the interactive features with the user. This work introduces a VR application for memory rehabilitation by walking through a maze and using the Oculus Go head-mounted display (HMD) technology. The mechanics of the game require memorizing geometric shapes while the player progresses in two modes, autonomous or manual, with two levels of difficulty depending on the number of elements to remember. The application is developed in the Unity 3D video game engine considering the optimization of computational resources to improve the performance in the processing and maintaining adequate benefits for the user, while the generated data is stored and sent to a remote server. The maze task was assessed with 29 subjects in a controlled environment. The obtained results show a significant correlation between participants' response accuracy in both the maze task and a face-pair test. Thus, the proposed task is able to perform memory assessments.
Wan T, Liu K, Li B, Wang X. Effectiveness of immersive virtual reality in orthognathic surgical education: A randomized controlled trial. <i>J</i> <i>Dent Educ</i> . 2024;88(1):109- 117. doi:10.1002/jdd.13380	<b>Purpose:</b> To evaluate the efficacy of an iVR surgical training system for orthognathic surgery training in medical students. <b>Methods:</b> This study comprised 20 fifth year medical students who were randomly assigned to the VR or traditional group for orthognathic surgical education. All participants were initially provided a lecture on orthognathic surgery. The VR group then received 10 educational sessions using the self-developed iVR training system, whereas the traditional group received 10 sessions using technical manuals and annotated operation videos. These sessions were 40-min long in both the groups. Before the evaluation, the traditional group completed one session using the training and assessment modes to become familiar with the iVR training system. The score in the assessment mode, time to complete the procedure, number of instrument selection errors, number of prompts given by the system, number of positional and angular errors, and number of timeouts during each step were recorded to evaluate the learning effect. <b>Results:</b> The VR group achieved higher scores than the traditional group (94.67 vs. 87.65). Compared with the control group, the VR group completed the procedure more quickly, with fewer instrument selection and angular errors. No difference in the number of prompts given by the system was observed between the two groups. <b>Conclusions:</b> The iVR surgical training system showed a better learning effect than the traditional learning method for orthognathic surgery. The iVR surgical training system may have utility as a supplement and potential substitute for the traditional surgical training method.





Wan T, Liu K, Li B, Wang X.	Virtual reality (VR) has been proven an important supplement for surgical
Validity of an immersive	education in medical students. However, studies on immersive VR (iVR)
virtual reality training system	simulation in orthognathic surgical education are limited. This study aimed to
for orthognathic surgical	assess the validity of the iVR surgical training system for orthognathic surgery.
education. Front Pediatr.	Participants completed questionnaires at the end of the course to assess the
2023;11:1133456. Published	validity of the training system. The questionnaires included questions on the
2023 Mar 23.	experience of using the iVR system and surgical authenticity. Seven experienced
doi:10.3389/fped.2023.1133	surgeons and seven inexperienced students were recruited in this study to use
456	our self-developed iVR training system for orthognathic surgery. The participants
	showed strong agreement to the fidelity of our training system (4.35 out of 5),
	including the virtual environment, instruments, anatomy structures, and surgical
	procedures. The participants also strongly agreed that the iVR technique was
	essential in imparting surgical education. However, most of the participants
	experienced some degree of dizziness or fatigue after 1 h of using the system.
	The iVR training system is a new method for imparting education about
	orthognathic surgery. The iVR training system can act as a supplement and
	potential substitute of the traditional surgical training method.
Wilkerson W, Avstreih D,	Objectives: A descriptive study was performed to better understand the
Wilkerson W, Avstreih D, Gruppen L, Beier KP,	<b>Objectives:</b> A descriptive study was performed to better understand the possible utility of immersive virtual reality simulation for training first responders
Wilkerson W, Avstreih D, Gruppen L, Beier KP, Woolliscroft J. Using	<b>Objectives:</b> A descriptive study was performed to better understand the possible utility of immersive virtual reality simulation for training first responders in a mass casualty event. <b>Methods:</b> Utilizing a virtual reality cave automatic
Wilkerson W, Avstreih D, Gruppen L, Beier KP, Woolliscroft J. Using immersive simulation for	<b>Objectives:</b> A descriptive study was performed to better understand the possible utility of immersive virtual reality simulation for training first responders in a mass casualty event. <b>Methods:</b> Utilizing a virtual reality cave automatic virtual environment (CAVE) and high-fidelity human patient simulator (HPS), a
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Wilkerson W, Avstreih D, Gruppen L, Beier KP, Woolliscroft J. Using immersive simulation for training first responders for mass casualty incidents. Acad Emerg Med.	<b>Objectives:</b> A descriptive study was performed to better understand the possible utility of immersive virtual reality simulation for training first responders in a mass casualty event. <b>Methods:</b> Utilizing a virtual reality cave automatic virtual environment (CAVE) and high-fidelity human patient simulator (HPS), a group of experts modeled a football stadium that experienced a terrorist explosion during a football game. Avatars (virtual patients) were developed by expert consensus that demonstrated a spectrum of injuries ranging from death
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Wilkerson W, Avstreih D, Gruppen L, Beier KP, Woolliscroft J. Using immersive simulation for training first responders for mass casualty incidents. <i>Acad Emerg Med</i> . 2008;15(11):1152-1159. doi:10.1111/j.1553- 2712.2008.00223.x	<b>Objectives:</b> A descriptive study was performed to better understand the possible utility of immersive virtual reality simulation for training first responders in a mass casualty event. <b>Methods:</b> Utilizing a virtual reality cave automatic virtual environment (CAVE) and high-fidelity human patient simulator (HPS), a group of experts modeled a football stadium that experienced a terrorist explosion during a football game. Avatars (virtual patients) were developed by expert consensus that demonstrated a spectrum of injuries ranging from death to minor lacerations. A group of paramedics was assessed by observation for decisions made and action taken. A critical action checklist was created and used for direct observation and viewing videotaped recordings. <b>Results:</b> Of the
Wilkerson W, Avstreih D, Gruppen L, Beier KP, Woolliscroft J. Using immersive simulation for training first responders for mass casualty incidents. <i>Acad Emerg Med</i> . 2008;15(11):1152-1159. doi:10.1111/j.1553- 2712.2008.00223.x	<b>Objectives:</b> A descriptive study was performed to better understand the possible utility of immersive virtual reality simulation for training first responders in a mass casualty event. <b>Methods:</b> Utilizing a virtual reality cave automatic virtual environment (CAVE) and high-fidelity human patient simulator (HPS), a group of experts modeled a football stadium that experienced a terrorist explosion during a football game. Avatars (virtual patients) were developed by expert consensus that demonstrated a spectrum of injuries ranging from death to minor lacerations. A group of paramedics was assessed by observation for decisions made and action taken. A critical action checklist was created and used for direct observation and viewing videotaped recordings. <b>Results:</b> Of the 12 participants, only 35.7% identified the type of incident they encountered.
Wilkerson W, Avstreih D, Gruppen L, Beier KP, Woolliscroft J. Using immersive simulation for training first responders for mass casualty incidents. <i>Acad Emerg Med</i> . 2008;15(11):1152-1159. doi:10.1111/j.1553- 2712.2008.00223.x	<b>Objectives:</b> A descriptive study was performed to better understand the possible utility of immersive virtual reality simulation for training first responders in a mass casualty event. <b>Methods:</b> Utilizing a virtual reality cave automatic virtual environment (CAVE) and high-fidelity human patient simulator (HPS), a group of experts modeled a football stadium that experienced a terrorist explosion during a football game. Avatars (virtual patients) were developed by expert consensus that demonstrated a spectrum of injuries ranging from death to minor lacerations. A group of paramedics was assessed by observation for decisions made and action taken. A critical action checklist was created and used for direct observation and viewing videotaped recordings. <b>Results:</b> Of the 12 participants, only 35.7% identified the type of incident they encountered. None identified a secondary device that was easily visible. All participants were
Wilkerson W, Avstreih D, Gruppen L, Beier KP, Woolliscroft J. Using immersive simulation for training first responders for mass casualty incidents. <i>Acad Emerg Med</i> . 2008;15(11):1152-1159. doi:10.1111/j.1553- 2712.2008.00223.x	<b>Objectives:</b> A descriptive study was performed to better understand the possible utility of immersive virtual reality simulation for training first responders in a mass casualty event. <b>Methods:</b> Utilizing a virtual reality cave automatic virtual environment (CAVE) and high-fidelity human patient simulator (HPS), a group of experts modeled a football stadium that experienced a terrorist explosion during a football game. Avatars (virtual patients) were developed by expert consensus that demonstrated a spectrum of injuries ranging from death to minor lacerations. A group of paramedics was assessed by observation for decisions made and action taken. A critical action checklist was created and used for direct observation and viewing videotaped recordings. <b>Results:</b> Of the 12 participants, only 35.7% identified the type of incident they encountered. None identified a secondary device that was easily visible. All participants were enthusiastic about the simulation and provided valuable comments and
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Wilkerson W, Avstreih D, Gruppen L, Beier KP, Woolliscroft J. Using immersive simulation for training first responders for mass casualty incidents. <i>Acad Emerg Med</i> . 2008;15(11):1152-1159. doi:10.1111/j.1553- 2712.2008.00223.x	<b>Objectives:</b> A descriptive study was performed to better understand the possible utility of immersive virtual reality simulation for training first responders in a mass casualty event. <b>Methods:</b> Utilizing a virtual reality cave automatic virtual environment (CAVE) and high-fidelity human patient simulator (HPS), a group of experts modeled a football stadium that experienced a terrorist explosion during a football game. Avatars (virtual patients) were developed by expert consensus that demonstrated a spectrum of injuries ranging from death to minor lacerations. A group of paramedics was assessed by observation for decisions made and action taken. A critical action checklist was created and used for direct observation and viewing videotaped recordings. <b>Results:</b> Of the 12 participants, only 35.7% identified the type of incident they encountered. None identified a secondary device that was easily visible. All participants were enthusiastic about the simulation and provided valuable comments and insights. <b>Conclusions:</b> Learner feedback and expert performance review suggests that immersive training in a virtual environment has the potential to be a powerful tool to train first responders for high-acuity, low-frequency events,
Wilkerson W, Avstreih D, Gruppen L, Beier KP, Woolliscroft J. Using immersive simulation for training first responders for mass casualty incidents. <i>Acad Emerg Med</i> . 2008;15(11):1152-1159. doi:10.1111/j.1553- 2712.2008.00223.x	<b>Objectives:</b> A descriptive study was performed to better understand the possible utility of immersive virtual reality simulation for training first responders in a mass casualty event. <b>Methods:</b> Utilizing a virtual reality cave automatic virtual environment (CAVE) and high-fidelity human patient simulator (HPS), a group of experts modeled a football stadium that experienced a terrorist explosion during a football game. Avatars (virtual patients) were developed by expert consensus that demonstrated a spectrum of injuries ranging from death to minor lacerations. A group of paramedics was assessed by observation for decisions made and action taken. A critical action checklist was created and used for direct observation and viewing videotaped recordings. <b>Results:</b> Of the 12 participants, only 35.7% identified the type of incident they encountered. None identified a secondary device that was easily visible. All participants were enthusiastic about the simulation and provided valuable comments and insights. <b>Conclusions:</b> Learner feedback and expert performance review suggests that immersive training in a virtual environment has the potential to be a powerful tool to train first responders for high-acuity, low-frequency events, such as a terrorist attack.





Winter C, Kern F, Gall D, Latoschik ME, Pauli P, Käthner I. Immersive virtual reality during gait rehabilitation increases walking speed and motivation: a usability evaluation with healthy participants and patients with multiple sclerosis and stroke. *J Neuroeng Rehabil*. 2021;18(1):68. Published 2021 Apr 22. doi:10.1186/s12984-021-00848-w **Background:** The rehabilitation of gait disorders in patients with multiple sclerosis (MS) and stroke is often based on conventional treadmill training. Virtual reality (VR)-based treadmill training can increase motivation and improve therapy outcomes. The present study evaluated an immersive virtual reality application (using a head-mounted display, HMD) for gait rehabilitation with patients to (1) demonstrate its feasibility and acceptance and to (2) compare its short-term effects to a semi-immersive presentation (using a monitor) and a conventional treadmill training without VR to assess the usability of both systems and estimate the effects on walking speed and motivation. Methods: In a within-subjects study design, 36 healthy participants and 14 persons with MS or stroke participated in each of the three experimental conditions (VR via HMD, VR via monitor, treadmill training without VR). **Results:** For both groups, the walking speed in the HMD condition was higher than in treadmill training without VR and in the monitor condition. Healthy participants reported a higher motivation after the HMD condition as compared with the other conditions. Importantly, no side effects in the sense of simulator sickness occurred and usability ratings were high. No increases in heart rate were observed following the VR conditions. Presence ratings were higher for the HMD condition compared with the monitor condition for both user groups. Most of the healthy study participants (89%) and patients (71%) preferred the HMD-based training among the three conditions and most patients could imagine using it more frequently. Conclusions: For the first time, the present study evaluated the usability of an immersive VR system for gait rehabilitation in a direct comparison with a semi-immersive system and a conventional training without VR with healthy participants and patients. The study demonstrated the feasibility of combining a treadmill training with immersive VR. Due to its high usability and low side effects, it might be particularly suited for patients to improve training motivation and training outcome e.g. the walking speed compared with treadmill training using no or only semi-immersive VR. Immersive VR systems still require specific technical setup procedures. This should be taken into account for specific clinical use-cases during a cost-benefit assessment.





Xin B, Chen G, Wang Y, et al. The Efficacy of Immersive Virtual Reality Surgical simulator Training for Pedicle Screw Placement: A Randomized Double-Bild doi:10.1016/j.wneu.2018.12. <b>Purpose:</b> To assess efficacy of immersive virtual reality (VR) surgical simulator training for pedicle screw placement (PSP) in surgical graduate students. Wethods: Sixteen inexperienced surgical graduate students were equally randomly assigned to an experimental group (VR group) and a control group (non-VR group). Students in the VR group performed PSP on the immersive VR surgical simulator, and students in the non-VR group were given at raditional introductor, and students in the non-VR group were given at raditional introductory teaching session before a cadaver test. Eight adult fresh cadavers, 6 male and 2 female, were collected and randomly allocated to the 2 groups. Eacember 28, 2018. 6 male and 2 female, were collected and randomly allocated to the 2 groups. tastistically. <b>Results:</b> Accuracy rate of PSP in the VR group was 89.6% versus 60.4% in the non-VR group (P < 0.05), success rate was 100% versus 79.2% (P < 0.05), and mean time was 2.8 ± 1 minutes versus 4.9 ± 1 minutes (P < 0.05), all showing significant differences between the 2 groups.Xin B, Huang X, Wan W, et al. The efficacy of immersive virtual reality surgical simulator training model in terms of accuracy, success rate, and efficiency, showing potential in training new orthopedic sprew placement (PSP) skills of young surgeons receiving immersive virtual reality surgical simulator (IVRSS) training could be improved effectively and whether the IVRSS-PSP training mode could prouce a react clinical value in clinical asurgery. Methods: Situed in the maters in VR group received IVRSS-PSP training and those in NON-VR group were 82.9% and 65.6% vs. 74.2% and 55.4%, respectively, showing statistically significant d		
Kinditional training model in terms of accuracy, success rate, and efficiency, showing potential in training mow orthopedic spine surgeons.Xin B, Huang X, Wan W, et al. The efficacy of immersive virtual reality surgical <b>Objective:</b> To verify whether the pedicle screw placement (PSP) skills of young surgeons receiving immersive virtual reality surgical simulator (IVRSS) training could be improved effectively and whether the IVRSS-PSP training mode could produce a real clinical value in clinical surgery. <b>Methods:</b> Twenty-four young surgeons were equally randomized to a VR group and a NON-VR group. Participants in VR group received IVRSS-PSP training, and those in NON-VR group used the conventional model of observing a spinal model first and then watching a teaching video of spinal surgery for 40 minutes x five. The nailing outcome of the participants before and after training was evaluated by statistical analysis in both groups. <b>Results:</b> Post-training data analysis showed that the success rate and accuracy rate of screw placement in VR group and NON-VR group were 82.9% and 69.6% vs. 74.2% and 55.4%, respectively, showing statistically significant differences between the two groups by chi-square test (P < 0.05). <b>Conclusion:</b> The present study demonstrated that IVRSS-PSP was helpful to improve the success rate of PSP for young surgeons, and may provide valuable reference for PSP training of young surgeons. In addition, our study also showed a promising potential of the VR technology in surgical simulation training.	Xin B, Chen G, Wang Y, et al. The Efficacy of Immersive Virtual Reality Surgical Simulator Training for Pedicle Screw Placement: A Randomized Double-Blind Controlled Trial. <i>World</i> <i>Neurosurg</i> . Published online December 28, 2018. doi:10.1016/j.wneu.2018.12. 090	<b>Purpose:</b> To assess efficacy of immersive virtual reality (VR) surgical simulator training for pedicle screw placement (PSP) in surgical graduate students. <b>Methods:</b> Sixteen inexperienced surgical graduate students were equally randomly assigned to an experimental group (VR group) and a control group (non-VR group). Students in the VR group performed PSP on the immersive VR surgical simulator, and students in the non-VR group were given a traditional introductory teaching session before a cadaver test. Eight adult fresh cadavers, 6 male and 2 female, were collected and randomly allocated to the 2 groups. Each group performed bilateral T11-L4 PSP on the cadavers independently, and the outcomes of PSP in terms of accuracy, success rate, and efficiency were assessed by computed tomography and compared between the 2 groups statistically. <b>Results:</b> Accuracy rate of PSP in the VR group was 89.6% versus 60.4% in the non-VR group (P < 0.05), success rate was 100% versus 79.2% (P < 0.05), and mean time was 2.8 ± 1 minutes versus 4.9 ± 1 minutes (P < 0.05), all showing significant differences between the 2 groups. The immersive VR surgical simulator for PSP training model is superior to the traditional differences of performent of accuracy.
Xin B, Huang X, Wan W, et al. The efficacy of immersive virtual reality surgicalObjective: To verify whether the pedicle screw placement (PSP) skills of young surgeons receiving immersive virtual reality surgical simulator (IVRSS) training could be improved effectively and whether the IVRSS-PSP training mode could produce a real clinical value in clinical surgery. Methods: Twenty-four young surgeons were equally randomized to a VR group and a NON-VR group. Participants in VR group received IVRSS-PSP training, and those in NON-VR group used the conventional model of observing a spinal model first and then watching a teaching video of spinal surgery for 40 minutes x five. The nailing outcome of the participants before and after training was evaluated by statistical analysis in both groups. Results: Post-training data analysis showed that the success rate and accuracy rate of screw placement in VR group and NON-VR group were 82.9% and 69.6% vs. 74.2% and 55.4%, respectively, showing statistically significant differences between the two groups by chi-square test (P < 0.05). Conclusion: The present study demonstrated that IVRSS-PSP was helpful to improve the success rate of PSP for young surgeons, and may provide valuable reference for PSP training of young surgeons. In addition, our study also showed a promising potential of the VR technology in surgical simulation training.		traditional training model in terms of accuracy, success rate, and efficiency,
American B, Hading A, Wah W, et al.Collective: To verify whether the perfective screw placement (if of ) skitls of youngThe efficacy of immersivesurgeons receiving immersive virtual reality surgical simulator (IVRSS) trainingsimulator training for pediclecould be improved effectively and whether the IVRSS-PSP training mode couldscrew placement: arandomized double-blindrandomized double-blindproduce a real clinical value in clinical surgery. Methods: Twenty-four youngsurgeons were equally randomized to a VR group and a NON-VR group.Participants in VR group received IVRSS-PSP training, and those in NON-VR2020;44(5):927-934.doi:10.1007/s00264-020-04488-y04488-yanalysis in both groups.Results: Post-training data analysis showed that the success rate and accuracy rate of screw placement in VR group and NON-VR group were 82.9% and 69.6% vs. 74.2% and 55.4%, respectively, showing statistically significant differences between the two groups by chi-square test (P< 0.05).Conclusion: The present study demonstrated that IVRSS-PSP was helpful to improve the success rate of PSP for young surgeons, and may provide valuable reference for PSP training of young surgeons. In addition, our study also showed a promising potential of the VR technology in surgical simulation training.	Xin B. Huang X. Wan W. et al.	<b>Objective:</b> To verify whether the pedicle screw placement (PSP) skills of young
training.	Xin B, Huang X, Wan W, et al. The efficacy of immersive virtual reality surgical simulator training for pedicle screw placement: a randomized double-blind controlled trial. <i>Int Orthop</i> . 2020;44(5):927-934. doi:10.1007/s00264-020- 04488-y	<b>Objective:</b> To verify whether the pedicle screw placement (PSP) skills of young surgeons receiving immersive virtual reality surgical simulator (IVRSS) training could be improved effectively and whether the IVRSS-PSP training mode could produce a real clinical value in clinical surgery. <b>Methods:</b> Twenty-four young surgeons were equally randomized to a VR group and a NON-VR group. Participants in VR group received IVRSS-PSP training, and those in NON-VR group used the conventional model of observing a spinal model first and then watching a teaching video of spinal surgery for 40 minutes x five. The nailing outcome of the participants before and after training was evaluated by statistical analysis in both groups. <b>Results:</b> Post-training data analysis showed that the success rate and accuracy rate of screw placement in VR group and NON-VR group were 82.9% and 69.6% vs. 74.2% and 55.4%, respectively, showing statistically significant differences between the two groups by chi-square test (P < 0.05). <b>Conclusion:</b> The present study demonstrated that IVRSS-PSP was helpful to improve the success rate of PSP for young surgeons, and may provide valuable reference for PSP training of young surgeons. In addition, our study also
		training.





