

Efficacy of Immersive Virtual Reality in Patients with Cancer Receiving Chemotherapy: A Systematic Review and Meta-Analysis

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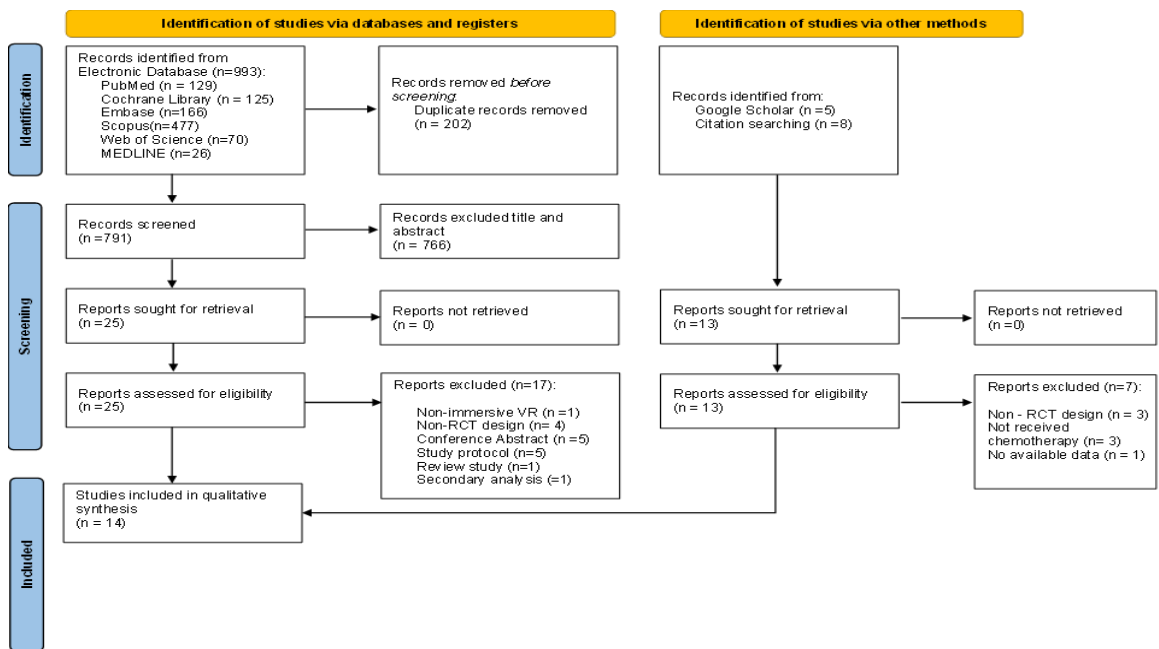
Introduction

The use of immersive virtual reality (IVR) in the cancer field is promising, especially for those receiving chemotherapy. Therefore, examining the current evidence on the application of VR in chemotherapy settings and strengthening the evidence are crucial to support standard care for cancer patients. This systematic review and meta-analysis examined the efficacy of IVR in adult and pediatric patients with cancer receiving chemotherapy.

Methods

We searched for relevant studies in PubMed, Cochrane Library, Embase, Scopus, Web of Science, and MEDLINE. The primary outcomes were anxiety, depression, fatigue, heart rate and blood pressure. The secondary outcomes were pain and distress. The study protocol has been registered and approved by PROSPERO (CRD4202359886).

Figure 1. PRISMA Flow Diagram of Study Selection Process



Result

Fourteen trials were enrolled, of which 9 enrolled 547 adult cancer patients and 5 recruited 257 pediatric cancer patients. In adult patients, IVR significantly reduced anxiety (SMD = -1.73, 95% CI = -2.59 to -0.86), depression (SMD = -2.21, 95% CI = -3.97 to -0.45), and fatigue (SMD = -1.81, 95% CI = -2.93 to -0.69) and systolic blood pressure (MD = -3.54, 95% CI = -6.67 to -0.40). However, IVR did not significantly reduce distress (SMD = -0.63, 95% CI = -1.77 to 0.52), pain (SMD = -0.70, 95% CI = -2.66 to 1.27), and heart rate (MD = -0.13, 95% CI = -0.61 to 0.36). In pediatric patients, IVR significantly reduced pain (SMD = -1.17, 95% CI = -1.84 to -0.50) and anxiety (SMD = -1.18, 95% CI = -1.77 to -0.59) but not heart rate (MD = 0.48, 95% CI = -2.38 to 3.34).