Yang SY, Oh YH. The effects of neonatal resuscitation gamification program using immersive virtual reality: A quasi-experimental study. *Nurse Educ Today*. 2022;117:105464. doi:10.1016/j.nedt.2022.105 464 **Background:** Clinical practice in neonatal intensive care units for nursing college students has been restricted due to the COVID-19 pandemic outbreak; thus, the gamification program has emerged as an alternative learning method. Consequently, there is a need to examine the effectiveness of such alternative learning methods to enhance the response to high-risk newborn emergencies. **Objectives:** To examine the effects (neonatal resuscitation nursing knowledge, problem-solving and clinical reasoning ability, self-confidence in practical performance, degree of anxiety, and learning motivation) of a neonatal resuscitation gamification program using immersive virtual reality based on Keller's ARCS model. **Design:** A non-randomized controlled simulation study with a pretest-posttest design. Setting: Lab and lecture rooms of two universities in South Korea, from June to November 2021. Participants: Prelicensure nursing students. Methods: The virtual reality group (n = 29) underwent a neonatal resuscitation gamification program using virtual reality based on Keller's ARCS model. The simulation group (n = 28) received high-fidelity neonatal resuscitation simulations and online neonatal resuscitation program lectures. The control group (n = 26) only received online neonatal resuscitation program lectures. Changes in scores among these groups were compared using analysis of variance and analysis of covariance with SPSS for Windows version 27.0. Results: Post intervention, neonatal resuscitation knowledge [F(2) = 3.83, p = .004] and learning motivation [F(2) = 1.79, p = .025] were significantly higher in the virtual reality and simulation groups than in the control group, whereas problem-solving ability [F(2) = 2.07, p = .038] and self-confidence [F(2) = 6.53, p < .001] were significantly higher in the virtual reality group than in the simulation and control groups. Anxiety [F(2) = 16.14, p < .001 was significantly lower in the simulation group than in the virtual reality and control groups. Conclusions: The neonatal resuscitation gamification program using immersive virtual reality was found to be effective in increasing neonatal resuscitation knowledge, problem-solving ability, selfconfidence, and learning motivation of the nursing students who participated in the trial application process.





Yang YS, Koontz AM, Hsiao YH, Pan CT, Chang JJ. Assessment of Wheelchair Propulsion Performance in an Immersive Virtual Reality Simulator. <i>Int J Environ Res</i> <i>Public Health</i> . 2021;18(15):8016. Published 2021 Jul 29. doi:10.3390/ijerph18158016	Maneuvering a wheelchair is an important necessity for the everyday life and social activities of people with a range of physical disabilities. However, in real life, wheelchair users face several common challenges: articulate steering, spatial relationships, and negotiating obstacles. Therefore, our research group has developed a head-mounted display (HMD)-based intuitive virtual reality (VR) stimulator for wheelchair propulsion. The aim of this study was to investigate the feasibility and efficacy of this VR stimulator for wheelchair propulsion performance. Twenty manual wheelchair users (16 men and 4 women) with spinal cord injuries ranging from T8 to L2 participated in this study. The differences in wheelchair propulsion kinematics between immersive and non-immersive VR environments were assessed using a 3D motion analysis system. Subjective data of the HMD-based intuitive VR stimulator were collected with a Presence Questionnaire and individual semi-structured interview at the end of the trial. Results indicated that propulsion performance was very similar in terms of start angle ( $p = 0.34$ ), end angle ( $p = 0.46$ ), stroke angle ( $p = 0.76$ ), and shoulder movement ( $p = 0.66$ ) between immersive and non-immersive VR environments. In the VR episode featuring an uphill journey, an increase in propulsion speed ( $p < 0.01$ ) and cadence ( $p < 0.01$ ) were found, as well as a greater trunk forward inclination ( $p = 0.01$ ). Qualitative interviews showed that this VR simulator made an attractive, novel impression and therefore demonstrated the potential as a tool for stimulating training motivation. This HMD-based intuitive VR stimulator can be an effective resource to enhance
Yasuda K, Muroi D, Ohira M, Iwata H. Validation of an immersive virtual reality system for training near and far space neglect in individuals with stroke: a pilot study. <i>Top Stroke</i> <i>Rehabil</i> . 2017;24(7):533-538. doi:10.1080/10749357.2017. 1351069	<ul> <li>Background: Unilateral spatial neglect (USN) is defined as impaired ability to attend and see on one side, and when present, it interferes seriously with daily life. These symptoms can exist for near and far spaces combined or independently, and it is important to provide effective intervention for near and far space neglect. Objective: The purpose of this pilot study was to propose an immersive virtual reality (VR) rehabilitation program using a head-mounted display that is able to train both near and far space neglect, and to validate the immediate effect of the VR program in both near and far space neglect.</li> <li>Methods: Ten USN patients underwent the VR program with a pre-post design and no control. In the virtual environment, we developed visual searching and reaching tasks using an immersive VR system. Behavioral inattention test (BIT) scores obtained pre- and immediate post-VR program revealed that far space neglect but not near space neglect improved promptly after the VR program. This effect for far space neglect was observed in the cancelation task, but not in the line bisection task. Conclusions: Positive effects of the immersive VR program for far space neglect are suggested by the results of the present pilot study. However, further studies with rigorous designs are needed to validate its clinical effectiveness.</li> </ul>





Yi WS, Rouhi AD, Duffy CC, Ghanem YK, Williams NN, Dumon KR. A Systematic Review of Immersive Virtual Reality for Nontechnical Skills Training in Surgery. J Surg Educ. 2024;81(1):25-36. doi:10.1016/j.jsurg.2023.11. 012 Objective: Immersive virtual reality (IVR) can be utilized to provide low cost and easily accessible simulation on all aspects of surgical education. In addition to technical skills training in surgery, IVR simulation has been utilized for nontechnical skills training in domains such as clinical decision-making and preoperative planning. This systematic review examines the current literature on the effectiveness of IVR for nontechnical skill acquisition in surgical education. Design: A literature search was performed using MEDLINE, EMBASE, and Web of Science for primary studies published between January 1, 1995 and February 9, 2022. Four reviewers screened titles, abstracts, full texts, extracted data, and analyzed included studies to answer 5 key questions: How is IVR being utilized in nontechnical skills surgical education? What is the methodological quality of studies? What technologies are being utilized? What metrics are reported? What are the findings of these studies? **Results:** The literature search yielded 2340 citations, with 12 articles included for qualitative synthesis. Of included articles, 33% focused on clinical decision-making and 67% on anatomy/pre-operative planning. Motion sickness was a recorded metric in 25% of studies, with an aggregate incidence of 13% (11/87). An application score was reported in 33% and time to completion in 16.7%. A commercially developed application was utilized in 25%, while 75% employed a noncommercial application. The Oculus Rift was used in 41.7% of studies, HTC Vive in 25%, Samsung Gear in 16.7% of studies, Google Daydream in 8%, and 1 study did not report. The mean Medical Education Research Quality Instrument (MERSQI) score was 10.3 ± 2.3 (out of 18). In all studies researching clinical decision-making, participants preferred IVR to conventional teaching methods and in a nonrandomized control study it was found to be more effective. Averaged across all studies, mean scores were 4.33 for enjoyment, 4.16 for utility, 4.11 for usability, and 3.73 for immersion on a 5-point Likert scale. Conclusions: The IVR nontechnical skills applications for surgical education are designed for clinical decision-making or anatomy/preoperative planning. These applications are primarily noncommercially produced and rely upon a diverse array of HMDs for content delivery, suggesting that development is primarily coming from within academia and still without clarity on optimal utilization of the technology. Excitingly, users find these applications to be immersive, enjoyable, usable, and of utility in learning. Although a few studies suggest that IVR is additive or superior to conventional teaching or imaging methods, the data is mixed and derived from studies with weak design. Motion sickness with IVR remains a complication of IVR use needing further study to determine the cause and means of mitigation.





Zackoff MW, Cruse B, Sahay RD, et al. Multiuser immersive virtual reality simulation for interprofessional sepsis recognition and management. *J Hosp Med*. 2024;19(3):185-192. doi:10.1002/jhm.13274 Introduction: Sepsis is a leading cause of pediatric mortality. While there has been significant effort toward improving adherence to evidence-based care, gaps remain. Immersive multiuser virtual reality (MUVR) simulation may be an approach to enhance provider clinical competency and situation awareness for sepsis. Methods: A prospective, observational pilot of an interprofessional MUVR simulation assessing a decompensating patient from sepsis was conducted from January to June 2021. The study objective was to establish validity and acceptability evidence for the platform by assessing differences in sepsis recognition between experienced and novice participants. Interprofessional teams assessed and managed a patient together in the same VR experience with the primary outcome of time to recognition of sepsis utilizing the Situation Awareness Global Assessment Technique analyzed using a logistic regression model. Secondary outcomes were perceived clinical accuracy, relevancy to practice, and side effects experienced. Results: Seventy-two simulations included 144 participants. The cumulative odds ratio of recognizing sepsis at 2 min into the simulation in comparison to later time points by experienced versus novice providers were significantly higher with a cumulative odds ratio of 3.70 (95% confidence interval: 1.15-9.07, p = .004). Participants agreed that the simulation was clinically accurate (98.6%) and will impact their practice (81.1%), with a high degree of immersion (95.7%-99.3%), and the majority of side effects were perceived as mild (70.4%-81.4%). **Conclusions:** Our novel MUVR simulation demonstrated significant differences in sepsis recognition between experienced and novice participants. This validity evidence along with the data on the simulation's acceptability supports expanded use in training and assessment.





Zackoff MW, Davis D, Rios M, et al. Tolerability and Acceptability of Autonomous Immersive Virtual Reality Incorporating Digital Twin Technology for Mass Training in Healthcare. <i>Simul</i> <i>Healthc</i> . Published online November 13, 2023. doi:10.1097/SIH.00000000 0000755	<b>Introduction:</b> As part of onboarding and systems testing for a clinical expansion, immersive virtual reality (VR) incorporating digital twin technology was used. While digital twin technology has been leveraged by industry, its use in health care has been limited with no prior application for onboarding or training. The tolerability and acceptability of immersive VR for use by a large population of healthcare staff were unknown. <b>Methods:</b> A prospective, observational study of an autonomous immersive VR onboarding experience to a new clinical space was conducted from May to September 2021. Participants were healthcare staff from several critical care and acute care units. Primary outcomes were tolerance and acceptability measured by reported adverse effects and degree of immersion. Secondary outcomes were attitudes toward the efficacy of VR compared with standard onboarding experiences. <b>Results:</b> A total of 1522 healthcare staff participated. Rates of adverse effects were low and those with prior VR experience were more likely to report no adverse effects. Odds of
	reporting immersion were high across all demographic groups, though decreased with increasing age. The preference for VR over low-fidelity methods
	was high across all demographics; however, preferences were mixed when compared with traditional simulation and real-time clinical care.
	<b>Conclusions:</b> Large-scale VR onboarding is feasible, tolerable, and acceptable to a diverse population of healthcare staff when using digital twin technology.
	This study also represents the largest VR onboarding experience to date and may address preconceived notions that VR-based training in health care is not ready for widespread adoption.
Zackoff MW, Lin L, Israel K, et	An immersive virtual reality curriculum was piloted with new nurse graduates
Implementation of	pediatric respiratory distress and impending respiratory failure. Learnings from
Immersive Virtual Reality for	this pilot could inform strategies for development of standardized, efficient, and
Nursing Clinical Assessment	safe onboarding curricula to increase the likelihood of successful transition to
2020;36(4):235-240.	
doi:10.1097/NND.00000000	
0000020	1




Zackoff MW, Real FJ, Sahay RD, et al. Impact of an Immersive Virtual Reality Curriculum on Medical Students' Clinical Assessment of Infants With Respiratory Distress. *Pediatr Crit Care Med*. 2020;21(5):477-485. doi:10.1097/PCC.00000000 0002249 **Objective:** To determine whether exposure to an immersive virtual reality curriculum on pediatric respiratory distress improves medical students' recognition of impending respiratory failure. **Design:** Randomized, controlled, prospective study conducted from July 2017 to June 2018. Evaluators blinded to student groupings. Setting: Academic, free-standing children's hospital. Participants: All third-year medical students (n = 168) were eligible. The standard curriculum was delivered to all students during their pediatric rotation with optional inclusion of research data per Institutional Review Board review. A randomized selection of students was exposed to the virtual reality curriculum. Intervention: All students received standard training on respiratory distress through didactics and high-fidelity mannequin simulation. Intervention students underwent an additional 30-minute immersive virtual reality curriculum, experienced through an OculusRift headset, with three simulations of an infant with 1) no distress, 2) respiratory distress, and 3) impending respiratory failure. Measurements and main results: The impact of the virtual reality curriculum on recognition/interpretation of key examination findings, assignment of an appropriate respiratory status assessment, and recognition of the need for escalation of care for patients in impending respiratory failure was assessed via a free response clinical assessment of video vignettes at the end of the pediatric rotation. Responses were scored on standardized rubrics by physician experts. All eligible students participated (78 intervention and 90 control). Significant differences between intervention and control were demonstrated for consideration/interpretation of mental status (p < 0.01), assignment of the appropriate respiratory status assessment (p < 0.01), and recognition of a need for escalation of care (p = 0.0004). **Conclusions:** Exposure to an immersive virtual reality curriculum led to improvement in objective competence at the assessment of respiratory distress and recognition of the need for escalation of care for patients with signs of impending respiratory failure. This study represents a novel application of immersive virtual reality and suggests that it may be effective for clinical assessment training.





Zackoff MW, Young D, Sahay RD, et al. Establishing Objective Measures of Clinical Competence in Undergraduate Medical Education Through Immersive Virtual Reality. *Acad Pediatr*. 2021;21(3):575-579. doi:10.1016/j.acap.2020.10. 010

Objective: The Association of American Medical Colleges defines recognition of the need for urgent or emergent escalation of care as a key Entrustable Professional Activity (EPA) for entering residency (EPA#10). This study pilots the use of an immersive virtual reality (VR) platform for defining objective observable behaviors as standards for evaluation of medical student recognition of impending respiratory failure. **Methods:** A cross-sectional observational study was conducted from July 2018 to December 2019, evaluating student performance during a VR scenario of an infant in impending respiratory failure using the OculusRift VR platform. Video recordings were rated by 2 pair of physician reviewers blinded to student identity. One pair provided a consensus global assessment of performance (not competent, borderline, or competent) while the other used a checklist of observable behaviors to rate performance. Binary discriminant analysis was used to identify the observable behaviors that predicted the global assessment rating. **Results:** Twenty-six fourth year medical students participated. Student performance of 8 observable behaviors was found to be most predictive of a rating of competent, with a 91% probability. Correctly stating that the patient required an escalation of care had the largest contribution toward predicting a rating of competent, followed by commenting on the patient's increased heart rate, low oxygen saturation, increased respiratory rate, and stating that the patient was in respiratory distress. Conclusions: This study demonstrates that VR can be used to establish objective and observable performance standards for assessment of EPA attainment - a key step in moving towards competency based medical education.





Zagury-Orly I, Solinski MA, Nguyen LH, et al. What is the Current State of Extended Reality Use in Otolaryngology Training? A Scoping Review. *Laryngoscope*. 2023;133(2):227-234. doi:10.1002/lary.30174 **Objective:** To map current literature on the educational use of extended reality (XR) in Otolaryngology-Head and Neck Surgery (OHNS) to inform teaching and research. Study design: Scoping Review. Methods: A scoping review was conducted, identifying literature through MEDLINE, Ovid Embase, and Web of Science databases. Findings were reported according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for scoping review checklist. Studies were included if they involved OHNS trainees or medical students who used XR for an educational purpose in OHNS. XR was defined as: fully-immersive virtual reality (VR) using head-mounted displays (HMDs), nonimmersive and semi-immersive VR, augmented reality (AR), or mixed reality (MR). Data on device use were extracted, and educational outcomes were analyzed according to Kirkpatrick's evaluation framework. Results: Of the 1,434 unique abstracts identified, 40 articles were included. All articles reported on VR; none discussed AR or MR. Twenty-nine articles were categorized as semiimmersive, none used occlusive HMDs therefore, none met modern definitions of immersive VR. Most studies (29 of 40) targeted temporal bone surgery. Using the Kirkpatrick four-level evaluation model, all studies were limited to level-1 (learner reaction) or level-2 (knowledge or skill performance). **Conclusions:** Current educational applications of XR in OHNS are limited to VR, do not fully immerse participants and do not assess higher-level learning outcomes. The educational OHNS community would benefit from a shared definition for VR technology, assessment of skills transfer (level-3 and higher), and deliberate testing of AR, MR, and procedures beyond temporal bone surgery.





Zhu K, Zhang Q, He B, Huang M, Lin R, Li H. Immersive Virtual Reality-Based Cognitive Intervention for the Improvement of Cognitive Function, Depression, and Perceived Stress in Older Adults With Mild Cognitive Impairment and Mild Dementia: Pilot Pre-Post Study. *JMIR Serious Games*. 2022;10(1):e32117. Published 2022 Feb 21. doi:10.2196/32117 Background: The incidence of dementia is increasing annually, resulting in varying degrees of adverse effects for individuals, families, and society. With the continuous development of computer information technology, cognitive interventions are constantly evolving. The use of immersive virtual reality (IVR) as a cognitive intervention for older adults with mild cognitive impairment (MCI) and mild dementia (MD) is promising, although only few studies have focused on its use. Objective: The Chinese virtual supermarket (CVSM) IVR system was developed to provide a comprehensive and individual cognitive intervention program for older patients with MCI and MD. The aim of this study was to explore the feasibility and clinical effectiveness of this 5-week IVR-based cognitive intervention. Methods: A pretest-posttest study design was conducted with 31 older adults with MCI and MD from August 2020 to January 2021. All participants participated in a 5-week immersive virtual cognitive training program using the CVSM system. Feasibility was assessed as the incidence and severity of cybersickness symptoms and participant satisfaction based on questionnaires conducted after the intervention. Clinical effectiveness was evaluated using neuropsychological assessments, including several commonly used measures of cognitive function, depression, perceived stress, and activities of daily living. Measurements were obtained at baseline and after the intervention period. **Results:** A total of 18 patients with MCI (mean age 82.94 [SD 5.44] years; 12 females) and 13 patients with MD (mean age 85.7 [SD 4.67] years, 10 females) participated in this pilot study. Both groups showed significant improvements in all cognitive function measurements (P<.001). The MD group had a significantly greater improvement in general cognitive function compared to the MCI group in Montreal Cognitive Assessment Scale, Symbol Digit Modalities Test, Shape Trail Test, and Auditory Verbal Learning Test. Furthermore, an intervention effect was observed in the improvement of perceived stress (P=.048 for MD group, P=.03 for MCI group). Conclusions: The use of the CVSM system may be effective in enhancing the cognitive function of patients with MCI and MD, including general cognitive function, memory, executive function, and attention. IVR technology enriches cognitive intervention approaches and provides acceptable, professional, personalized, and interesting cognitive training for older adults with cognitive impairment.





## Table 8: Patient Education

Citation	Abstract
Aardoom JJ, Hilt AD,	Background: Pre- and postoperative anxiety is a common phenomenon
Woudenberg T, Chavannes	associated with negative postoperative outcomes. Symptoms of posttraumatic
NH, Atsma DE. A	stress disorder, such as fear, nightmares, and sleep deprivation, are prevalent
Preoperative Virtual Reality	in approximately 30% to 50% of patients following discharge from intensive care
App for Patients Scheduled	units after cardiac surgery. Preliminary evidence suggests a promising role of
for Cardiac Catheterization:	virtual reality (VR) in preventing stress-related reactions using stress inoculation
Pre-Post Questionnaire Study	training. Such training enables cognitive preparation of individuals for stressful
Examining Feasibility,	situations, thereby becoming more tolerant and resistant to stress,
Usability, and	subsequently reducing the risk of potential negative psychological
Acceptability. JMIR Cardio.	consequences. This study investigated a preoperative VR app-Pre-View-aimed
2022;6(1):e29473. Published	at better informing and preparing patients for cardiac catheterization.
2022 Feb 22.	<b>Objective:</b> This study aims to assess the feasibility, usability, and acceptability
doi:10.2196/29473	of Pre-View in patients undergoing cardiac catheterization. <b>Methods:</b> Eligible
	participants were adults scheduled for elective cardiac catheterization. Pre-
	View comprised an interactive virtual representation of the whole care process
	related to cardiac catheterization, from entering the hospital for admission to
	postprocedural stay and discharge. These processes were represented through
	360° videos and interactive photos. Self-report questionnaires were completed
	at baseline (ie, before catheterization and after undergoing the VR experience)
	and after cardiac catheterization. Outcome measures included user experience
	and satisfaction, VR presence and immersive tendencies, and user friendliness.
	The perceived effectiveness was assessed exploratively. <b>Results:</b> A total of 8
	individuals, with a mean age of 67 (SD 7.5) years, participated in this study. Half
	of them underwent the VR experience at the hospital and the other half at home.
	Participants reported high levels of presence in the virtual environment
	(Presence Questionnaire score: mean 129.1, SD 13.4). The usability of Pre-View
	was well evaluated (System Usability Scale score: mean 89.1, SD 12.0), and
	patient satisfaction was high (Client Satisfaction Questionnaire score: mean
	27.1, SD 3.2). Usability and satisfaction scores were higher for participants who
	underwent Pre-View at home versus those who underwent Pre-View at the
	hospital, although the latter group was significantly older; 72.8 versus 61.3,
	respectively. All participants reported Pre-View to be effective in terms of feeling
	better informed about the care process of cardiac catheterization. Most
	participants (7/8, 88%) reported Pre-View to be effective in terms of feeling
	better prepared for cardiac catheterization, acknowledging the potential of Pre-
	View in reducing negative psychological consequences after catheterization.
	Conclusions: The results provide initial support for the feasibility and
	acceptability of a preoperative VR app, creating a virtual environment that
	supports patient education and preparation for upcoming cardiac
	catheterization. More studies are needed to further investigate the effects of VR
	as a tool to better prepare patients for medical procedures, its effectiveness in
	reducing negative patient outcomes (eg, anxiety, stress, and postoperative





	recovery outcomes), and the generalizability of effects across different settings
	and patient populations.
Ahmed A, Goel D, Lohre R.	Simulation provides an effective learning strategy to offset real-world training.
Virtual reality for shoulder	Immersive virtual reality (IVR) is a form of simulation that incorporates unique
arthroplasty education.	software and hardware to create interactive, 3-dimensional (3D) virtual worlds
Seminars in Arthroplasty:	to practice surgical procedures. In shoulder arthroplasty, IVR has shown
JSES. 2023;33(4):824-829.	consistent improvements in both technical skill and knowledge acquisition
doi:10.1053/j.sart.2023.04.0	relative to traditional learning formats for trainees. The purpose of this review is
01	to describe the current availability and application of IVR for shoulder
	arthroplasty education, and to describe future uses.
Bekelis K, Calnan D,	Objective: To investigate the effect of exposure to a virtual reality (VR)
Simmons N, MacKenzie TA,	environment preoperatively on patient-reported outcomes for surgical
Kakoulides G. Effect of an	operations. Background: There is a scarcity of well-developed quality
Immersive Preoperative	improvement initiatives targeting patient satisfaction. Methods: We performed
Virtual Reality Experience on	a randomized controlled trial of patients undergoing cranial and spinal
Patient Reported Outcomes:	operations in a tertiary referral center. Patients underwent a 1:1 randomization
A Randomized Controlled	to an immersive preoperative VR experience or standard preoperative
Trial. Ann Surg.	experience stratified on type of operation. The primary outcome measures were
2017;265(6):1068-1073.	the Evaluation du Vecu de l'Anesthesie Generale (EVAN-G) score and the
doi:10.1097/SLA.000000000	Amsterdam Preoperative Anxiety and Information (APAIS) score, as markers of
0002094	the patient's experience during the surgical encounter. <b>Results:</b> During the
	study period, a total of 127 patients (mean age 55.3 years, 41.9% females)
	underwent randomization. The average EVAN-G score was 84.3 (standard
	deviation, SD, 6.4) after VR, and 64.3 (SD, 11.7) after standard preoperative
	experience (difference, 20.0; 95% confidence interval, CI, 16.6-23.3). Exposure
	to an immersive VR experience also led to higher APAIS score (difference, 29.9;
	95% CI, 24.5-35.2). In addition, VR led to lower preoperative VAS stress score
	(difference, -41.7; 95% CI, -33.1 to -50.2), and higher preoperative VAS
	preparedness (difference, 32.4; 95% CI, 24.9-39.8), and VAS satisfaction
	(difference, 33.2; 95% CI, 25.4-41.0) scores. No association was identified with
	VAS stress score (difference, -1.6; 95% CI, -13.4 to 10.2). Conclusions: In a
	randomized controlled trial, we demonstrated that patients exposed to
	preoperative VR had increased satisfaction during the surgical encounter.
	Harnessing the power of this technology, hospitals can create an immersive
	environment that minimizes stress, and enhances the perioperative experience.





Chang SL, Kuo MJ, Lin YJ, et al. Virtual reality-based preprocedural education increases preparedness and satisfaction of patients about the catheter ablation of atrial fibrillation. *Journal of the Chinese Medical Association*. 2021;84(7):690-697. doi:10.1097/JCMA.0000000 00000555

Background: A recent study suggested to develop and implement more interacted material for preprocedural education to decrease patients' anxiety about the atrial fibrillation (AF) ablation. This study compared the effectiveness of using either newly developed virtual reality (VR) materials (VR group) or paperbased materials (paper group) on giving AF preprocedural education. Methods: This study consequentially enrolled 33 AF patients preparing for ablation from November 2019 to October 2020. After enrollment, patients were randomized as either paper (n = 22) or VR (n = 11) groups. **Results:** In comparison with the baseline stage, at the posteducation stage, the degree of improvement in patients' self-assessed self-efficacy on AF ablation knowledge was higher among VR group patients than those in the paper group. At the posteducation stage, the patients' satisfaction to preprocedural education and used materials were higher among the VR group than that among the paper group. In addition to meet their needs and give accurate medical information, VR group patients reported that VR materials increased the effectiveness of education, increased their preparedness for AF catheter ablation, achieved paperless purposes, and willing to recommend VR materials to others. Operators subjectively reported that the periprocedure cooperation was increased both among paper and VR group patients after preprocedural education for the details of procedure. Better preparedness of VR group patients was supported by less periprocedure pain, anxiety, and impatience than those among paper group patients. Conclusion: Interactive VR-based materials are superior to the paper-based materials to provide patients immerse and imagine the journey and detail knowledge of AF catheter ablation before the procedure and better prepared patients for the procedure.





Chen G, Zhao Y, Xie F, et al. Educating Outpatients for Bowel Preparation Before Colonoscopy Using Conventional Methods vs Virtual Reality Videos Plus Conventional Methods: A Randomized Clinical Trial. *JAMA Netw Open*. 2021;4(11):e2135576. Published 2021 Nov 1. doi:10.1001/jamanetworkope n.2021.35576 **Importance:** Adequate bowel preparation is essential for diagnostic, screening, and surveillance colonoscopy. Virtual reality (VR) has the characteristics of immersion, interaction, and imagination and has been widely used in medicine for training and teaching, indicating that it could be used in the education of outpatients for bowel preparation before colonoscopy. Objective: To investigate whether using VR videos for patient education before colonoscopy could improve bowel preparation. Design, setting, and participants: A prospective, single-blinded, randomized clinical trial of 346 patients undergoing colonoscopy with local anesthesia in a tertiary care hospital was conducted between October 1, 2018, and November 1, 2020. Outpatients who had indications for colonoscopy and had not received one before were enrolled. Statistical analysis was performed from November 1 to December 31, 2020. All data were analyzed according to the intention-to-treat approach. Exposures: Conventional bowel preparation education (oral instructions and written materials that had the same contents) or conventional education plus VR videos. Main outcomes and measures: The primary outcome was the quality of bowel preparation measured by the Boston Bowel Preparation Scale score (range, 0-9, where 0 indicates extremely unsatisfactory bowel preparation and 9 indicates complete bowel preparation). Secondary outcomes included polyp and adenoma detection rates, compliance with complete bowel cleansing, preprocedure anxiety, overall satisfaction, and willingness to undergo a follow-up colonoscopy. Results: A total of 346 outpatients were enrolled in the trial, with 173 patients randomly assigned to each group (control group: 87 women [50.3%]; mean [SD] age, 50.5 [12.5] years; VR video group: 84 women [48.6%]; mean [SD] age, 52.6 [11.4] years). Baseline characteristics, including demographic information, medical history, lifestyle, and the characteristics of stool, were comparable between the VR video group and the control group. The mean (SD) Boston Bowel Preparation Scale score was significantly higher in the VR video group than in the control group (7.61 [1.65] vs 7.04 [1.70]; P = .002). The detection rate of polyps (72 of 172 [41.9%] vs 46 of 172 [26.7%]; P = .003) and the detection rate of adenomas (56 of 172 [32.6\%] vs 38 of 172 [22.1%]; P = .03) were also higher in the VR video group. Patients who received VR education had better compliance (119 [68.8%] vs 87 [50.3%]; P < .001) and higher mean (SD) overall satisfaction (8.68 [1.70] vs 8.16 [2.15]; P = .01) with bowel preparation. Conclusions and relevance: Patients who received VR video education before colonoscopy had better bowel preparation, higher polyp and adenoma detection rates, and improved compliance and satisfaction.





Găină MA, Szalontay AS, Ștefănescu G, et al. State-of- the-Art Review on Immersive Virtual Reality Interventions for Colonoscopy-Induced Anxiety and Pain. <i>J Clin Med</i> . 2022;11(6):1670. Published 2022 Mar 17. doi:10.3390/jcm11061670	<b>Background:</b> Colonoscopy related fear impairs the current gold standard screening of colorectal cancer. Compared to other minimally invasive procedures for cancer screening, colonoscopy-induced anxiety exceeds the procedure through bowel preparation. Immersive virtual reality's (iVR) role in alleviating the complex stress-pain relationship encountered during medical procedures is directly proportional to the rising affordability of state-of-the-art Head-Mounted-Displays (HMDs). <b>Objective:</b> to assess the effect of iVR on patients' colonoscopy-induced anxiety and pain. <b>Materials and methods:</b> A systematic search was conducted in PubMed, Cochrane Central Register of Controlled Trials, Web of Science, Embase and Scopus databases up to January 2022. Clinical trials evaluating anxiety as an outcome were included without language restriction. <b>Results:</b> Four clinical trials were included: three on the patients' intraprocedural anxiety and one on patient education. Intraprocedural iVR interventions for colonoscopy-induced anxiety and pain revealed a similar effect as conventional sedation, while a statistically significant reduction was reported for non-sedated patients. iVR patient education improved the quality of bowel preparation and reduced patient anxiety before colonoscopy. <b>Conclusions:</b> The current research highlights the need to use high-end HMDs and appropriate interactive iVR software content for colonoscopy-induced anxiety. Methodological frameworks regarding the eligibility of participants, double-blinding and randomization of iVR studies can facilitate the
Grilo AM Almoida B	Durpage: To understand the impact of radiotherapy educational sessions with
Bodrigues C. Isabel Gomes	virtual reality on oncologic adult patients' nsychological and cognitive
A. Caetano M. Using virtual	outcomes related to the treatment experience. <b>Methods:</b> This review was
reality to prepare patients for	performed according to the Preferred Reporting Items for Systematic Reviews
radiotherapy: A systematic	guidelines. A systematic electronic search in three databases, MEDLINE,
review of interventional	Scopus, and Web of Science, was conducted in December 2021 to find
studies with educational	interventional studies with adult patients undergoing external radiotherapy who
sessions. Technical	received an educational session with virtual reality before or during the
Innovations & Patient	treatment. The studies that provided qualitative or quantitative information
Support in Radiation	about the impact of educational sessions on patients' psychological and
Oncology. 2023;25:100203.	cognitive dimensions related to RT experience were retained for analysis.
doi:10.1016/j.tipsro.2023.100	<b>Results:</b> Of the 25 records found, eight articles about seven studies were
203	analysed that involved 376 patients with different oncological pathologies. Most
	studies evaluated knowledge and treatment-related anxiety, mainly through
	self-reported questionnaires. The analysis showed a significant improvement in
	patients' knowledge and comprehension of radiotherapy treatment. Anxiety
	levels also decreased with virtual reality educational sessions and throughout
	the treatment in almost all the studies, although with less homogeneous
	results. <b>Conclusion:</b> Virtual reality methods in standard educational sessions
	their understanding of treatment and reducing anxiety.





Gulick V, Graves D, Ames S, Krishnamani PP. Effect of a Virtual Reality–Enhanced Exercise and Education Intervention on Patient Engagement and Learning in Cardiac Rehabilitation: Randomized Controlled Trial. *J Med Internet Res*. 2021;23(4):e23882. doi:10.2196/23882

Background: Cardiac rehabilitation (CR) is clinically proven to reduce morbidity and mortality; however, many eligible patients do not enroll in treatment. Furthermore, many enrolled patients do not complete their full course of treatment. This is greatly influenced by socioeconomic factors but is also because of patients' lack of understanding of the importance of their care and a lack of motivation to maintain attendance. **Objective:** This study aims to explore the potential benefits of virtual reality (VR) walking trails within CR treatment, specifically with regard to patient knowledge retention, satisfaction with treatment, and the overall attendance of treatment sessions. Methods: New CR patients were enrolled and randomized on a rolling basis to either the control group or intervention group. Intervention patients completed their time on the treadmill with VR walking trails, which included audio-recorded education, whereas control patients completed the standard of care therapy. Both groups were assisted by nursing staff for all treatment sessions. Primary outcomes were determined by assessing 6-minute walk test improvement. In addition, secondary outcomes of patients' cardiac knowledge and satisfaction were assessed via a computer-based questionnaire; patient adherence to the recommended number of sessions was also monitored. Cardiac knowledge assessment included a prerehabilitation education guiz, and the same guiz was repeated at patients' final visit and again at the 2-month follow-up. The satisfaction questionnaire was completed at the final visit. **Results:** Between January 2018 and May 2019, 72 patients were enrolled—41 in the intervention group and 31 in the control group. On the basis of the results of the prerehabilitation and postrehabilitation 6-minute walk test, no significant differences were observed between the intervention and control groups (P=.64). No statistical differences were observed between groups in terms of education (P=.86) or satisfaction (P=.32) at any time point. The control group had statistically more favorable rates of attendance, as determined by the risk group comparison (P=.02) and the comparison of the rates for completing the minimum number of sessions (P=.046), but no correlation was observed between the study group and reasons for ending treatment. **Conclusions:** Although no improvements were seen in the VR intervention group over the control group, it is worth noting that limitations in the study design may have influenced these outcomes, not the medium itself. Furthermore, the qualitative information suggests that patients may have indeed enjoyed their experience with VR, even though quantitative satisfaction data did not capture this. Further considerations for how and when VR should be applied to CR are suggested in this paper.





Harvie DS. Immersive	Chronic conditions represent a significant twenty first century challenge.
Education for Chronic	Education and self-management training are the mainstay of clinical
Condition Self-Management.	intervention for such conditions since care is dependent on health literacy and
Front Virtual Real.	self-management. This intervention not only imparts the necessary
2021;2:657761.	understanding and skills for self-management, but also helps people to
doi:10.3389/frvir.2021.65776	overcome personal barriers to positive behavioral change, such as low self-
1	efficacy. Moreover, education maximizes dignity, by enabling shared decision-
	making. A plethora of research supports the role of education and self-
	management training in the management of chronic conditions, whilst at the
	same time highlighting that not all approaches lead to meaningful behavioral
	change. Immersive virtual reality (VR) offers a unique set of features and tools
	for delivering these interventions. For example, the immersive nature focuses
	attention and promotes engagement: the ability to simulate authentic and
	interactive real-world scenarios can be used to promote the benefits of active
	learning: and the ability to facilitate embodiment of avatars with distinct
	appearance and capability can be used to bias new perceptions and behaviors
	in-line with the avatar's characteristics. Moreover, the ability to use VR
	independent of a clinician renders a potential solution to instances where
	significant barriers to healthcare access exist. This short perspective paper will
	discuss how VR may be used to host education and self-management
	interventions in the domain of chronic condition management. Further, it will
	outline considerations for developers and conclude with a call for the co-
	creation of new VR-based education and self-management interventions.
	-
Hilt AD, Hierck BP, Eijkenduijn	Aims: Statin treatment is one of the hallmarks of secondary prevention after
Hilt AD, Hierck BP, Eijkenduijn J, et al. Development of a	<b>Aims:</b> Statin treatment is one of the hallmarks of secondary prevention after myocardial infarction. Adherence to statins tends to be difficult and can be
Hilt AD, Hierck BP, Eijkenduijn J, et al. Development of a patient-oriented Hololens	<b>Aims:</b> Statin treatment is one of the hallmarks of secondary prevention after myocardial infarction. Adherence to statins tends to be difficult and can be improved by patient education. Novel technologies such as mixed reality (MR)
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Hilt AD, Hierck BP, Eijkenduijn J, et al. Development of a patient-oriented Hololens application to illustrate the function of medication after myocardial infarction. <i>Eur</i> <i>Heart J Digit Health</i> .	<b>Aims:</b> Statin treatment is one of the hallmarks of secondary prevention after myocardial infarction. Adherence to statins tends to be difficult and can be improved by patient education. Novel technologies such as mixed reality (MR) expand the possibilities to support this process. To assess if an MR medication-application supports patient education focused on function of statins after myocardial infarction. <b>Methods and results:</b> A human-centred designapproach was used to develop an MR statin tool for Microsoft HoloLens <sup>™</sup> .
Hilt AD, Hierck BP, Eijkenduijn J, et al. Development of a patient-oriented Hololens application to illustrate the function of medication after myocardial infarction. <i>Eur</i> <i>Heart J Digit Health</i> . 2021;2(3):511-520. Published	<b>Aims:</b> Statin treatment is one of the hallmarks of secondary prevention after myocardial infarction. Adherence to statins tends to be difficult and can be improved by patient education. Novel technologies such as mixed reality (MR) expand the possibilities to support this process. To assess if an MR medication-application supports patient education focused on function of statins after myocardial infarction. <b>Methods and results:</b> A human-centred designapproach was used to develop an MR statin tool for Microsoft HoloLens <sup>™</sup> . Twenty-two myocardial infarction patients were enrolled; 12 tested the
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Hilt AD, Hierck BP, Eijkenduijn J, et al. Development of a patient-oriented Hololens application to illustrate the function of medication after myocardial infarction. <i>Eur</i> <i>Heart J Digit Health</i> . 2021;2(3):511-520. Published 2021 Jun 11. doi:10.1093/ehjdh/ztab053	Aims: Statin treatment is one of the hallmarks of secondary prevention after myocardial infarction. Adherence to statins tends to be difficult and can be improved by patient education. Novel technologies such as mixed reality (MR) expand the possibilities to support this process. To assess if an MR medication- application supports patient education focused on function of statins after myocardial infarction. <b>Methods and results:</b> A human-centred design- approach was used to develop an MR statin tool for Microsoft HoloLens <sup>™</sup> . Twenty-two myocardial infarction patients were enrolled; 12 tested the application, 10 patients were controls. Clinical, demographic, and qualitative data were obtained. All patients performed a test on statin knowledge. To test if
Hilt AD, Hierck BP, Eijkenduijn J, et al. Development of a patient-oriented Hololens application to illustrate the function of medication after myocardial infarction. <i>Eur</i> <i>Heart J Digit Health</i> . 2021;2(3):511-520. Published 2021 Jun 11. doi:10.1093/ehjdh/ztab053	Aims: Statin treatment is one of the hallmarks of secondary prevention after myocardial infarction. Adherence to statins tends to be difficult and can be improved by patient education. Novel technologies such as mixed reality (MR) expand the possibilities to support this process. To assess if an MR medication- application supports patient education focused on function of statins after myocardial infarction. <b>Methods and results:</b> A human-centred design- approach was used to develop an MR statin tool for Microsoft HoloLens <sup>™</sup> . Twenty-two myocardial infarction patients were enrolled; 12 tested the application, 10 patients were controls. Clinical, demographic, and qualitative data were obtained. All patients performed a test on statin knowledge. To test if patients with a higher tendency to become involved in virtual environments
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Hilt AD, Hierck BP, Eijkenduijn J, et al. Development of a patient-oriented Hololens application to illustrate the function of medication after myocardial infarction. <i>Eur</i> <i>Heart J Digit Health</i> . 2021;2(3):511-520. Published 2021 Jun 11. doi:10.1093/ehjdh/ztab053	Aims: Statin treatment is one of the hallmarks of secondary prevention after myocardial infarction. Adherence to statins tends to be difficult and can be improved by patient education. Novel technologies such as mixed reality (MR) expand the possibilities to support this process. To assess if an MR medication- application supports patient education focused on function of statins after myocardial infarction. <b>Methods and results:</b> A human-centred design- approach was used to develop an MR statin tool for Microsoft HoloLens <sup>™</sup> . Twenty-two myocardial infarction patients were enrolled; 12 tested the application, 10 patients were controls. Clinical, demographic, and qualitative data were obtained. All patients performed a test on statin knowledge. To test if patients with a higher tendency to become involved in virtual environments affected test outcome in the intervention group, validated Presence- and Immersive Tendency Questionnaires (PQ and ITQ) were used. Twenty-two myocardial infarction patients (ST-elevation myocardial infarction, 18/22, 82%) completed the study. Ten out of 12 (83%) patients in the intervention group improved their statin knowledge by using the MR application (median 8 points, IQR 8). Test improvement was mainly the result of increased understanding of
Hilt AD, Hierck BP, Eijkenduijn J, et al. Development of a patient-oriented Hololens application to illustrate the function of medication after myocardial infarction. <i>Eur</i> <i>Heart J Digit Health</i> . 2021;2(3):511-520. Published 2021 Jun 11. doi:10.1093/ehjdh/ztab053	Aims: Statin treatment is one of the hallmarks of secondary prevention after myocardial infarction. Adherence to statins tends to be difficult and can be improved by patient education. Novel technologies such as mixed reality (MR) expand the possibilities to support this process. To assess if an MR medication- application supports patient education focused on function of statins after myocardial infarction. <b>Methods and results:</b> A human-centred design- approach was used to develop an MR statin tool for Microsoft HoloLens <sup>™</sup> . Twenty-two myocardial infarction patients were enrolled; 12 tested the application, 10 patients were controls. Clinical, demographic, and qualitative data were obtained. All patients performed a test on statin knowledge. To test if patients with a higher tendency to become involved in virtual environments affected test outcome in the intervention group, validated Presence- and Immersive Tendency Questionnaires (PQ and ITQ) were used. Twenty-two myocardial infarction patients (ST-elevation myocardial infarction, 18/22, 82%) completed the study. Ten out of 12 (83%) patients in the intervention group improved their statin knowledge by using the MR application (median 8 points, IQR 8). Test improvement was mainly the result of increased understanding of statin mechanisms in the body and secondary preventive effects. A high
Hilt AD, Hierck BP, Eijkenduijn J, et al. Development of a patient-oriented Hololens application to illustrate the function of medication after myocardial infarction. <i>Eur</i> <i>Heart J Digit Health</i> . 2021;2(3):511-520. Published 2021 Jun 11. doi:10.1093/ehjdh/ztab053	Aims: Statin treatment is one of the hallmarks of secondary prevention after myocardial infarction. Adherence to statins tends to be difficult and can be improved by patient education. Novel technologies such as mixed reality (MR) expand the possibilities to support this process. To assess if an MR medication- application supports patient education focused on function of statins after myocardial infarction. <b>Methods and results:</b> A human-centred design- approach was used to develop an MR statin tool for Microsoft HoloLens <sup>™</sup> . Twenty-two myocardial infarction patients were enrolled; 12 tested the application, 10 patients were controls. Clinical, demographic, and qualitative data were obtained. All patients performed a test on statin knowledge. To test if patients with a higher tendency to become involved in virtual environments affected test outcome in the intervention group, validated Presence- and Immersive Tendency Questionnaires (PQ and ITQ) were used. Twenty-two myocardial infarction patients (ST-elevation myocardial infarction, 18/22, 82%) completed the study. Ten out of 12 (83%) patients in the intervention group improved their statin knowledge by using the MR application (median 8 points, IQR 8). Test improvement was mainly the result of increased understanding of statin mechanisms in the body and secondary preventive effects. A high tendency to get involved and focused in virtual environments was moderately
Hilt AD, Hierck BP, Eijkenduijn J, et al. Development of a patient-oriented Hololens application to illustrate the function of medication after myocardial infarction. <i>Eur</i> <i>Heart J Digit Health</i> . 2021;2(3):511-520. Published 2021 Jun 11. doi:10.1093/ehjdh/ztab053	Aims: Statin treatment is one of the hallmarks of secondary prevention after myocardial infarction. Adherence to statins tends to be difficult and can be improved by patient education. Novel technologies such as mixed reality (MR) expand the possibilities to support this process. To assess if an MR medication- application supports patient education focused on function of statins after myocardial infarction. <b>Methods and results:</b> A human-centred design- approach was used to develop an MR statin tool for Microsoft HoloLens <sup>™</sup> . Twenty-two myocardial infarction patients were enrolled; 12 tested the application, 10 patients were controls. Clinical, demographic, and qualitative data were obtained. All patients performed a test on statin knowledge. To test if patients with a higher tendency to become involved in virtual environments affected test outcome in the intervention group, validated Presence- and Immersive Tendency Questionnaires (PQ and ITQ) were used. Twenty-two myocardial infarction patients (ST-elevation myocardial infarction, 18/22, 82%) completed the study. Ten out of 12 (83%) patients in the intervention group improved their statin knowledge by using the MR application (median 8 points, IQR 8). Test improvement was mainly the result of increased understanding of statin mechanisms in the body and secondary preventive effects. A high tendency to get involved and focused in virtual environments was moderately positive correlated with better test improvement ( <i>r</i> = 0.57, <i>P</i> < 0.05). The median
Hilt AD, Hierck BP, Eijkenduijn J, et al. Development of a patient-oriented Hololens application to illustrate the function of medication after myocardial infarction. <i>Eur</i> <i>Heart J Digit Health</i> . 2021;2(3):511-520. Published 2021 Jun 11. doi:10.1093/ehjdh/ztab053	Aims: Statin treatment is one of the hallmarks of secondary prevention after myocardial infarction. Adherence to statins tends to be difficult and can be improved by patient education. Novel technologies such as mixed reality (MR) expand the possibilities to support this process. To assess if an MR medication- application supports patient education focused on function of statins after myocardial infarction. <b>Methods and results:</b> A human-centred design- approach was used to develop an MR statin tool for Microsoft HoloLens <sup>TM</sup> . Twenty-two myocardial infarction patients were enrolled; 12 tested the application, 10 patients were controls. Clinical, demographic, and qualitative data were obtained. All patients performed a test on statin knowledge. To test if patients with a higher tendency to become involved in virtual environments affected test outcome in the intervention group, validated Presence- and Immersive Tendency Questionnaires (PQ and ITQ) were used. Twenty-two myocardial infarction patients (ST-elevation myocardial infarction, 18/22, 82%) completed the study. Ten out of 12 (83%) patients in the intervention group improved their statin knowledge by using the MR application (median 8 points, IQR 8). Test improvement was mainly the result of increased understanding of statin mechanisms in the body and secondary preventive effects. A high tendency to get involved and focused in virtual environments was moderately positive correlated with better test improvement ( $r = 0.57$ , $P < 0.05$ ). The median post-test score in the control group was poor (median 6 points, IQR 4).
Hilt AD, Hierck BP, Eijkenduijn J, et al. Development of a patient-oriented Hololens application to illustrate the function of medication after myocardial infarction. <i>Eur</i> <i>Heart J Digit Health</i> . 2021;2(3):511-520. Published 2021 Jun 11. doi:10.1093/ehjdh/ztab053	<ul> <li>Aims: Statin treatment is one of the hallmarks of secondary prevention after myocardial infarction. Adherence to statins tends to be difficult and can be improved by patient education. Novel technologies such as mixed reality (MR) expand the possibilities to support this process. To assess if an MR medication-application supports patient education focused on function of statins after myocardial infarction. Methods and results: A human-centred design-approach was used to develop an MR statin tool for Microsoft HoloLens™. Twenty-two myocardial infarction patients were enrolled; 12 tested the application, 10 patients were controls. Clinical, demographic, and qualitative data were obtained. All patients performed a test on statin knowledge. To test if patients with a higher tendency to become involved in virtual environments affected test outcome in the intervention group, validated Presence- and Immersive Tendency Questionnaires (PQ and ITQ) were used. Twenty-two myocardial infarction patients (ST-elevation myocardial infarction, 18/22, 82%) completed the study. Ten out of 12 (83%) patients in the intervention group improved their statin knowledge by using the MR application (median 8 points, IQR 8). Test improvement was mainly the result of increased understanding of statin mechanisms in the body and secondary preventive effects. A high tendency to get involved and focused in virtual environments was moderately positive correlated with better test improvement (<i>r</i> = 0.57, <i>P</i> &lt; 0.05). The median post-test score in the control group was poor (median 6 points, IQR 4).</li> </ul>





<b>Introduction:</b> Affordable virtual reality (VR) technology is now widely available. Billions of dollars are currently being invested into improving and mass producing VR and augmented reality products. <b>Purpose of the Study:</b> The purpose of the present study is to explore the potential of immersive VR to make physical therapy/occupational therapy less painful, more fun, and to help motivate patients to cooperate with their hand therapist. <b>Discussion:</b> The following topics are covered: a) psychological influences on pain perception, b) the logic of how VR analgesia works, c) evidence for reduction of acute procedural pain during hand therapy, d) recent major advances in VR technology, and e) future directions—immersive VR embodiment therapy for phantom limb (chronic) pain. <b>Conclusion:</b> VR hand therapy has potential for a wide range of patient populations needing hand therapy, including acute pain and potentially chronic pain patients. Being in VR helps reduce the patients' pain, making it less painful for patients to move their hand/fingers during hand therapy, and gamified VR can help motivate the patient to perform therapeutic hand exercises, and make hand therapy more fun. In addition, VR camera– based hand tracking technology may be used to help therapists monitor how well patients are doing their hand therapy exercises, and to quantify whether adherence to treatment increases long-term functionality. Additional research and development into using VR as a tool for hand therapist is recommended for
both acute pain and persistent pain patient populations.
Radiology includes a wide range of imaging technologies that use different technologies to capture patients' data. Virtual Reality (VR) is an innovative technology that provides a clear virtual image of a patient. We see the vast potential of VR to provide a positive impact in radiology. Most relevant papers on Virtual reality in Healthcare/Radiology are identified from Scopus, ScienceDirect, Google Scholar and ResearchGate. Paper tries to technologically explore VR and its applications to improve radiological training and learners' participation levels. Paper briefs about Virtual reality and its working process steps for radiology based clinical treatments. Supportive features of virtual reality in the broad radiology domain are discussed diagrammatically. This paper's primary strength is identifying and discussing thirteen significant VR applications in radiology. VR is an important technology that is viable for healthcare. With the integration of various components and software, it provides a complete virtual display. In the starting years, this technology was for entertainment purposes. Nowadays, this technology is used to visualise the internal structure. The patient's internal or external parts are used to create more integrated interaction, providing a better procedure for guidance. A radiologist can benefit from this technology for trainees' procedural





Jaravska Godula B, Jaravsky O, Matheislova G, et al. Virtual Reality for Patient Education about Hypertension: A Randomized Pilot Study. J <i>Cardiovasc Dev Dis</i> . 2023;10(12):481. Published 2023 Nov 29. doi:10.3390/jcdd10120481	<b>Background:</b> Hypertension challenges arise in part from poor adherence due to inadequate patient education. VR offers immersive learning to improve hypertension knowledge. <b>Objective:</b> To compare VR education with traditional verbal education to improve hypertension knowledge. <b>Methods:</b> In this randomised trial, 182 patients with hypertension were assigned to receive either traditional physician-led education (n = 88) or VR education (n = 94) with equivalent content. The VR group experienced a 3D video using Oculus Quest 2 headsets. Knowledge was assessed post-intervention using a 29-item questionnaire. The primary outcome was the objective score. Subjective satisfaction and responder characteristics were secondary outcomes. <b>Results:</b> Median objective scores were significantly higher for VR (14, IQR 3) versus traditional education (10, IQR 5), <i>p</i> < 0.001, indicating superior hypertension knowledge acquisition with VR. Subjective satisfaction was high in both groups. Participants were categorized into low (first quartile) and medium- high (second to fourth quartiles) responders based on their scores. Low responders had a significantly higher prevalence of older women than medium- high responders (57% vs. 40% female, <i>p</i> = 0.024; 68 vs. 65 years), <i>p</i> = 0.036). <b>Conclusions:</b> VR outperforms traditional education. Tailoring to groups such as older women can optimise learning.
Johnson K, Liszewski B, Dawdy K, Lai Y, McGuffin M. Learning in 360 Degrees: A Pilot Study on the Use of Virtual Reality for Radiation Therapy Patient Education. <i>J</i> <i>Med Imaging Radiat Sci</i> . 2020;51(2):221-226. doi:10.1016/j.jmir.2019.12.00 8	<b>Background:</b> Patient education for external beam radiation therapy (EBRT) is traditionally delivered in verbal and/or written form, which may not provide a full picture of the complex, technical aspects of treatment. The purpose of this pilot study was to create and evaluate a prototype 360-degree virtual reality (VR) video outlining the technical aspects of EBRT to the pelvis as a supplement to traditional education methods. <b>Materials and methods:</b> A prototype VR video was filmed to simulate the delivery of one fraction of image-guided EBRT to the pelvis. Patients having a radical course of image-guided EBRT to the pelvis were approached while on active treatment to participate in focus groups evaluating the prototype VR video. Focus group discussions were recorded, transcribed, and subjected to thematic analysis. <b>Results:</b> All patients were accrued from a single academic cancer centre in a large metropolitan area. In total, seven patients were enrolled to participate in the focus groups. Thematic analysis revealed 71% of participants felt the traditional patient education met their needs. However, 86% mentioned the education did not fully capture the treatment experience. Participants identified potential benefits of VR could include an increased understanding of the treatment process, specifically the spatial and acoustic aspects of treatment, as well as the potential to reduce anxiety in new patients. Timing was also important, with 86% of participants provided feedback such as including two-dimensional elements in the VR video and other changes which could potentially make the viewing experience more realistic. <b>Conclusions:</b> Traditional teaching methods are seen as satisfactory by patients at our institution, but it is recognized that there is a gap in current education methods. An immersive VR education tool has the potential to





Kaphingst KA, Persky S, McCall C, et al. Testing the effects of educational strategies on comprehension of a genomic concept using virtual reality technology. <i>Patient Education and Counseling</i> . 2009;77(2):224- 230. doi:10.1016/j.pec.2009.03.02 9	<b>Objective:</b> Applying genetic susceptibility information to improve health will likely require educating patients about abstract concepts, for which there is little existing research. This experimental study examined the effect of learning mode on comprehension of a genomic concept. <b>Methods:</b> 156 individuals aged 18–40 without specialized knowledge were randomly assigned to either a virtual reality active learning or didactic learning condition. The outcome was comprehension (recall, transfer, mental models). <b>Results:</b> Change in recall was greater for didactic learning than for active learning (p<0.001). Mean transfer and change in mental models were also higher for didactic learning (p<0.0001 and p<0.05, respectively). Believability was higher for didactic learning (p<0.05), while ratings for motivation (p<0.05), interest (p<0.0001), and enjoyment (p<0.0001) were higher for active learning, but these variables did not mediate the association between learning mode affects comprehension, but additional research is needed regarding how and in what contexts different approaches are best for educating patients about abstract concepts. <b>Practice implications:</b> Didactic, interpersonal health education approaches may be more effective than interactive games in educating patients about abstract, unfamiliar concepts. These findings indicate the importance of traditional health education approaches in emerging areas like genomics.
Lastrucci A, Votta C, Serventi	Background: Virtual Environment Radiotherapy Training (VERT) is a virtual tool
E, et al. The application of virtual environment radiotherapy for RTT training: A scoping review. <i>Journal of</i> <i>Medical Imaging and</i> <i>Radiation Sciences</i> . Published online 2024:S1939865424000250. doi:10.1016/j.jmir.2024.02.01 3	used in radiotherapy with a dual purpose: patient education and student training. This scoping review aims to identify the applications of VERT to acquire new skills in specific activities of Radiation Therapists (RTTs) clinical practice and education as reported in the literature. This scoping review will identify any gaps in this field and provide suggestions for future research. <b>Methods:</b> In accordance with Preferred Reporting Items for Systematic Review and Meta-Analysis (PRISMA) extension for scoping reviews and Arskey and O'Malley framework, an electronic search was conducted to retrieve complete original studies, reporting the use and implementation of VERT for teaching skills to RTTs. Studies were searched in PubMed, EMBASE, and SCOPUS databases and included retrieved articles if they investigated the use of VERT for RTTs training. <b>Results:</b> Of 251 titles, 16 articles fulfilled the selection criteria and most of the studies were qualitative evaluation studies (n=5) and pilot studies (n=4). The specific use of VERT for RTTs training was grouped into four categories (Planning CT, Set-up, IGRT, and TPS). <b>Conclusion:</b> The use of VERT was described for each category by examining the interaction of the students or trainee RTTs in performing each phase within the virtual environment and describing their perceptions. This system Virtual Reality (VR) enables the development of specific motor skills without interfering and pressurising clinical resources by using clinical equipment in a risk-free offline environment, improving the clinical confidence of students or trainee RTTs. However, even if VR can be integrated into the RTTs training with a great advantage, VERT has still not been embraced. This mainly due to the presence of significant issues and limitations, such as inadequate coverage within the current literature, software and hardware costs.





Lee S, Shin S. Effectiveness of virtual reality using video gaming technology in elderly adults with diabetes mellitus. <i>Diabetes Technol</i> <i>Ther</i> . 2013;15(6):489-496. doi:10.1089/dia.2013.0050	<b>Background:</b> Diabetes in elderly adults is associated with an increased risk of fall. The aim of study was to determine whether a virtual reality exercise (VRE) program would improve balance, strength, gait, and falls efficacy in elderly adults with diabetes. <b>Subjects and methods:</b> Fifty-five subjects with diabetes mellitus over 65 years of age were randomly assigned to a VRE group (VREG) (n=27) and a control group (CG) (n=28). The VREG received the VRE program and diabetes education, whereas the CG received only the diabetes education. The VRE program used video gaming (PlayStation(*) 2; Sony, Tokyo, Japan) and was conducted for 50 min twice a week for 10 weeks. Balance, muscle strength, gait, and falls efficacy were measured at baseline and after intervention. Measurements were taken using a clinical tests (the one-leg-standing test, the Berg Balance Scale, the functional reach test, the timed up-and-go test, and the sit-to-stand test), and gait analysis. A self-administered questionnaire was used to measure falls efficacy. <b>Conclusions:</b> The VRE program was to maximize the effects of exercise by triggering players was to be fully immersed into the games and enhanced major influential factors on the falls of subject. This study suggests VRE programs are feasible and effective for reduced the risk of falls in alded we dulte with true 2 diabatee.
Mahajan UV, Sunshine KS, Herring EZ, Labak CM, Wright JM, Smith G. Virtual reality in presurgical patient education: A scoping review and recommended trial design guidelines. <i>The</i> <i>American Journal of Surgery</i> . 2021;222(4):704-705. doi:10.1016/j.amjsurg.2021.0 3.022	In the past decade, virtual reality (VR) has emerged as a robust tool in medical education. Among health professional students, VR has proven to be a superior learning resource as compared to traditional learning and other digital educational methods. 1 Surgeons have shown to develop improved skills via VR, through learning and rehearsing procedures. 2 While these original applications focused on aiding the medical professional, more recently, VR has been utilized to educate and engage with surgical candidate patients. This may allow for increased informed decision making, decreased apprehension and anxiety associated with surgery, and increased patient preparedness and satisfaction. To understand the current status of VR in surgery, we conducted a scoping literature Aptos (Body) review (please see Supplemental Materials for search strategy and inclusion criteria), and then present suggested guidelines for trial design.





Nowak GJ, Evans NJ, Wojdynski BW, et al. Using immersive virtual reality to improve the beliefs and intentions of influenza vaccine avoidant 18-to-49year-olds: Considerations, effects, and lessons learned. *Vaccine*. 2020;38(5):1225-1233. doi:10.1016/j.vaccine.2019.1 1.009

Objective: Only one-third of adults 18-49 years old in the United States receive a recommended annual influenza vaccination. This study examined whether supplementing vaccine information statements (VIS) with an immersive virtual reality (VR), short video or electronic pamphlet story designed to convey the community immunity benefits of influenza vaccination would improve influenza vaccine avoidant participants' influenza-related perceptions as well as their influenza vaccination-related beliefs, confidence and intentions. Method: A one-way between-subjects experimental design compared the effects of adding a supplemental education experience prior to VIS exposure with flu vaccine avoidant 18-to-49-year-olds. The 171 participants recruited from the community were randomly assigned to one of three modality treatment conditions [VR, video, or e-pamphlet (i.e., story board presented via electronic tablet)] or a VISonly control condition. Results: Compared to the modalities, the VR intervention created a stronger perception of presence (i.e., feeling of "being there" in the story), which, in turn, increased participants' concern about transmitting influenza to others and raised vaccination intention. Increased concern about transmitting influenza to others was associated with positive effects on influenza vaccination-related beliefs, including confidence that one's flu vaccination would protect others. Neither the e-pamphlet nor the video intervention were able to elicit a sense of presence nor were they able to improve the impact of the VIS on the outcome measures. **Conclusions:** Immersive VR has much potential to increase understanding of key immunization concepts, such as community immunity, through creative executions that increase a sense of presence. Given the need to increase influenza vaccination uptake among 18-to-49-year-olds, and the projected growth in VR accessibility and use, additional applications and assessments related to vaccination communication and education are needed and warranted. By increasing the ability to convey key vaccine and immunization concepts, immersive VR could help address vaccination hesitancy and



acceptance challenges.



Pandrangi VC, Gaston B,	Background: Virtual reality (VR) provides an immersive image-viewing
Appelbaum NP, Albuquerque	experience that has recently been expanding in use in clinical medicine. We
FC Jr, Levy MM, Larson RA.	developed a three-dimensional (3D) model of an abdominal aortic aneurysm
The Application of Virtual	(AAA) for patients with a diagnosis of an AAA to view in VR to assess the use of
Reality in Patient	VR in patient education. <b>Methods:</b> This was a cross-sectional study using an
Education. Ann Vasc Surg.	educational intervention. A standardized 3D model of an AAA was generated
2019;59:184-189.	from a computed tomography scan and uploaded onto a 3D image-hosting
doi:10.1016/j.avsg.2019.01.0	website. Patients with an AAA who participated in the study wore a Google
15	Cardboard VR headset, with a mobile device displaying the digital 3D AAA image
	in VR. Patients completed a survey afterward for assessing satisfaction with VR
	on a 5-point agreement Likert scale. <b>Results:</b> Between September 2017 and
	January 2018, 19 natients narticinated in our study (90% narticination rate)
	Most participants had no prior experience with VR ( $n = 15$ ; 79%), and the mean
	are was 69 + 8 years. Seventeen (80%) participants agreed or strongly agreed
	that they fall better informed about their health status after using VB and would
	like to see VP used more in their health care, while sixteen (840%) agreed or
	the to see vn used that they falt mere angeged in their health agree because of using
	Strongly agreed that they felt more engaged in their health care because of using
	VR. Almost all participants feit comfortable using VR ( $n = 17$ ; 90%) and enjoyed
	using the technology (n = 16; 84%). <b>Conclusions:</b> VR proved to be an engaging
	learning tool that patients perceived as beneficial in understanding their health
	status. Further efforts to investigate the role of VR in education and health care
	should be explored.
Pinter C, Lasso A, Choueib S,	Virtual reality (VR) provides immersive visualization that has proved to be useful
et al. SlicerVR for Medical	in a variety of medical applications. Currently, however, no free open-source
Intervention Training and	software platform exists that would provide comprehensive support for
Planning in Immersive Virtual	translational clinical researchers in prototyping experimental VR scenarios in
Reality. IEEE Trans Med Robot	training, planning or guiding medical interventions. By integrating VR functions
Bionics. 2020;2(2):108-117.	in 3D Slicer, an established medical image analysis and visualization platform,
doi:10.1109/tmrb.2020.2983	SlicerVR enables virtual reality experience by a single click. It provides functions
199	to navigate and manipulate the virtual scene, as well as various settings to
	abate the feeling of motion sickness. SlicerVR allows for shared collaborative
	VR experience both locally and remotely. We present illustrative scenarios
	created with SlicerVR in a wide spectrum of applications, including
	echocardiography, neurosurgery, spine surgery, brachytherapy intervention
	training and personalized nationt education. Slicer//R is freely available under
	BSD type license as an extension to 3D Slicer and it has been downloaded over
	7 800 times at the time of writing this article





Raith A, Kamp C, Stoiber C, Jakl A, Wagner M. Augmented Reality in Radiology for Education and Training-A Design Study. <i>Healthcare</i> <i>(Basel)</i> . 2022;10(4):672. Published 2022 Apr 2. doi:10.3390/healthcare1004 0672	Education is an important component of every healthcare system. Patients need to be educated about their planned procedures; healthcare professionals need to be trained in their respective profession. Both patient education and the training of healthcare professionals are often completed in person, which requires resources and is bound to certain times and places. Virtual educational environments can potentially save human and monetary resources, increase learner engagement, and enable users to learn according to their own schedules. This design study describes proofs of concept for two augmented reality-enabled (AR) educational tools, utilizing a Microsoft HoloLens head- mounted display. In the first use case, we demonstrate an AR application which could be used to educate cancer patients about their radiotherapy treatment and potentially reduce patient anxiety. The second use case demonstrates an AR training environment, which could complement the practical training of undergraduate radiography students. Two prototypes-VIPER, for patient education, and ARTUR for the training of radiography students-were developed and tested for viability and usability, both based on individual user tests. Both patient and student education were evaluated as viable and usable additions to conventional educational methods, despite being limited in terms of accessibility, usability, and fidelity. Suitable hardware is becoming more accessible and capable, and higher-fidelity holograms, better utilization of real- world objects, and more intuitive input methods could increase user immersion
Reis G, Yilmaz M, Rambach J, et al. Mixed reality applications in urology: Requirements and future potential. <i>Ann Med Surg</i> ( <i>Lond</i> ). 2021;66:102394. Published 2021 May 13. doi:10.1016/j.amsu.2021.102 394	<b>Background:</b> Mixed reality (MR), the computer-supported augmentation of a real environment with virtual elements, becomes ever more relevant in the medical domain, especially in urology, ranging from education and training over surgeries. We aimed to review existing MR technologies and their applications in urology. <b>Methods:</b> A non-systematic review of current literature was performed using the PubMed-Medline database using the medical subject headings (MeSH) term "mixed reality", combined with one of the following terms: "virtual reality", "augmented reality", "urology" and "augmented virtuality". The relevant studies were utilized. <b>Results:</b> MR applications such as MR guided systems, immersive VR headsets, AR models, MR-simulated ureteroscopy and smart glasses have enormous potential in education, training and surgical interventions of urology. Medical students, urology residents and inexperienced urologists can gain experience thanks to MR technologies. MR applications are also used in patient education before interventions. <b>Conclusions:</b> For surgical support, the achievable accuracy is often not sufficient. The main challenges are the non-rigid nature of the genitourinary organs, intraoperative data acquisition, online and multimodal registration and calibration of devices. However, the progress made in recent years is tremendous in all respects and the gap is constantly shrinking.





Rohaj A, Bulaj G. Digital Therapeutics (DTx) Expand Multimodal Treatment Options for Chronic Low Back Pain: The Nexus of Precision Medicine, Patient Education, and Public Health. <i>Healthcare (Basel)</i> . 2023;11(10):1469. Published 2023 May 18. doi:10.3390/healthcare1110 1469	Digital therapeutics (DTx, software as a medical device) provide personalized treatments for chronic diseases and expand precision medicine beyond pharmacogenomics-based pharmacotherapies. In this perspective article, we describe how DTx for chronic low back pain (CLBP) can be integrated with pharmaceutical drugs (e.g., NSAIDs, opioids), physical therapy (PT), cognitive behavioral therapy (CBT), and patient empowerment. An example of an FDA-authorized DTx for CLBP is RelieVRx, a prescription virtual reality (VR) app that reduces pain severity as an adjunct treatment for moderate to severe low back pain. RelieVRx is an immersive VR system that delivers at-home pain management modalities, including relaxation, self-awareness, pain distraction, guided breathing, and patient education. The mechanism of action of DTx is aligned with recommendations from the American College of Physicians to use non-pharmacological modalities as the first-line therapy for CLBP. Herein, we discuss how DTx can provide multimodal therapy options integrating conventional treatments with exposome-responsive, just-in-time adaptive interventions (JITAI). Given the flexibility of software-based therapies to accommodate diverse digital content, we also suggest that music-induced analgesia can increase the clinical effectiveness of digital interventions for chronic pain. DTx offers opportunities to simultaneously address the chronic pain crisis and opioid epidemic while supporting patients and healthcare providers to improve therapy outcomes.
Sanders JJ, Caponigro E,	<b>Objective:</b> This scoping review explores the potential for virtual environments
Ericson JD, et al. Virtual	(VE) to evaluate emotional outcomes in clinical communication research.
environments to study	Authors representing multiple disciplines use review results to propose
emotional responses to	potential research opportunities and considerations. <b>Methods:</b> We utilized a
clinical communication: A	structured framework for scoping reviews. We searched four literature
scoping review. Patient Educ	databases for relevant articles. We applied multidisciplinary perspectives to
Couns. 2021;104(12):2922-	synthesize relevant potential opportunities for emotion-focused
2935.	communications research using VE. <b>Results:</b> Twenty-one articles met inclusion
doi:10.1016/j.pec.2021.04.02	criteria. They applied different methodological approaches, including a range of
2	VE technologies and diverse emotional outcome measures, such as
	psychophysiological arousal, emotional valence, or empathy. Major research
	topics included use of virtual reality to provoke and measure emotional
	responses, train clinicians in communication skills, and increase clinician
	empathy. <b>Conclusion:</b> Researchers may leverage VE technologies to ethically
	and systematically examine how characteristics of clinical interactions,
	environments, and communication impact emotional reactions and responses
	among patients and clinicians. Variability exists in how VE technologies are
	employed and reported in published literature, and this may limit the internal
	and external validity of the research. However, virtual reality can provide a low-
	cost, low-risk, experimentally controlled, and ecologically valid approach for
	studying clinician-patient communication. <b>Practice implications:</b> Future
	research should leverage psychophysiological measures to further examine
	emotional responses during clinical communication scenarios and clearly
	report virtual environment characteristics to support evaluation of study
	conclusions, study replicability, and meta-analyses.





Shepherd T, Trinder M,	Background: Virtual reality (VR) enhanced radiology could help improve
Theophilus M. Does virtual	communication with colorectal cancer patients and therefore increase
reality in the preoperative	understanding in the perioperative setting. The objective of this pilot trial is to
setting for colorectal cancer	assess the feasibility of conducting a randomized control trial in terms of
surgery improve patient	recruitment, use and acceptability of the VR technology and validity of data
understanding? A	collection methods. Methods: A prospective, single-centre randomized control
randomized pilot study. ANZ J	trial was conducted at St John of God Midland Hospital in Western Australia
Surg. 2024;94(3):391-396.	from November to December 2021. After standard informed consent with their
doi:10.1111/ans.18787	surgeon, elective patients planned for resection of colorectal cancer were
	randomized to either 'standard consent' (shown computed tomography (CT)
	images only) or 'VR consent' (shown CT images and immersive VR models).
	<b>Results:</b> Nine patients were recruited (four control; five intervention). There was
	a trend towards improved patient reported understanding without reaching
	statistical significance. Most patients preferred the use of VR as compared to
	CT as an educational tool during the consent process (P = 0.03). There were no
	adverse effects. Conclusion: VR was well tolerated and patients enjoyed using
	the technology. Its use in an outpatient clinic setting for elective colorectal
	cancer surgery is feasible. Improvement in patient understanding using VR
	compared to standard consent processes in colorectal surgery should be tested
	in a statistically powered, high quality study design.
Shepherd T, Trinder M,	Background: The potential uses of Virtual Reality (VR) to educate patients
Theophilus M. Does virtual	perioperatively are now an emerging field of research. The objective of this
reality in the perioperative	scoping review is to assess the extent of the literature on how immersive VR is
setting for patient education	being used perioperatively to specifically improve patient understanding of their
improve understanding? A	pathology or procedure. Methods: A systematic search was carried out with
scoping review. Surgery in	inclusion criteria; adults (≥18 years old); use of immersive VR; perioperative
Practice and Science.	setting for patient education. Results: Twelve studies were reviewed, the
2022;10:100101.	majority of which were unpowered, non-randomised experimental trials. VR was
doi:10.1016/j.sipas.2022.100	mainly used during procedure consent to show patients a 3D anatomical model
101	of the relevant anatomy. Subjective and objective patient understanding was
	improved after exposure to VR. Conclusions: Continuing advances in VR
	technology will make this option more accessible to health care settings in the
	future and further research in this arena should prioritise statistically powered,
	high quality study design.





Siripongsaporn S, Yongsiriwit K, Tantitanawat K, Chirapongsathorn S. Use of virtual reality in patient education program to reduce anxiety in upper gastrointestinal endoscopy: A randomized controlled trial. <i>JGH Open</i> . 2024;8(3):e13046. Published 2024 Mar 4. doi:10.1002/jgh3.13046	<b>Background and aim:</b> Virtual reality (VR) provides an immersive image-viewing experience that has recently been expanding its use in clinical medicine. We aimed to examine a patient education program by VR to reduce anxiety in patients undergoing esophagogastroduodenoscopy (EGD). <b>Methods:</b> We conducted a randomized controlled trial and consecutively enrolled patients who had an indication for unsedated EGD with topical anesthesia. Patients were randomly assigned to use Oculus GO with three-dimensionally specific software content (a stand-alone VR headset) for patient education or standard patient education using oral information (the control group) before EGD. The primary outcome was the variation in anxiety scores before and after patient education programs. <b>Results:</b> A total of 107 patients underwent EGD and received a VR ( $n = 58$ ) and control ( $n = 49$ ) patient education program. The mean anxiety score before starting the patient education program was 41.4 9.6 in the VR group and 41.9 7.7 in the control group. The mean anxiety score after the patient education program was 37.1 10.8 in the VR group and 38.9 8.07 in the control group ( $P$ -value = 0.354). The anxiety score in the VR group decreased more than in the control group but was not significant. The recall questionnaire scores were higher in the VR group ( $4.70.4$ ) than the control group ( $3.91$ , $P$ -value 0.001). <b>Conclusion:</b> A virtual reality-assisted patient education program before EGD did not significantly reduce anxiety but may provide more memory and understanding about the procedure to patients who underwent unsedated EGD
Skidmore N, Ryan CG, Mankelow J, Martin D.	<b>Objective:</b> The development of health literacy is important in the management of chronic pain and virtual reality may be an effective medium for its
Acceptability and feasibility	development. This study aims to understand the usability and acceptability of a
of virtual reality to promote	virtual reality-based pain education system for the facilitation of health literacy.
health literacy in primary care	Methods: Semi-structured interviews were conducted with health
from the health	professionals who had used a VR-based pain education system within their
professional's view: A	clinical practice, to explore perceptions of feasibility. Data collection and
qualitative study. Patient	analyses were informed by the Unified Theory of Acceptance and Use of
2024·123·108179	narticipants, the VR-based system was considered feasible in providing
doi:10.1016/j.pec.2024.1081	immersive experiential learning which addressed patient understanding and
79	health-related communication. <b>Conclusion:</b> VR appears to be perceived as an
	acceptable and feasible technology to support the development of health
	literacy in people with chronic pain. Its largest perceived benefit was its
	capacity to provide an immersive and entertaining alternative to conventional
	methods of pain education. Practice implications: Virtual reality is considered
	as a feasible method of facilitating patient understanding and health-related
	communication related to chronic pain. Feasibility of such a tool relies clinically
	on time available, social expectations of VR, and the role of immersive and
	experiential learning within the management of chronic pain.





Isai IY, Onuma Y, Ztanoda- Huzior A, et al. Merging virtual and physical experiences: extended realities in cardiovascular medicine. <i>Eur Heart J</i> . 2023;44(35):3311-3322. doi:10.1093/eurheartj/ehad3 52	Technological advancement and the COVID-19 pandemic have brought virtual learning and working into our daily lives. Extended realities (XR), an umbrella term for all the immersive technologies that merge virtual and physical experiences, will undoubtedly be an indispensable part of future clinical practice. The intuitive and three-dimensional nature of XR has great potential to benefit healthcare providers and empower patients and physicians. In the past decade, the implementation of XR into cardiovascular medicine has flourished such that it is now integrated into medical training, patient education, pre- procedural planning, intra-procedural visualization, and post-procedural care. This review article discussed how XR could provide innovative care and complement traditional practice, as well as addressing its limitations and considering its future perspectives.
Van Der Kruk SR, Zielinski R, MacDougall H, Hughes- Barton D, Gunn KM. Virtual reality as a patient education tool in healthcare: A scoping review. <i>Patient Education and</i> <i>Counseling</i> . 2022;105(7):1928-1942. doi:10.1016/j.pec.2022.02.00 5	<b>Objective:</b> To explore what is currently known about the use of virtual reality (VR) as a patient education tool in healthcare. <b>Methods:</b> Arksey and O'Malley's scoping review method and the PRISMA-ScR Checklist were employed. Four peer-reviewed databases were searched (Medline, Embase, PsychINFO, the Cochrane library). Pre-defined selection criteria identified 18 studies for inclusion. Results were synthesized using a narrative approach. <b>Results:</b> VR as an educational tool in healthcare is feasible and acceptable, and may improve patient's knowledge about their illness and satisfaction with treatment. Most studies used the Oculus VR glasses or headset, educated patients though the use of 3D 360° VR anatomical models, and were conducted with people affected with cancer. Opportunities exist for exploring unintended consequences, and the role of VR in educating populations with lower health literacy. <b>Conclusion:</b> VR could assist in communicating medical information and knowledge to patients, but more research is needed, particularly to identify for whom and in what situations this method is most useful and to improve understanding about the potential unintended consequences. <b>Practice implications:</b> Health professionals should consider using VR to educate their patients, and researchers can use this as a road map on how to address knowledge gaps in this field.





Xie L, O'Leary M, Jefferson FA, et al. Interactive Virtual Reality Renal Models as an Educational and Preoperative Planning Tool for Laparoscopic Donor Nephrectomy. *Urology*. 2021;153:192-198. doi:10.1016/j.urology.2020.1 2.046

**Objective:** To evaluate the efficacy of interactive virtual reality (iVR) in providing a three-dimensional (3D) experience with the donor's anatomy for surgeons and patients, we present a retrospective, case-controlled study assessing the impact of iVR renal models prior to LDN on both surgical outcomes and patients' understanding of the procedure. Materials and Methods: Twenty patients undergoing LDN were prospectively recruited; their contrast-enhanced CT scans were transformed into iVR models. An iVR platform allowed the surgeons to rotate and deconstruct the renal anatomy; patients could also view their anatomy as the procedure was explained to them. Questionnaires assessed surgeons' understanding of renal anatomy after CT alone and after CT+iVR. Surgeons also commented on whether iVR impacted their preoperative plan. Patients assessed their anatomical understanding and anxiety level before and after iVR. Surgical outcomes for the iVR cohort were compared to a retrospectively matched, non-iVR cohort of LDN patients. Results: Surgeons altered their preoperative plan in 18 of 20 LDNs after viewing iVR models. Patients reported better understanding of their anatomy (5/5) and noted decreased preoperative anxiety (5/5) after viewing iVR. When compared to the non-iVR group, the iVR group had a 25% reduction in median operative time (P < .001). In terms of surgical outcomes, patients in the iVR group had a 40% lower median relative change in postoperative creatinine (P < .001). Conclusion: Preoperative viewing of iVR models altered the operative approach, decreased the operative time, and improved donor patient outcomes. iVR models also reduced patients' preoperative anxiety.





Yang J, Rhu J, Lim S, et al. Impact of virtual reality education on diseasespecific knowledge and anxiety for hepatocellular carcinoma patient scheduled for liver resection: a randomized controlled study. *International Journal of Surgery*. Published online February 21, 2024. doi:10.1097/JS9.000000000 001197

Purpose: Hepatocellular carcinoma (HCC) is a significant health concern, and the complexity of liver anatomy poses challenges in conveying radiologic findings and surgical plans to patients. This study aimed to evaluate the impact of a virtual reality (VR) education program on anxiety and knowledge in HCC patients undergoing hepatic resection. Method: From January 1, 2022, to February 28, 2023, 88 patients were enrolled in a randomized controlled trial, divided into the VR group (n=44) and the control group (n=44). The VR group received patient-specific 3D liver model education through a VR platform, while the control group underwent conventional explanation processes. Both groups completed pre- and post-intervention questionnaires assessing anxiety (using STAI-X-1, STAI-X-2, and VAS) and knowledge about liver resection. Comparison of the questionnaires were performed between the two groups. Multivariable logistic regression was performed to analyze factor related to decrease in anxiety. **Result:** While there was no significant difference in pre-intervention anxiety and knowledge scores between the two groups, the VR group exhibited significant reduction in STAI-X-1 scores (-4.14±7.5) compared to the control group (-0.84±5.7, P=0.023), as well as knowledge scores (17.20±2.6) compared to the control group (13.42±3.3, P < 0.001). In the multivariable logistic regression model, VR education showed significant impact on decrease in STAI-X-1 score, post-intervention. (OR=2.902, CI=1.097-7.674, P=0.032) Conclusion: The VR education program significantly improved knowledge and reduced anxiety among HCC patients compared to conventional methods. This study suggests that VR can be a valuable tool in patient education, enhancing comprehension and alleviating pre-surgical anxiety.





Zhao Q, Liu B, Sun Q, Jin Y. Development and validation of a cost-effective virtual reality educational tool to reduce anxiety and improve set-up accuracy in radiotherapy patients. *Cancer Med*. 2023;12(5):6161-6169. doi:10.1002/cam4.5348 **Purpose:** This study proposes a cost-effective method for educating radiotherapy patients through an immersive virtual reality (VR) system. Methods: The VR educational tool comprises VR glasses, a handheld controller, the scientific knowledge of radiotherapy, radiotherapy demonstration, and an audio introduction. To verify its efficacy, 120 radiotherapy patients with tumors were prospectively enrolled and divided into the control group or VR intervention group. After the first treatment, set-up errors, including three translation errors and three rotation errors, were recorded in six directions. In addition, participants were required to complete a questionnaire before radiotherapy to assess anxiety and understanding degrees. The questionnaire was scored using a five-point Likert Scale. Finally, Spearman's rank correlation test was used to evaluate set-up errors and questionnaire scores. Results: The set-up errors are significantly reduced in AP, SI, total translation, Roll and total rotation in the intervention group compared with the control group (p < 0.05). The scores are higher in the intervention group than in the control group in question 1 (2.1 ± 0.58 vs. 3.3 ± 0.55), question 2 (1.3 ± 0.44 vs. 2.5 ± 0.65), question 4 ( $2.2 \pm 0.65$  vs.  $3.2 \pm 0.82$ ), question 5 ( $1.8 \pm 0.59$  vs.  $3.1 \pm 0.79$ ), and all subscales  $(5.5 \pm 1.2 \text{ vs. } 8.9 \pm 1.3 \text{ and } 6.4 \pm 1.3 \text{ vs. } 9.2 \pm 1.5)$ . The scores of high, moderate, and low correlation are 47 (74%), 15 (23%), and 2 (3%) for the control group and 44 (69%), 17 (26%), and 3 (5%) for the intervention group, respectively. Conclusion: The VR educational tool can significantly improve comprehension and reduce anxiety. There is a strong correlation between setup errors and questionnaire scores. The VR educational tool may help reduce set-up errors for radiotherapy patients.





## Table 9: Palliative Care

Citation	Abstract
Bani Mohammad E, Ahmad	<b>Objective:</b> The goal of this study was to assess the effectiveness of immersive
M. Virtual reality as a	virtual reality (VR) distraction technology in reducing pain and anxiety among
distraction technique for	female patients with breast cancer. <b>Method:</b> A randomized control trial design
pain and anxiety among	was used with a sample of 80 female patients with breast cancer at a specialized
patients with breast cancer:	cancer center in Jordan. Participants were randomly assigned into intervention
A randomized control trial.	and comparison groups. <b>Result:</b> The study findings showed that one session of
Pall Supp Care.	the immersive VR plus morphine made a significant reduction in pain and anxiety
2019;17(1):29-34.	self-reported scores, compared with morphine alone, in breast cancer patients.
doi:10.1017/S147895151800	Significance of results: Immersive VR is an effective distraction intervention for
0639	managing pain and anxiety among breast cancer patients. Using immersive VR
	as an adjuvant intervention is more effective than morphine alone in relieving
	pain and anxiety; furthermore, VR is a safe intervention more than
	pharmacological treatment.
Benham S, Kang M,	Immersive virtual reality (VR) can provide a high level of engagement and
Grampurohit N. Immersive	distraction analgesia to address pain. However, community-based applications
Virtual Reality for the	of this technology for older adults have not been studied. The objective of this
Management of Pain in	study was to examine the applicability and effectiveness of an immersive VR
Community-Dwelling Older	intervention for pain, depression, and quality of life (QOL) in older adults. This
Adults. OTJR: Occupation,	pretest–posttest, mixed-methods design included senior center members ( <i>n</i> =
Participation and Health.	12) with pain that interfered with daily functioning. The outcomes included the
2019;39(2):90-96.	Numeric Pain Rating Scale, Patient-Reported Outcomes Measurement
doi:10.1177/1539449218817	Information System (PROMIS <sup>®</sup> ) depression scale, World Health Organization
291	Quality of Life Scale Brief Version (WHO QOL-BREF), and open-ended questions.
	The VR intervention (15- to 45-min sessions, 12 sessions over 6 weeks) was well
	accepted with no dropouts. There was a significant decrease in pain ( $p$ = .002, $d$
	= $-1.54$ ) with no effect on depression and QOL. There were no adverse effects,
	and positive perceptions of VR were reported. The 6-week immersive VR
	intervention was applicable and effective in reducing pain intensity for
	community-dwelling older adults.





Use of virtual reality in oncology: From the state of the art to an integrative model. <i>Front Virtual Real</i> . 2022;3:894162. doi:10.3389/frvir.2022.89416 2	interest in oncology. More and more researchers are studying the effects of virtual environments to contribute to current thinking on technologies likely to support patients undergoing oncological treatment. Recent research highlights how VR can divert attention while reducing anxiety in stressful healthcare situations through its multisensory and participative nature. VR appears to be a promising tool capable of reducing cancer-related anxiety symptoms, improving treatment adherence, and increasing satisfaction with oncology care. While the literature reports these positive effects in the therapeutic management of cancer, few studies have focused on theoretical models capable of explaining the psychological benefits of virtual immersion. This literature review provides a theoretical framework combining results from all relevant empirical work in oncology. The review can help researchers identify the optimal conditions for using VR in oncology and bridge the gap between divergent devices, modalities, and practices (e.g., headmounted displays, environments, interactivity, immersion time).
Burrai F, Ortu S, Marinucci M, De Marinis MG, Piredda M	<b>Objectives:</b> This study aims to assess the effects of immersive Virtual Reality in people with cancer undergoing antiblastic therapy, on anxiety, fatigue and pain
Effectiveness of Immersive	<b>Data Sources:</b> This is a randomized controlled three-arm trial. Seventy-four
Virtual Reality in People with	cancer patients were recruited from a regional hospital in Italy, and randomly
Cancer Undergoing	allocated into three groups: a Virtual Reality group (n=25), a narrative medicine
Antiblastic Therapy: A	group (n=25) and a standard care group (n=24). The primary outcome was
Randomized Controlled Trial.	anxiety. Secondary outcomes included fatigue and pain. The outcomes were
Seminars in Oncology	evaluated immediately before and after the interventions. The findings showed
Nursing. 2023;39(4):151470.	that anxiety decreased more in the Virtual Reality group (Dpre-post = 6.24, 95%
dol: 10.1016/J.soncn.2023.15	CI 2.578 to 9.902, p=.001, d = 0.63) than in the harrative medicine group,
1470	decreased in the Virtual Reality group (Dpre-post = 0.576, 95% CL0.246 to 0.907
	p=.001, $d = 0.23$ ), while remaining stable in the narrative medicine group, and
	increasing in the standard care group. Average levels of pain did not change
	before and after the intervention $[F(1,71) = 1.06, p=.307, hp2 = .015]$ .
	<b>Conclusion:</b> Findings show that virtual reality is effective to reduce anxiety and
	fatigue in people with cancer undergoing antiblastic therapy. <b>Implications for</b>
	<b>Nursing Practice:</b> Virtual Reality can be recommended as an complementary
	antiblastic therapy





Burrai F, Sguanci M, Petrucci G, De Marinis MG, Piredda M. Effectiveness of immersive virtual reality on anxiety, fatigue and pain in patients with cancer undergoing chemotherapy: A systematic review and meta-analysis. <i>European Journal of</i> <i>Oncology Nursing</i> . 2023;64:102340. doi:10.1016/j.ejon.2023.102 340	<b>Purpose:</b> This Systematic review and meta-analysis aimed to assess the effectiveness of Virtual Reality on anxiety, fatigue and pain in patients with cancer during chemotherapy and provide evidence for decision-making in clinical practice. <b>Methods:</b> A systematic literature search was performed in the databases PubMed, Web of Science, Scopus, Cumulative Index of Nursing and Allied Health Literature and the Cochrane Library. Risk of Bias was used to assess the quality of individual studies, and Grading of Recommendations Assessment, Development and Evaluation was used to assess confidence for each individual outcome. A random-effects model was used to examine the overall effect. <b>Results:</b> Four randomized controlled trials and four crossover studies were included, with an overall sample of 459 patients. Results showed that Virtual Reality compared with standard care had a significant reduction of anxiety only (MD = $-6.57, 95\%$ CI: $-11.59$ to $-1.54$ , p = 0.01) but with considerable heterogeneity (I2 = 92%), while Virtual Reality was not significantly different from integrative interventions. The trials included showed small sample sizes, lack of statistical power, low methodological quality, high heterogeneity, and different Virtual Reality technology types, lengths and frequencies. <b>Conclusion:</b> The quality of evidence is very low and the strength of recommendation is weak. Further research has large potential for reducing uncertainty about the effects of Virtual Reality in patients with cancer receiving chemotherapy
Carmont H, McIlfatrick S. Using virtual reality in palliative care: a systematic integrative review. <i>Int J Palliat</i> <i>Nurs</i> . 2022;28(3):132-144. doi:10.12968/ijpn.2022.28.3. 132	<b>Background:</b> Recently, healthcare services have witnessed an exponential increase in the use of immersive and non-immersive virtual reality (VR) technology to improve health-related outcomes. However, the use of VR in palliative care remains relatively unexplored. <b>Aims:</b> To review and synthesise evidence regarding the experiences of patients, families and healthcare professionals in palliative care who have engaged with immersive/non-immersive VR technology. <b>Methods:</b> A systematic integrative review using predefined MeSH search terms to identify eligible studies from five electronic databases (Cochrane Library, CINAHL, OVID Medline, Pubmed and Scopus) between April 2020 and February 2021. <b>Findings:</b> In total, 1066 articles were reviewed, 55 articles were considered eligible and subject to further analysis and a total of 16 articles met the inclusion criteria and were subject to critical appraisal. Rigorous analysis of eligible articles resulted in the identification of five overarching and interconnected themes: connection, VR as an emergent technology, perceptual change, safety, and future research. <b>Conclusion:</b> This review identified that VR could support patients, families and healthcare professionals in palliative care. As a result of the COVID-19 pandemic, the findings could prove particularly significant for facilitating connection. However, further research is necessary to explore the full scope of VR use in this speciality.





Desselle MR, Holland LR, McKittrick A, Kennedy G, Yates P, Brown J. "A Wanderer's Tale": The development of a virtual reality application for pain and quality of life in Australian burns and oncology patients. *Pall Supp Care*. 2023;21(3):454-460. doi:10.1017/S147895152200 0530 Objectives: The primary objective of this study was to co-design and conduct a pilot evaluation of a novel, immersive virtual reality (VR) experience for procedural pain and anxiety in an Australian healthcare setting. The secondary objective was to identify key parameters that can facilitate the development and implementation of VR experiences in clinical practice. Method: A qualitative, Design Box method was selected for co-design. It was used with adult burns survivors and adolescents and young adults (AYAs) with cancer, and healthcare professionals from these fields to identify the practical and design parameters required for the application of VR technology within the clinical setting. Results informed the development of the VR experience that was evaluated by consumers and healthcare professionals, who completed qualitative surveys. Thematic analysis was conducted on co-design notes and survey data. Results: Procedural pain and management was a challenge for both cohorts, but particularly the burns cohort. Anxiety was significant challenge for both cohorts. Boredom and quality of life was a significant challenge, particularly for the AYA oncology cohort. These results informed the development of "A Wanderers Tale," an Australiana-themed, gaze-controlled VR application for Oculus Quest platforms. Thematic analysis results suggest that cultural preferences, procedural contexts of use, and agency through customization and interaction are three parameters to consider when creating or selecting VR experiences for application in health. Significance of results: This work describes a novel method for the use VR as an adjuvant pain management tool in patients with burns and cancer. The VR experience may provide a culturally, practice and procedure-appropriate tool in comparable settings of care. The study also describes interdisciplinary co-design and evaluation approaches that can help maximize the use of VR to improve healthcare approaches that address clinical challenges in pain, anxiety, and quality of life for patients while in hospital.





Elzie CA Shaia I A Pilot	Compassionate end-of-life care matters deeply for patients and their caregivers
Study of the Impact of	but studies continue to demonstrate ways in which physicians fall short. Despite
Virtually Embodying a	specific training during medical school, many patients report lack of empathy in
Patient with a Terminal	their providers with respect to end-of-life conversations. This is likely because
Illness. MedSciEduc.	empathy is simply hard to teach. Numerous activities have been tried to combat
2021:31(2):665-675.	the decline in empathy during medical training with little to moderate success.
doi:10.1007/s40670-021-	However, virtual reality, which allows users to viscerally experience anything
01243-9	from another person's point of view, could be a game changer for building
	empathy within medicine. This type of perspective-taking has previously shown
	to improve understanding, reduce biases, facilitate empathy, and promote
	prosocial behaviors. In this pilot study, virtual reality was used to allow students
	to "become a patient" virtually embodying their daily activities, symptoms, and
	interactions with caregivers. Using the Embodied Labs modules, first-year
	medical students were able to experience first-hand having a terminal illness,
	being told no further treatments are available and witnessing loved ones'
	reactions. Data generated through surveys and reflections indicated a high level
	of place illusion, plausibility, and embodiment of users. This high level of
	immersion generated an increase in comfortability with talking about end-of-life
	issues, produced a better understanding of what patients and their families
	experience, and promoted a change in the way students would approach clinical
	skills. Analysis of reflections indicated a high level of empathy for the patient and
	his family members. Overall, the activity was highly received by students as a
	valuable learning activity. As such, we propose that virtual reality could be a
	useful pedagogical tool to facilitate empathy and clinical skills within medical
	education.
Ferguson C, Shade MY,	education. <b>Objectives:</b> To explore acceptability, tolerability, and subjective experience of
Ferguson C, Shade MY, Blaskewicz Boron J, Lyden E,	education. <b>Objectives:</b> To explore acceptability, tolerability, and subjective experience of virtual reality (VR) as therapeutic recreation for hospice patients living with
Ferguson C, Shade MY, Blaskewicz Boron J, Lyden E, Manley NA. Virtual Reality for	education. <b>Objectives:</b> To explore acceptability, tolerability, and subjective experience of virtual reality (VR) as therapeutic recreation for hospice patients living with dementia (hPLWD). <b>Design:</b> Descriptive study setting. <b>Community Hospice</b> Agency Participants: A companience complete of n = 25 bPLWD correct for by c
Ferguson C, Shade MY, Blaskewicz Boron J, Lyden E, Manley NA. Virtual Reality for Therapeutic Recreation in	education. <b>Objectives:</b> To explore acceptability, tolerability, and subjective experience of virtual reality (VR) as therapeutic recreation for hospice patients living with dementia (hPLWD). <b>Design:</b> Descriptive study setting. <b>Community Hospice</b> <b>Agency Participants:</b> A convenience sample of n = 25 hPLWD cared for by a local baseling agency. <b>Intervention:</b> Participants viewed a baseb score using VR
Ferguson C, Shade MY, Blaskewicz Boron J, Lyden E, Manley NA. Virtual Reality for Therapeutic Recreation in Dementia Hospice Care: A	education. <b>Objectives:</b> To explore acceptability, tolerability, and subjective experience of virtual reality (VR) as therapeutic recreation for hospice patients living with dementia (hPLWD). <b>Design:</b> Descriptive study setting. <b>Community Hospice</b> <b>Agency Participants:</b> A convenience sample of n = 25 hPLWD cared for by a local hospice agency. <b>Intervention:</b> Participants viewed a beach scene using VR headset for < 30 minutes. <b>Measurements:</b> Tolerability was measured with Pain
Ferguson C, Shade MY, Blaskewicz Boron J, Lyden E, Manley NA. Virtual Reality for Therapeutic Recreation in Dementia Hospice Care: A Feasibility Study. Am J Hosp Palliat Care	education. <b>Objectives:</b> To explore acceptability, tolerability, and subjective experience of virtual reality (VR) as therapeutic recreation for hospice patients living with dementia (hPLWD). <b>Design:</b> Descriptive study setting. <b>Community Hospice</b> <b>Agency Participants:</b> A convenience sample of n = 25 hPLWD cared for by a local hospice agency. <b>Intervention:</b> Participants viewed a beach scene using VR headset for ≤30 minutes. <b>Measurements:</b> Tolerability was measured with Pain Assessment IN Advanced Dementia (PAINAD)scores at baseline. every 5 minutes
Ferguson C, Shade MY, Blaskewicz Boron J, Lyden E, Manley NA. Virtual Reality for Therapeutic Recreation in Dementia Hospice Care: A Feasibility Study. <i>Am J Hosp</i> <i>Palliat Care</i> . 2020:37(10):809-815	education. <b>Objectives:</b> To explore acceptability, tolerability, and subjective experience of virtual reality (VR) as therapeutic recreation for hospice patients living with dementia (hPLWD). <b>Design:</b> Descriptive study setting. <b>Community Hospice</b> <b>Agency Participants:</b> A convenience sample of n = 25 hPLWD cared for by a local hospice agency. <b>Intervention:</b> Participants viewed a beach scene using VR headset for ≤30 minutes. <b>Measurements:</b> Tolerability was measured with Pain Assessment IN Advanced Dementia (PAINAD)scores at baseline, every 5 minutes during VB use, and 5 minutes after beadset removal. Additionally, follow-up
Ferguson C, Shade MY, Blaskewicz Boron J, Lyden E, Manley NA. Virtual Reality for Therapeutic Recreation in Dementia Hospice Care: A Feasibility Study. <i>Am J Hosp</i> <i>Palliat Care</i> . 2020;37(10):809-815. doi:10.1177/10/9909120901	education. <b>Objectives:</b> To explore acceptability, tolerability, and subjective experience of virtual reality (VR) as therapeutic recreation for hospice patients living with dementia (hPLWD). <b>Design:</b> Descriptive study setting. <b>Community Hospice</b> <b>Agency Participants:</b> A convenience sample of n = 25 hPLWD cared for by a local hospice agency. <b>Intervention:</b> Participants viewed a beach scene using VR headset for ≤30 minutes. <b>Measurements:</b> Tolerability was measured with Pain Assessment IN Advanced Dementia (PAINAD)scores at baseline, every 5 minutes during VR use, and 5 minutes after headset removal. Additionally, follow-up phone calls to caregivers several hours after the intervention were performed to
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Guenther M, Görlich D, Bernhardt F, et al. Virtual reality reduces pain in palliative care–A feasibility trial. *BMC Palliat Care*. 2022;21(1):169. doi:10.1186/s12904-022-01058-4 **Background:** Effective symptom control is a stated goal of palliative care (PC) to improve quality of life for terminally ill patients. Virtual reality (VR) provides temporary escapes from pharmacologically resistant pain and allows for experiences and journeys patients may not access in any other way. Enabling wishes through virtual worlds may also offer additional benefits such as controlling psychological and physical symptoms. Aims: We investigated the feasibility of a single VR experience as a viable, satisfying, and effective tool for end-of-life pain relief for inpatients presenting palliative needs. **Design:** This is an observational, single-arm and national single-center feasibility trial. Methods: A one-time VR experience with a selection of several videos and games was offered to 45 inpatients receiving PC at Muenster University Hospital. Patients with brain tumors, brain metastases, seizures, motion sickness, claustrophobia, vertigo, hearing or visual impairment, or unable to consent were excluded. Primary outcome measured patient reported pain on a visual analogue scale (VAS). We also measured Karnofsky performance status, health-related quality of life (HRQOL) using the EQ-5D-5 L questionnaire, and the Pain Out Questionnaire for postoperative pain. Results: We analyzed data from 21 women (52.5%) and 19 men (47.5%) at an average age of 51.9 (SD: 15.81) years. The mean Karnofsky score among the sample was 45.5 (SD: 14.97) and the HROOL was 41.9 (SD: 23.08). While no serious side effects were reported during the intervention, three patients experienced nausea (7%), two headaches (5%), and three reported dry eyes (7%) afterwards. Significant pain reduction (baseline VAS 2.25 (SD: 0.4399)) was demonstrated during (VAS 0.7 (SD: 0.2983, p < 0.0001)), immediately after (VAS 0.9 (SD: 0.3354, p = 0.0001)) and one hour after the intervention (VAS 1.15 (SD: 0.4163, p = 0.0004)). More than 80% rated the VR experience as very good or good (85%, n = 34) and intended to make use of the device again (82.5%, n = 33). However, two participants (5%) also expressed sadness by becoming aware of old memories and previous opportunities that are gone. Discussion: The present pilot study suggests that VR seems to be a feasible and effective tool for pain relief in PC. Its use encompasses the approach of a total pain and symptom therapy and enhances patients' dignity and autonomy. Future research ought to include if and to what extent VR could reduce the necessity of pharmacological pain relief.





Hayden L, Chaze F, Kamath A, et al. Implementation of a Virtual Reality recreation program in long-term care. Journal of Rehabilitation and Assistive Technologies Engineering. 2022;9:205566832110709. doi:10.1177/2055668321107 0994 Introduction: This manuscript describes the implementation of a Virtual Reality (VR) recreation program at long-term care sites across Ontario, Canada, using the RE-AIM Framework to guide the implementation and its evaluation. Methods: We developed a VR recreation program to enhance the lives of longterm care residents, through 3 sequential phases. In Phase 1, we learned about resident and staff needs through focus groups, staff surveys and observations. In Phase 2, we developed 10 VR experiences, based on the data from Phase 1. In Phase 3, we implemented the VR experiences and supporting manual and measured their implementation, using the RE-AIM Framework. Results: We found the VR program to be highly (but not consistently) implementable across all sites. Factors that supported implementation were the following: resident interest in the content and technology, relative ease of use for staff to implement and formally integrating VR into the recreation calendar. Factors that impeded implementation were the following: the size of the headset, inability for the headset to cast given the sites' Information Technology infrastructure and some content that was not engaging. Conclusions: VR programs are highly implementable and this implementation is enhanced by integration of the program into existing recreational systems, ease of use and resident engagement.





Herwest S, Bozem A, Iggena D, et al. Virtual Reality Treatment in a Neuropalliative Care Unit (P5-6.002). *Neurology*. 2024;102(17\_supplement\_1) :3899. doi:10.1212/WNL.0000000 00205453

Objective: Assessing whether a VR-intervention in patients receiving neuropalliative care (NPC) (I) is feasible and accepted by patients, (II) without relevant side effects and (III) can alleviate symptom burden. Background: Patients in NPC-settings suffer from complex neurological deficits as well as from pain, anxiety, fatigue, and sadness. Immersive virtual reality (VR) is increasingly used as non-pharmacological treatment of these symptoms. However, data on NPCpatients are not available. **Design/Methods:** Our prospective single-arm study recruited patients from the NPC unit at Charité Berlin. In a 15–20 minute VRintervention (CUREosity Oculus Quest VR-system), patients explored different landscapes and performed activities like directing a butterfly by gaze, catching meteors, or breathing exercises. To assess feasibility and acceptance, a semistructured interview was conducted, and consent- and dropout-rate were determined. Symptom burden and side effects were assessed using Edmonton Symptom Assessment Scale and Simulator Sickness Questionnaire. Results: We recruited 35% of all inward NPC-patients (n=50, mean age 64 years, 62%) male) from 09/2022 – 09/2023. Main reasons for exclusion of the remaining 65% were relevant neurological deficits (e.g. aphasia, cognitive deficits). Included patients had neuro-oncological (42%), neurodegenerative (40%), and neurovascular (8%) diseases. Most patients described the VR-intervention as enjoyable, distracting, and relaxing, and 88% wished for another intervention. Three patients (6%) discontinued the VR-intervention (exacerbation of preexisting dizziness, dislike of the VR-landscapes). Mild side effects (eyestrain, nausea, tiredness, dizziness) occurred in 24%. The VR-intervention was associated with a significant reduction in sadness (p<0.001, d=0.79), pain (p=0.01, d=0.50), fatigue (p=0.01, d=0.47), anxiety (p=0.02, d=0.47), and dyspnea (p=0.049, d=0.43), and well-being improved significantly (p=0.001, d=0.68). Conclusions: Immersive VR in NPC-patients is feasible and accepted, and can be performed without relevant side effects. In our cohort, the VR-intervention was associated with reduced levels of sadness, pain, fatigue, anxiety, and dyspnea, and increased well-being. Immersive VR should therefore be further evaluated as non-pharmacological treatment for NPC-patients.





Hoffman HG, Patterson DR,	Objective: The current study explored whether immersive virtual reality
Carrougher GJ, Sharar SR.	continues to reduce pain (via distraction) with repeated use. <b>Setting:</b> The study
Effectiveness of virtual	was conducted in a burn care unit at a regional trauma center. <b>Patients:</b> Seven
reality-based pain control	patients aged 9-32 years (mean age of 21.9 years; average of 23.7% total body
with multiple	surface area burned [range, 3-60%]) performed range-of-motion exercises of
treatments. Clin J Pain.	their injured extremity under an occupational therapist's direction on at least 3
2001;17(3):229-235.	separate days each. Intervention: For each physical therapy session, each
doi:10.1097/00002508-	patient spent equal amounts of time in virtual reality and in the control condition
200109000-00007	(no distraction). The mean duration of physical therapy in virtual reality was 3.5,
	4.9, and 6.4 minutes for the first, second, and third session, respectively.
	Condition order was randomized and counter-balanced. <b>Outcome</b>
	measures: For each of the three physical therapy sessions, five visual analog
	pain scores for each treatment condition served as the dependent variables.
	<b>Besults:</b> Pain ratings were statistically lower when patients were in virtual
	reality, and the magnitude of pain reduction did not diminish with repeated use
	of virtual reality. The results of this study may be examined in more detail at
	www.vrnain.com <b>Conclusions:</b> Although the small sample size limits
	generalizability results provide converging preliminary evidence that virtual
	reality can function as a strong nonpharmacological pain reduction technique
	for hum patients during physical therapy. Posults suggest that virtual reality
	doos not diminish in analysis of factiveness with three (and possibly more)
	uses Virtual reality may also have analyzed potential for other painful
	uses. Virtual reality may also have analgesic potential for other painful
	Virtual reality (/D) has a maximum and a remarkable available
Javvaji CK, Reddy H, vagna	Virtual reality (VR) has experienced a remarkable evolution over recent decades,
JD, laksande A,	evolving from its initial applications in specific military domains to becoming a
Kommareddy A, Reddy NS.	ubiquitous and easily accessible technology. This thorough review delves into
Immersive Innovations:	the intricate domain of VR within healthcare, seeking to offer a comprehensive
Exploring the Diverse	understanding of its historical evolution, theoretical foundations, and current
Applications of Virtual	adoption status. The examination explores the advantages of VR in enhancing
Reality (VR) in	the educational experience for medical students, with a particular focus on skill
Healthcare. Cureus.	acquisition and retention. Within this exploration, the review dissects the
2024;16(3):e56137.	applications of VR across diverse medical disciplines, highlighting its role in
Published 2024 Mar 14.	surgical training and anatomy/physiology education. While navigating the
doi:10.7759/cureus.56137	expansive landscape of VR, the review addresses challenges related to
	technology and pedagogy, providing insights into overcoming technical hurdles
	and seamlessly integrating VR into healthcare practices. Additionally, the review
	looks ahead to future directions and emerging trends, examining the potential
	impact of technological advancements and innovative applications in
	healthcare. This review illuminates the transformative potential of VR as a tool
	poised to revolutionize healthcare practices.
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Kelleher SA, Fisher HM, Winger JG, et al. Virtual reality for improving pain and pain-related symptoms in patients with advanced stage colorectal cancer: A pilot trial to test feasibility and acceptability. *Pall Supp Care*. 2022;20(4):471-481. doi:10.1017/S147895152100 2017 Objective: Virtual reality (VR) has the potential to improve pain and pain-related symptoms. We examined the feasibility, acceptability, safety, and impact of a 30min virtual underwater/sea environment (VR Blue) for reducing pain and painrelated symptoms in advanced colorectal cancer patients. A qualitative exit interview was conducted to understand preferences, thoughts, and feelings about the VR session. **Method:** Participants (N = 20) had stage IV colorectal cancer and moderate-to-severe pain. Participants completed a 30-min VR Blue session that visually and aurally immersed them in virtual ocean scenarios. Feasibility was assessed by accrual (N = 20), protocol adherence ( $\geq 80\%$ completing VR Blue), and completed data ( $\geq$ 80% assessment completion). Acceptability was determined by patients reporting ≥80% intervention satisfaction. Safety was determined by ≥80% of patients completing the session without self-reported side effects. Measures of pain, tension, relaxation, stress, anxiety, and mood were collected before, during, and after the VR Blue session. A semi-structured qualitative interview was conducted after VR Blue to assess participants' VR experiences. Results: All participants (100%) completed the VR Blue session. There was 100% data collection at the pre- and post-assessments. Satisfaction with VR Blue was high M = 3.3 (SD = 0.4) (83%). No significant side effects were reported. Pain decreased by 59% (Pre-M = 3 [1]; Post-M = 1 [1]). Tension decreased by 74% (Pre-M = 30 [24]; Post-M = 8 [13]). Relaxation improved by 38% (Pre-M = 62 [21]); Post-M = 86 [17]). Stress decreased by 68% (Pre-*M* = 24 [24]; Post-*M* = 8 [14]). Anxiety decreased by 65% (Pre-*M* = 20 [23]; Post-*M* = 7 [13]). Mood improved by 70% (Pre-*M* = 13 [16]; Post-*M* = 4 [11]). Qualitative data suggested a positive response to the VR Blue protocol. Significance of results: This work supports the feasibility, acceptability, and safety of VR Blue for advanced colorectal cancer patients. Participants showed significant pre-post improvement in pain and pain-related symptoms hinting to the potential feasibility of VR interventions in this population. Larger, randomized trials with a control condition are needed to examine the efficacy of VR-based interventions for patients with advanced colorectal cancer and pain.





Kupczik L, Farrelly W, Wilson S. Appraising Virtual Technologies' Impact on Older Citizens' Mental Health-A Comparative between 360° Video and Virtual Reality. Int J Environ Res Public Health.Aging populations across the world are facing a number of challenges in the context of health and healthcare. These challenges are driven by the aging process and the illnesses associated with aging. Healthcare for older people has become a point of concern with most health organizations, and this is particularly the case with palliative care. In this instance, the movement of the patient may be restricted to a room with no or limited access to the outdors.2022;19(18):11250. Published 2022 Sep 7. doi:10.3390/ijerph19181125This research focuses on the active integration of immersive technologies at the impact of a crossover study to discern technology preferences in relation to immersive technologies among a sample of older people is reported. In addition, the study highlights factors that contribute to a meaningful immersive experience that can improve psychological and physiological wellbeing. The study identifies that there are two significant categorical aspects that contribute to such immersive experiences, technological appexis (including, for example, the weight of headsets, visual impairment, pixelation, and gamification) and emotive aspects (for example, joy, anger, and fear). The study suggests that older people prefer immersive Virtual Reality (VR) environments rather than 360 video experiences. This can be attributed to the greater flexibility in the provision of interactivity in virtual reality systems.Lamont K, Chin M, Kogan M. Miror Box Therapy – Seeing is Believing. <i>EXPLORE.</i> 2001;7(6):369-372. doi:10.1016/j.exptore.2011.0Working with patients with different chronic pain syndromes can be challenging. Pharmacolog		
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current evidence supporting use of Mirror Box Therapy and its successor, Immersive Virtual Reality.		Syndrome (CRPS) may prove to be an exception. In this review we summarize the
Immersive Virtual Reality.		current evidence supporting use of Mirror Box Therapy and its successor,
		Immersive Virtual Reality.




Lee AL, DeBest M, Koeniger-	The objective of this mixed methods study was to evaluate the feasibility and
Donohue R, Strowman SR,	acceptability of using a virtual world educational environment for
Mitchell SE. The feasibility	interprofessional health professions students learning about palliative care.
and acceptability of using	Graduate students (n = 35) from five different health professions programs
virtual world technology for	(medicine, nursing, nutrition, physical therapy, and social work) across two
interprofessional education	educational institutions participated in a small-group immersive educational
in palliative care: a mixed	experience focused on palliative care in the virtual world of Second Life.
methods study. J Interprof	Collected data included pre and post surveys of interprofessional attitudes using
Care. 2020:34(4):461-471.	previously-published questionnaires as well as student reflective writing and
doi:10.1080/13561820.2019.	photographs about their experience. We found it was feasible to create and
1643832	deliver an interprofessional educational experience in palliative care in a virtual
	world environment. The educational experience was acceptable to participants.
	with an improvement in attitudes toward interprofessional education and
	interprofessional teamwork after a single virtual world educational session
	hased on both quantitative and qualitative results. Students found the virtual
	world environment accentable for interprofessional education focused on
	nalliative care, based on qualitative results. As health professions schools
	develop interpretensional education curricula, the use of virtual world
	technology merpholessional education curricula, the use of virtual world
	technology may be an important modality to consider, to effectively and
	conveniently bring interprofessional learners together.
Lloyd A, Haraldsdottir E.	Background: Virtual reality (VR) technology as a therapeutic intervention has
Virtual reality in hospice:	been gaining attention in healthcare settings in recent years. Studies suggest
improved patient well-	that using the technology can help alleviate symptoms such as pain and anxiety
being. BMJ Support Palliat	and induce positive emotions for people in hospital. Managing symptoms and
Care. 2021;11(3):344-350.	promoting emotional and psychological well-being are core palliative care goals
doi:10.1136/bmjspcare-	of relieving suffering of people with life-limiting illness. Accordingly, VR may be
2021-003173	highly beneficial for use in hospice care yet remains underdeveloped in such
	settings. This qualitative study aimed to trial the technology and consider what
	benefits may emerge for hospice in patients. <b>Methods:</b> A one-off VR session was
	offered to patients at a hospice in Scotland. Sessions were observed by a
	researcher and followed by qualitative semi-structured interviews to discuss the
	experience with those who took part. Interviews were audio recorded,
	transcribed and thematically analyzed. <b>Results:</b> Nineteen hospice patients
	successfully tried an immersive VR experience. VR sessions were acceptable for
	people within the hospice environment. The majority of participants enjoyed the
	experience. Many expressed joy and delight at the process. VR holds
	possibilities for relieving symptoms such as pain and anxiety frequently
	experienced by people in hospices. Furthermore, the technology offers the
	capacity to reconnect with a previous sense of self and to allow respite through
	the capacity to transcend current reality and connect with another meaningful
	reality. This exploratory study offers a starting point for larger studies to
	investigate the utility of VR for hospice patients.





Lu Z, Wang W, Yan W, Kew CL, Seo JH, Ory M. The Application of Fully Immersive Virtual Reality on Reminiscence Interventions for Older Adults: Scoping Review. *JMIR Serious Games*. 2023;11:e45539. doi:10.2196/45539 **Background:** The increasing number of older adults with mental, behavioral, and memory challenges presents significant public health concerns. Reminiscence is one type of nonpharmacological intervention that can effectively evoke memories, stimulate mental activities, and improve psychological well-being in older adults through a series of discussions on previous experiences. Fully immersive virtual reality (FIVR) may be a useful tool for reminiscence interventions because it uses realistic virtual environments connected to a person's significant past stories. Objective: This review aims to examine empirical evidence regarding the application of FIVR in reminiscence interventions, its usability and acceptability, and its effectiveness in assisting the intervention to achieve optimal outcomes. Methods: We followed the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) approach for scoping reviews. The PubMed, PsycINFO, Embase, CINAHL, Web of Science, ACM, and IEEE Xplore electronic databases were used for the search. We included peer-reviewed studies that used FIVR as an assistive tool for reminiscence interventions; were published between January 1, 2000, and August 1, 2022; reported empirical research; involved older adults as participants; and addressed health- and behavior-related outcomes or the feasibility and usability of FIVR. We used Endnote X9 to organize the search results and Microsoft Excel for data extraction and synthesis. Results: Of the 806 articles collected from the databases and other resources, 11 were identified. Most of the studies involved participants aged between 70 and 90 years. Only 1 study did not involve those with cognitive impairments, whereas 3 specifically targeted people living with dementia. The results indicated that FIVR reminiscence interventions enhanced engagement and reduced fatigue. Although some studies have observed positive effects on anxiety, apathy, depression, cognitive functions, and caregiver burden reduction, these findings were inconsistent across other research. In addition, FIVR showed overall usability and acceptability with manageable side effects among older adults across various health conditions during reminiscence sessions. However, 1 study reported adverse feelings among participants, triggered by unpleasant memories evoked by the virtual reality content. Conclusions: The role of FIVR in reminiscence interventions remains nascent, with limited studies evaluating its impacts on older adults. Many of the reviewed studies had notable limitations: small sample sizes, absence of rigorous research design, limited assessment of long-term effects, lack of measures for health and behavior outcomes, and quality of life. Beyond these limitations, this review identified a list of future research directions in 6 categories. On the basis of the review findings, we provide practical recommendations to enhance FIVR reminiscence interventions, covering topics such as virtual reality content, device choice, intervention types, and the role and responsibility of facilitators.





Mahrer NE, Gold JI. The use	Virtual reality (VR) is a relatively new technology that enables individuals to
of virtual reality for pain	immerse themselves in a virtual world. This multisensory technology has been
control: a review. <i>Curr Pain</i>	used in a variety of fields, and most recently has been applied clinically as a
Headache Rep.	method of distraction for pain management during medical procedures.
2009;13(2):100-109.	Investigators have posited that VR creates a nonpharmacologic form of
doi:10.1007/s11916-009-	analgesia by changing the activity of the body's intricate pain modulation
0019-8	system. However, the efficacy of VR has not been proven and the exact
	mechanisms behind VR's action remain unknown. This article presents a
	comprehensive review of the literature to date exploring the clinical and
	experimental applications of VR for pain control. The review details specific
	research methodologies and popular virtual environments. Limitations of the
	research, recommendations for improvement of future studies, and clinical
	experiences with VR are also discussed.
Martin JL, Saredakis D,	Background: Virtual reality (VR) using head-mounted displays (HMDs) has
Hutchinson AD, Crawford	demonstrated to be an effective tool for treating various somatic and
GB, Loetscher T. Virtual	psychological symptoms. Technological advances and increased affordability of
Reality in Palliative Care: A	VR technology provide an interesting option for delivering psychological
Systematic Review.	interventions to patients in palliative care. The primary aim of this systematic
Healthcare. 2022;	review was to synthesise the available research on the use of VR for enhancing
10(7):1222.	psychological and somatic outcomes for palliative care patients. Secondary
https://doi.org/10.3390/healt	aims included assessing general satisfaction and overall usability. <b>Method:</b> A
hcare10071222	pre-registered systematic literature search was conducted according to PRISMA
	guidelines using OVID Emcare, Cochrane Library, Embase, Medline, PsycINFO,
	and PubMed Care Search: Palliative Care Knowledge Network. Peer-reviewed
	experimental, quasi-experimental, observational, case, and feasibility studies
	consisting of single or multiple VR sessions using HMDs that reported
	psychological and/or somatic outcomes were included. <b>Results:</b> Eight studies
	published between 2019 and 2021 were included, representing 138 patients.
	While the reported quantitative psychological and somatic outcomes were
	ambiguous, the qualitative outcomes were largely positive. Participants were
	generally satisfied with VR, and most studies reported the VR interventions as
	usable, feasible, and acceptable. <b>Conclusions:</b> VR shows promise in palliative
	care and generally addresses a range of symptoms with few adverse effects.
	Future research should consist of adequately powered RCTs evaluating dosage
	and focusing on providing meaningful activities to enhance outcomes further.





McGhee WRG, Doherty CJ, Graham-Wisener L, et al. Immersive virtual reality and psychological well-being in adult chronic physical illness: systematic review. <i>BMJ Support Palliat Care</i> . 2024;14(1):14-24. doi:10.1136/spcare-2023- 004502	<b>Introduction:</b> Individuals with chronic physical illness are at increased risk of negative psychological sequelae. Immersive virtual reality (VR) is an emerging treatment that might reduce these negative effects and increase quality of life in individuals with chronic physical illness. <b>Objective:</b> To systematically review literature examining the use of immersive VR in adult populations with chronic physical illness to understand: (1) how immersive VR is used to improve psychological well-being of adults with chronic physical illness (2) what effect this immersive VR has on the psychological well-being of adults with chronic physical illness. <b>Design:</b> Systematic literature review and meta-analysis. Searches of Ovid Medline/PubMed, PsycINFO, Embase, Web of Science and Scopus between July 1993 and March 2023 inclusive. <b>Results:</b> 12 811 texts were identified; 31 met the inclusion criteria. Relaxing and engaging immersive VR interventions were shown to be acceptable and feasible among adults with cancer, dementia, cardiovascular disease, kidney disease and multiple sclerosis. Many of the studies reviewed were feasibility or pilot studies and so the evidence about effectiveness is more limited. The evidence, mostly from studies of people with cancer, suggests that immersive VR can have a positive effects on anticipatory anxiety symptoms and pain. <b>Conclusions:</b> Environment-based and game-based relaxing immersive VR offer novel interventions, with beneficial effects among people with cancer and, potentially, beneficial effects
	In those with other long-term physical illness.
Moloney M, Doody O, O'Reilly M, et al. Virtual reality use and patient outcomes in palliative care: A scoping review. <i>DIGITAL</i> <i>HEALTH</i> . 2023;9:20552076231207576 doi:10.1177/2055207623120 7574	<b>Objective:</b> Virtual reality is increasingly used in healthcare settings. Potentially, it's use in palliative care could have a positive impact; however, there is limited evidence on the scope, purpose and patient outcomes relating to virtual reality use in this context. The objective of this scoping review is to chart the literature on virtual reality use in palliative care, identifying any evidence relating to biopsychosocial patient outcomes which could support its use in practice. <b>Methods:</b> A scoping review of the literature, involving a systematic search across 10 electronic bibliographic databases in December 2021. Eligibility criteria were primary research studies, of any research design within a 10-year timeframe, which reported on virtual reality use and patient outcomes in palliative care. A total of 993 papers were identified, and comprehensive screening resulted in 10 papers for inclusion. <b>Results:</b> This scoping review identified 10 papers addressing virtual reality in palliative care, published within a three-year timeframe 2019–2021. Research methodologies included mixed methods, quantitative and qualitative. The evidence highlights virtual reality use with patients receiving palliative care in a variety of settings, and data around useability, feasibility and acceptability is positive. However, the evidence regarding biopsychosocial patient outcomes linked to virtual reality use is limited. <b>Conclusion:</b> Virtual reality is gathering momentum in palliative care and is potentially a helpful intervention; however more research is needed to underpin the evidence base supporting its application, particularly in understanding the impact on biopsychosocial patient outcomes and ascertaining the best approach for measuring intervention effectivenees.





Moon NO, Henstridge-Blows JR, Sprecher EA, Thomas E, Byfield A, McGrane J. 'Godrevy Project': virtual reality for symptom control and well-being in oncology and palliative care – a nonrandomised pre-post interventional trial. *bmjonc*. 2023;2(1):e000160. doi:10.1136/bmjonc-2023-000160 Objective: The 'Godrevy Project' is an interventional trial designed to determine the effectiveness of immersive virtual reality (VR) on the holistic symptom control and well-being in oncology and palliative care patients. The primary objective of this study was to determine whether VR changed the revised Edmonton Symptom and Assessment System (ESAS-r) score representing an effective improvement in symptom control and well-being. Methods and Analysis: This study reports on 60 participants recruited from hospital inpatient oncology and palliative care lists, to participate in an unblinded, VR intervention. Participants were included aged >18 years with a diagnosis of cancer, receiving inpatient treatment of systemic anticancer therapy. Impact evaluation on symptoms was measured using the ESAS-r pre-VR and post-VR intervention. For ethical reasons, participants were not randomised. Results: From the 60 inpatients recruited, 58 participants were included for analysis. Participants recruited were aged 19-84 years with female (58%) and male (42%) participation. The primary outcome of the study demonstrated significant improvement in ESAS-r scores for symptoms and well-being. Total ESAS-r scores showed an improvement of 42% compared with baseline, with well-being ESAS-r scores improving 51%. The most common side effect was drowsiness. There were no adverse events related to study participation. Conclusion: The 'Godrevy Project' successfully demonstrates the feasible, effective use of VR on symptom control and well-being in oncology and palliative care patients. This study demonstrates VR as an effective, patient controlled, non-pharmacological intervention without significant side effects. This interventional trial is well placed to support future research and improve clinical practice.





Moscato S, Sichi V, Giannelli A, et al. Virtual Reality in Home Palliative Care: Brief Report on the Effect on Cancer-Related Symptomatology. <i>Front</i> <i>Psychol</i> . 2021;12:709154. Published 2021 Sep 24. doi:10.3389/fpsyg.2021.709 154	Virtual reality (VR) has been used as a complementary therapy for managing psychological and physical symptoms in cancer patients. In palliative care, the evidence about the use of VR is still inadequate. This study aims to assess the effect of an immersive VR-based intervention conducted at home on anxiety, depression, and pain over 4days and to evaluate the short-term effect of VR sessions on cancer-related symptomatology. Participants were advanced cancer patients assisted at home who were provided with a VR headset for 4days. On days one and four, anxiety and depression were measured by the Hospital Anxiety and Depression Scale (HADS) and pain by the Brief Pain Inventory (BPI). Before and after each VR session, symptoms were collected by the Edmonton Symptom Assessment Scale (ESAS). Participants wore a smart wristband measuring physiological signals associated with pain, anxiety, and depression. Fourteen patients (mean age 47.2±14.2years) were recruited. Anxiety, depression (HADS), and pain (BPI) did not change significantly between days one and four. However, the ESAS items related to pain, depression, anxiety, well-being, and shortness of breath collected immediately after the VR sessions showed a significant improvement ( $p$ <0.01). A progressive reduction in electrodermal activity has been observed comparing the recordings before, during, and after the VR sessions, although these changes were not statistically significant. This brief research report supports the idea that VR could represent a suitable complementary tool for psychological treatment in advanced cancer patients
	assisted at home.
Mukai T, Tsukiyama Y, Yamada S, at al. Virtual	<b>Background:</b> Malignancy patients who need long-term hospitalization can feel
Poplity Images of the Home	coursed visiting restrictions that could mean nation to who might be missing out
Are Useful for Patients With	on family support and palliative care, therefore, need to adapt and change. We
Hospital-Based Palliative	used virtual reality (VR) technology with the aim of reducing feelings of
Care: Prospective	loneliness among these patients. <b>Objectives:</b> In a small cohort setting we
Observational Study With	aimed to clarify the usefulness of VR viewing for this purpose by text mining
Analysis by Text	interviews with the natients in nalliative care after their VR experience, and to
Mining, Palliat Med Rep.	clarify the feasibility of this program. <b>Design and setting/subjects:</b> Four
2023:4(1):214-219.	consecutive Japanese patients in the palliative care unit viewed personalized
Published 2023 Aug 7.	familiar persons or places through VR goggles, while communicating by
doi:10.1089/pmr.2023.0017	telephone. After the VR experience, text mining of the patients' interviews was
•	used to extract the words for the frequency count and co-occurrence analysis.
	<b>Results:</b> Four clusters were extracted: "relief from the pain of hospitalization by
	feeling safe and secure with family members nearby," "using VR to regain daily
	life," "immersive feeling of being in the same space as family," and "loneliness
	due to the realistic feeling of separation from the family through VR experience."
	There were no cases of VR sickness. <b>Conclusion:</b> Our results attained by text
	mining suggest the promising potential of VR imaging of familiar surroundings for
	patients in palliative care.





Rolbiecki AJ, Craig K, Megan	Background: Evidence suggests the usefulness of complementary and
Polniak, Smith J, Ghosh P,	alternative medicine approaches, like neurofeedback and virtual reality, for the
Mehr DR. Virtual Reality and	management of cancer-related pain and mood. It is not well-understood whether
Neurofeedback for	neurofeedback delivered through virtual reality is feasible and acceptable to
Management of Cancer	patients actively undergoing cancer treatment. <b>Objective:</b> The purpose of this
Symptoms: A Feasibility	study was to explore the feasibility and acceptability of a nature-based virtual
Pilot. Am J Hosp Palliat Care.	reality combined with neurofeedback as a non-pharmacologic strategy for
2023;40(3):291-298.	managing cancer-related pain and anxiety. Methods: This study utilized a mixed-
doi:10.1177/1049909122110	methods approach. Participants included 15 cancer patients undergoing
9900	treatment. Patients engaged in a 22-minute nature-based virtual reality
	experience, wearing a virtual reality headset with a Brainlink headband
	measuring EEG activity. Participants were asked to complete the Edmonton
	Symptom Assessment System revised version (ESAS-r) before (T1) and after (T3)
	the experience to measure pain and anxiety. They were asked their level of pain
	midway through the experience (T2) and completed a follow-up interview
	afterward. Results: This study revealed feasible delivery of a virtual reality
	intervention combined with neurofeedback for patients seeking cancer
	treatment. All participants (100%) completed the intervention experience.
	Patients report this is an acceptable approach to managing cancer-related pain
	and anxiety. Comparisons between patients' pain scores at T1, T2, and T3 reveal
	statistically significant reductions in pain (p.001). Patients also report decreased
	depression and anxiety. <b>Conclusion:</b> This is the first study examining virtual
	reality combined with neurofeedback as a non-pharmacologic intervention for
	managing cancer symptoms during treatment. The study reveals it is a promising
	for managing cancer-symptoms.
Rudschies C, Schneider I.	Virtual agents (VAs) and immersive virtual reality (VR) applications broaden the
Ethical, legal, and social	opportunities for accessing healthcare by transposing certain processes from
implications (ELSI) of virtual	the analogue world into a virtual realm. While these innovations offer a number
agents and virtual reality in	of advantages including improved access for individuals in diverse geographic
healthcare. Social Science &	locations and novel therapeutic options, their implementation raises significant
Medicine. 2024;340:116483.	ethical, social, and legal implications. Key considerations pertain to the doctor-
doi:10.1016/j.socscimed.20	patient relationship, privacy and data protection, justice, fairness, and equal
23.116483	access as well as to issues of accountability, liability, and safety. This paper
	conducts a comprehensive review of the existing literature to analyse the
	ethical, social, and legal ramifications of employing VAs and VR applications in
	healthcare. It examines the recommended strategies to mitigate potential
	adverse effects and addresses current research gaps in this domain.





D, Ericson J, et al. Methodological innovations to strengthen evidence- based serious illness communication. <i>Patient</i> <i>Education and Counseling</i> . 2023;114:107790. doi:10.1016/j.pec.2023.1077 90	illness, prognostic uncertainty, patient diversity, and healthcare digitalization pose challenges for the future of serious illness communication. Yet, there is paucity of evidence to support serious illness communication behaviors among clinicians. Herein, we propose three methodological innovations to advance the basic science of serious illness communication. <b>Results:</b> First, advanced computation techniques – e.g. machine-learning techniques and natural language processing – offer the possibility to measure the characteristics and complex patterns of audible serious illness communication in large datasets. Second, immersive technologies – e.g., virtual- and augmented reality – allow for experimentally manipulating and testing the effects of specific communication strategies, and interactional and environmental aspects of serious illness communication. Third, digital-health technologies – e.g., shared notes and videoconferences – can be used to unobtrusively observe and manipulate communication and compare in-person to digitally-mediated communication elements and effects. Immersive and digital health technologies allow integration of physiological measurement (e.g. synchrony or gaze) that may advance our understanding of patient experience. <b>Conclusion/practice</b> <b>implications:</b> New technologies and measurement approaches, while imperfect, will help advance our understanding of the epidemiology and quality of serious illness communication in an evolving healthcare environment
Sandara II. Canonigra F	Objective: This seening review explores the netential for virtual environments
Sanders JJ, Caponigro E, Ericson JD, et al. Virtual environments to study emotional responses to clinical communication: A scoping review. <i>Patient Educ</i> <i>Couns</i> . 2021;104(12):2922- 2935. doi:10.1016/j.pec.2021.04.0 22	<ul> <li>(VE) to evaluate emotional outcomes in clinical communication research.</li> <li>Authors representing multiple disciplines use review results to propose potential research opportunities and considerations. Methods: We utilized a structured framework for scoping reviews. We searched four literature databases for relevant articles. We applied multidisciplinary perspectives to synthesize relevant potential opportunities for emotion-focused communications research using VE. Results: Twenty-one articles met inclusion criteria. They applied different methodological approaches, including a range of VE technologies and diverse emotional outcome measures, such as psychophysiological arousal, emotional valence, or empathy. Major research topics included use of virtual reality to provoke and measure emotional responses, train clinicians in communication skills, and increase clinician empathy.</li> <li>Conclusion: Researchers may leverage VE technologies to ethically and systematically examine how characteristics of clinical interactions, environments, and communication impact emotional reactions and responses among patients and clinicians. Variability exists in how VE technologies are employed and reported in published literature, and this may limit the internal and external validity of the research. However, virtual reality can provide a low-cost, low-risk, experimentally controlled, and ecologically valid approach for studying clinician-patient communication. Practice implications: Future research should leverage psychophysiological measures to further examine emotional responses during clinical communication scenarios and clearly report</li> </ul>
	virtual environment characteristics to support evaluation of study conclusions, study replicability, and meta-analyses.





Skidmore N, Ryan CG,	<b>Objective:</b> The development of health literacy is important in the management
Mankelow J, Martin D.	of chronic pain and virtual reality may be an effective medium for its
Acceptability and feasibility	development. This study aims to understand the usability and acceptability of a
of virtual reality to promote	virtual reality-based pain education system for the facilitation of health literacy.
health literacy in primary	Methods: Semi-structured interviews were conducted with health professionals
care from the health	who had used a VR-based pain education system within their clinical practice, to
professional's view: A	explore perceptions of feasibility. Data collection and analyses were informed by
qualitative study. Patient	the Unified Theory of Acceptance and Use of Technology and the Integrated
Educ Couns.	Model of Health Literacy. <b>Results:</b> From 10 participants, the VR-based system
2024;123:108179.	was considered feasible in providing immersive experiential learning which
doi:10.1016/j.pec.2024.1081	addressed patient understanding and health-related communication.
79	<b>Conclusion:</b> VR appears to be perceived as an acceptable and feasible
	technology to support the development of health literacy in people with chronic
	pain. Its largest perceived benefit was its capacity to provide an immersive and
	entertaining alternative to conventional methods of pain education. <b>Practice</b>
	implications: Virtual reality is considered as a feasible method of facilitating
	patient understanding and health-related communication related to chronic
	pain. Feasibility of such a tool relies clinically on time available, social
	expectations of VR, and the role of immersive and experiential learning within the
	management of chronic pain.
Strong J. Immersive Virtual	Dementia of any type is incurable and treatment is primarily focused on slowing
Reality and Persons with	its progression and managing symptoms, typically accomplished through a
Dementia: A Literature	combination of medication and lifestyle factors. Social workers are uniquely
Review. J Gerontol Soc Work.	positioned to suggest new and innovative strategies for improving the quality of
2020:63(3):209-226.	life. Technology opens a variety of options, and virtual reality is one of the more
doi:10.1080/01634372.2020.	recent additions to the available toolkit. This review describes the state of the
1733726	literature as it relates to the use of immersive virtual reality technology with
1,00,20	nersons with dementia. One hundred fifty-eight articles were returned by
	keyword search, but just three of those used modern virtual reality systems
	Each of the three studies found positive results in their respective uses of virtual
	reality with persons with dementia. VB was well tolerated by participants and
	angagement was high though sample sizes were small across studies. Besults
	demonstrated immersive VR is a viable nathway for a variety of novel
	interventions with this nonulation, but more research using modern immersive
	devices is required. Social workers in a variety of care settings can build on those
	early findings and develop an array of novel palliative and leigure-time
	evaluation and develop an array of novel pathative and tersure-time





Tashjian VC, Mosadeghi S, Howard AR, et al. Virtual Reality for Management of Pain in Hospitalized Patients: Results of a Controlled Trial. *JMIR Ment Health*. 2017;4(1):e9. doi:10.2196/mental.7387 Background: Improvements in software and design and reduction in cost have made virtual reality (VR) a practical tool for immersive, three-dimensional (3D), multisensory experiences that distract patients from painful stimuli. **Objective:** The objective of the study was to measure the impact of a onetime 3D VR intervention versus a two-dimensional (2D) distraction video for pain in hospitalized patients. Methods: We conducted a comparative cohort study in a large, urban teaching hospital in medical inpatients with an average pain score of ≥3/10 from any cause. Patients with nausea, vomiting, dementia, motion sickness, stroke, seizure, and epilepsy and those placed in isolation were excluded. Patients in the intervention cohort viewed a 3D VR experience designed to reduce pain using the Samsung Gear Oculus VR headset; control patients viewed a high-definition, 2D nature video on a 14-inch bedside screen. Pre- and postintervention pain scores were recorded. Difference-in-difference scores and the proportion achieving a half standard deviation pain response were compared between groups. **Results:** There were 50 subjects per cohort (N=100). The mean pain reduction in the VR cohort was greater than in controls (-1.3 vs -0.6 points, respectively; P=.008). A total of 35 (65%) patients in the VR cohort achieved a pain response versus 40% of controls (P=.01; number needed to treat=4). No adverse events were reported from VR. Conclusions: Use of VR in hospitalized patients significantly reduces pain versus a control distraction condition. These results indicate that VR is an effective and safe adjunctive therapy for pain management in the acute inpatient setting; future randomized trials should confirm benefit with different visualizations and exposure periods.





Taubert M, Webber L, Hamilton T, Carr M, Harvey M. Virtual reality videos used in undergraduate palliative and oncology medical teaching: results of a pilot study. *BMJ Support Palliat Care*. 2019;9(3):281-285. doi:10.1136/bmjspcare-2018-001720 **Background:** Virtual reality (VR) immersive environments have been shown to be effective in medical teaching. Our university hospital received funding from our deanery, Health Education in Wales, to film teaching videos with a 360-degree camera. Aims: To evaluate whether VR is an effective and acceptable teaching environment. VR headsets were set up for medical students who rotated through Velindre Cancer Hospital's Palliative Care department. Methods: Students were asked to put on a VR headset and experience a pre-recorded 27 min presentation on nausea and vomiting in palliative care settings. They subsequently viewed a radiotherapy treatment experience from a patient's point of view. Results: Of the 72 medical students who participated, 70 found the experience comfortable, with two students stating they felt the experience uncomfortable (1=headset too tight; 1=blurry visuals). Numerical scoring on ability to concentrate in VR from 0 to 10 (0=worst, 10=best) scored an average of 8.44 (range, 7-10). Asked whether this format suited their learning style, average score was 8.31 (range 6-10). 97.2 % (n=70) students stated that they would recommend this form of learning to a colleague, with one student saying he/she would not recommend and another stating he/she was unsure. Students left anonymous free-text feedback comments which helped frame future needs in this emerging area. Discussion: This study suggests that there is room for exploring new ways of delivering teaching and expanding it more widely in palliative care and oncology, but also provides feedback on areas that need further careful attention. Comments from students included: "Might have been the novelty factor but I learnt more from this 20 min VR thing than I have from many lectures". Summary: The project has proved sufficiently popular in medical student feedback, that the VR experience is now available on YouTube and has been permanently introduced into routine teaching. Further 360-degree teaching environments have been filmed. Of note is that our 360-degree videos have been viewed in Africa, so this format of teaching could prove valuable due to its global reach.





Woo OKL, Lee AM, Ng R, Eckhoff D, Lo R, Cassinelli A. Flourishing-Life-Of-Wish Virtual Reality Relaxation Therapy (FLOW-VRT-Relaxation) outperforms traditional relaxation therapy in palliative care: results from a randomized controlled trial. *Front Virtual Real.* 2024;4:1304155. doi:10.3389/frvir.2023.13041 55 Introduction: As the global population continues to age, the demand for palliative care is progressively increasing. This growing trend highlights the pressing need for groundbreaking interventions that can effectively manage palliative symptoms and improve the quality of end-of-life care. We present a brief, structured, personalized, and innovative psychological intervention named Flourishing-Life-Of-Wish Virtual Reality Therapy (FLOW-VRT)®, which capitalizes on the distinctiveness of virtual reality (VR) as an advanced technology for symptom management. FLOW-VRT is theoretically based on self-determination theory, stress coping theory, flow theory, and attention restoration theory. With a special focus on relaxation, "FLOW-VRT-Relaxation" is designed to enhance endof-life coping through personalized VR relaxation. As most studies on the use of VR in palliative care have been feasibility or pilot studies with small sample sizes, there is a need for a randomized controlled trial with sufficient statistical power. Methods: The current study used a randomized controlled trial (n = 128) to test the efficacy of FLOW-VRT-Relaxation by comparing it to traditional relaxation practice in palliative care. Results: Our results showed that following a FLOW-VRT-Relaxation session, the symptoms of distress that patients in palliative care have to endure significantly reduced, whether physical or emotional in nature. **Discussions:** The current findings provide promising results regarding the therapeutic potential of using FLOW-VRT-Relaxation as a cost-effective, scalable, and personalized VR relaxation for patients in palliative care.





Woo OKL, Lee AM. Case report: Therapeutic potential of Flourishing-Life-Of-Wish Virtual Reality Therapy on Relaxation (FLOW-VRT-Relaxation)—a novel personalized relaxation in palliative care. *Front Digit Health*. 2023;5:1228781. doi:10.3389/fdgth.2023.122 8781 In view of the global aging population and growing need of palliative care, innovative intervention for effective symptom management is of urgent need. Flourishing-Life-Of-Wish Virtual Reality Therapy (FLOW-VRT) is a brief, structured, manualized, and personalized psychological intervention with theoretical foundations based on stress coping theory, self-determination theory, flow theory, and attention restoration theory. With a specific focus on relaxation, FLOW-VRT-Relaxation intends to facilitate adaptive end-of-life coping through delivering personalized relaxation. This paper reports a case study of the application of FLOW-VRT-Relaxation, and discusses its therapeutic potential as a cost-effective method for reducing palliative symptoms by addressing patient's unmet needs. The case study is a 51-year-old Chinese female, diagnosed with advanced cervix cancer, and presented with unmet psychological (i.e., unfulfilled wishes) and physical needs (i.e., pain and fatigue) before FLOW-VRT-Relaxation. To address her unmet needs, FLOW-VRT-Relaxation was delivered by a registered clinical psychologist specialized in palliative care. Need assessment was first conducted, followed by a 10-min VR travel of Japan as her own choice. Relaxation was verbally coached during VR. Right after VR, consolidation with psychological components including psychoeducation, cognitive and emotional processing, and reminiscence intervention were delivered. The patient showed improvement in physical and psychological symptoms, lower sense of loneliness and engulfment, as well as enhanced peace after FLOW-VRT-Relaxation. The current findings provide encouraging initial support for the feasibility, acceptability, and therapeutic potential of using FLOW-VRT-Relaxation as a costeffective, scalable and personalized VR relaxation for patients under palliative care. It is hoped that with its optimal use, FLOW-VRT-Relaxation can serve as an alternative therapeutic tool that effectively improves the end-on-life care.





Yazdipour AB, Saeedi S, Bostan H, Masoorian H, Sajjadi H, Ghazisaeedi M. Opportunities and challenges of virtual reality- based interventions for patients with breast cancer: a systematic review. <i>BMC</i> <i>Med Inform Decis Mak</i> . 2023;23(1):17. Published 2023 Jan 23. doi:10.1186/s12911-023- 02108-4	<b>Background:</b> Breast cancer is one of the most common cancers diagnosed worldwide and the second leading cause of death among women. Virtual reality (VR) has many opportunities and challenges for breast cancer patients' rehabilitation and symptom management. The purpose of this systematic review is to look into the benefits and drawbacks of VR interventions for breast cancer patients. <b>Methods:</b> A systematic search was conducted on PubMed, Web of Science, Scopus, IEEE, and the Cochrane Library, from inception until February 6, 2022. The inclusion criteria were: (1) original studies without restriction in study design; (2) a study population consisting of patients with breast cancer; (3) any type of VR-based interventions (immersive and non-immersive); and (5) studies published in English. To assess the risk of bias, the Effective Public Health Practice Project (EPHPP) Tool was used. <b>Results:</b> Eighteen articles were included in this systematic review. The result showed that VR could provide many opportunities for patients with breast cancer, including reducing anxiety, time perception, pain, fatigue, chemotherapy-related symptom distress levels, and depression severity, as well as improvement in the range of motion, strength, and function. Cybersickness symptoms, the weight of headsets and helmets, the quality of the visual image, and the cost of the equipment are some of the challenges in using this technology on these patients. <b>Conclusions:</b> The systematic review showed that VR interventions have opportunities and challenges for patients with breast cancer. VR can be effective for rehabilitation and symptom management and is used in different stages of treatment to improve the condition of patients with breast cancer. However, before using it, the preserve a pauld experience to a partice the patient of patients with breast cancer.
Zeng Y, Zhang JE, Cheng ASK,	<b>Background:</b> This meta-analysis summarizes the results from recent studies
Cheng H, Wefel JS. Meta-	that examined the use of virtual reality (VR)-based interventions on health-
Analysis of the Efficacy of	related outcomes in patients with cancer, and quantitatively evaluates the
Virtual Reality-Based	efficacy of VR-based interventions. Findings of this meta-analysis can provide
Related Symptom	included a combination of "virtual reality" OR "virtual environment" OR "head-
Management, Integr Cancer	mounted display" with "oncology" OR "cancer." Three databases (Medline.
Ther.	PubMed, and CAJ Full-text Database), one search engine (Google Scholar), and
2019;18:153473541987110.	the website of ResearchGate, covering the period from December 2013 to May
doi:10.1177/1534735419871	15, 2019, and including articles published in both English and Chinese, were
108	searched. Data synthesis used the RevMan 5.3 to generate pooled estimates of
	effect size. <b>Results:</b> A total of 6 empirical studies met the eligibility criteria. VR-
	based interventions had statistically significant effects on reducing symptoms of
	anxiety, depression, pain, and cognitive function, whereas statistically significant
	benefit was observed for fatigue ( $\angle = 2.76$ , $P = .006$ ). <b>Conclusion:</b> Most recent
	studies nave primarily examined VR-based interventions for symptom
	International term and a offects in control to concer care. However, the management of
	burgeoning empirical support for further research to evaluate the efficacy of VP
	hased interventions in cancer rehabilitation
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# **APPENDIX A: Literature Search Protocol**

## Literature Search Protocol

## Background

Review Question	What are the benefits of immersive VR in health care?
	What are the risks and/or barriers of using immersive VR in health
	care?
	Topics included VR Use in Health Care, Physical Rehabilitation,
	Mental Health Treatment, Peer Support, Pulmonary Rehabilitation,
	Clinical Education, Medical Training, Patient Education, and
	Palliative Care

# Search strategy for identifying relevant research

Search Engines	PubMed, ScienceDirect, and Google Scholar
Publication Date Range	1995 to Present
Publication Languages	English only
Publication Types	Research studies, literature reviews, meta-analyses, and
	practice guidelines are included.
	Books, magazine articles, news articles, opinion pieces,
	conference abstracts, and study proposals/proposed research
	protocols are excluded.
Key words for search	"immersive virtual reality" AND "health care"
	"immersive virtual reality" AND "physical rehabilitation"
	"immersive virtual reality" AND "mental health treatment"
	"immersive virtual reality" AND "peer support"
	"immersive virtual reality" AND "pulmonary rehabilitation"
	"immersive virtual reality" AND "clinical education"
	"immersive virtual reality" AND "medical training"
	"immersive virtual reality" AND "patient education"
	"immersive virtual reality" AND "palliative care"

### Study selection

Screening Process	Use of a checklist of inclusion criteria for reviewing title and
	abstract – see below

### Data extraction

Information to be extracted	Citation and link to article, abstract	
from studies		





Screening Checklist for Article Inclusion

	Yes	No
Sample includes adults (ages 18+)		
Study examines the use of an intervention using immersive virtual reality		
Intervention involves a health care-related component (e.g., medical center, overseen by		
health care provider, targets health improvement)		
Study addresses one of the target areas:		
Health care		
Physical rehabilitation		
Mental health treatment		
Peer support		
Pulmonary rehabilitation		
Clinical education		
Medical training		
Patient education		
Palliative care		
Discusses benefits, risks, or barriers to the use of immersive virtual reality in health care		
Is available in English		
Is a research article, review article, meta-analysis, or practice guideline		
Is not a book, magazine article, news article, opinion piece, or conference abstract		