Table 1. Characteristics of the included trials

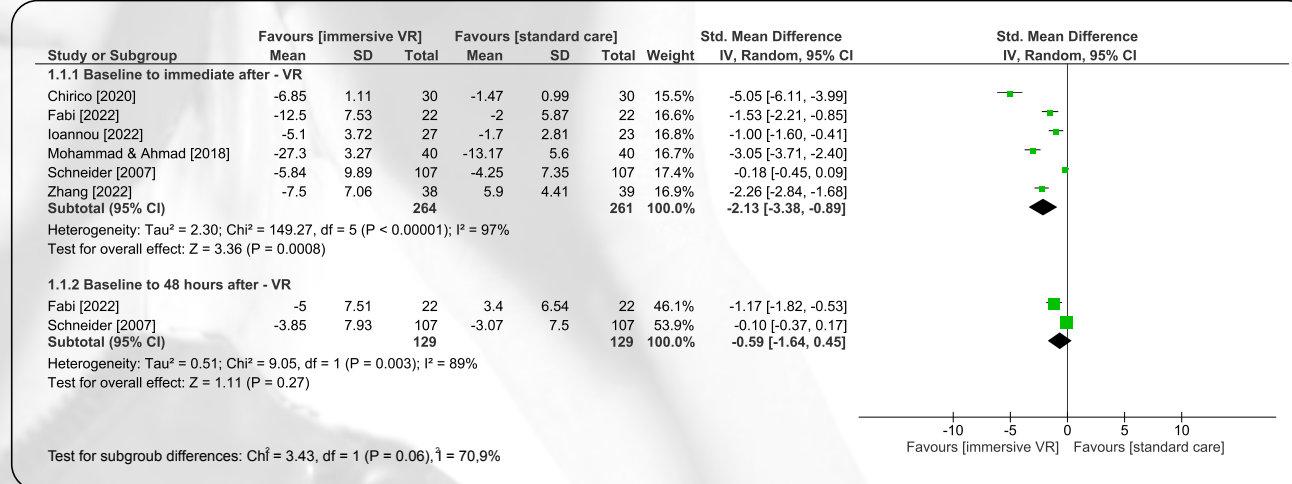
Author (Year)	Inclusion criteria (n/8 years)	Study design	Sample size, N (% of women)	Age (years) (mean ± SD)	Setting	Intervention
Oyama et al [2000]	Patients with cancer receiving chemotherapy, aged 18 to 70 years	RCT	EG: 15 (80%) CG: 15 (80%)	18-70 (53.5)	During chemotherapy	EG: D: Three-screen liquid-crystal display (LCD) with a 3D system, headphones, and speakers VE: Three virtual worlds consisting of lake, forest, and country town T: F: 20 minutes, once CG: Chemotherapy usual care
Schneider et al [2004]	Women with breast cancer who were scheduled to receive IV chemotherapy, aged 18-55 years	Crossover RCT	20 (100%)	27-55 (42.6 ± 7.9)	During chemotherapy	EG: D: Sony PC Classtron PLM5700 (head-mounted display) VE: Deep-sea diving, walking through an art museum, or solving a mystery T: F: 45-90 minutes, once CG: Chemotherapy usual care
Schneider et al [2007]	First diagnosis of breast, colon or lung cancer, aged ≥18 years, receiving IV chemotherapy	Crossover RCT	123 (77%)	32-78 (53.97 ± 10.89)	During chemotherapy	EG: D: VR HMD; I-Glasses SVGA head-mounted Display; I-O display systems VE: deep-sea diving, walking through an art museum, exploring ancient worlds, and solving a mystery T: F: 45-90 minutes, once CG: chemotherapy usual care
Mohammad & Ahmad [2018]	Female patients diagnosed as having breast cancer, aged between 18 and 70 years	RCT	EG: 40 (100%) CG: 40 (100%)	30-70 (51.99 ± 10.34)	In chemotherapy phases	EG: D: Head-mounted display with headphones, not specific described VE: deep-sea diving "Ocean Rift" and sitting on the beach with the "Happi Place" track T: F: 15 minutes, once CG: standard care
Chirico et al [2020]	Patients with breast cancer aged between 18-70 years, receiving IV chemotherapy	RCT	EG: 30 (100%) CG: 30 (100%)	EG: 55.18 ± 5.7 CG: 55.7 ± 5.26 CG: 56.2 ± 6.79	During chemotherapy	EG: D: Head-mounted glasses (Bvltic Wrap 1200 VR) with a head motion tracking system VE: Relating landscapes, participants explored an island, by walking through a forest, observing different animals, climbing a mountain, and swimming in the sea T: F: 20 minutes, once CG: Chemotherapy usual care
Verzwyvelt et al [2021]	Diagnosed as having stage 0 to IV solid cancer, aged ≥18 years	Crossover RCT	33 (75.8%)	26-84 (59.03 ± 13.2)	During chemotherapy	EG: D: Oculus Quest Head-Mounted Display (HMD). The VR HMD is a stand-alone device with built-in tracking and headphones (to allow audio) and has head tracking and a separate hand-controller VE: The Nature Treks software. Patients can explore tropical beaches, underwater oceans, and even watch the stars T: F: 53.3 minutes, once CG: standard care
Zhang et al [2022]	Patients with pathologically diagnosed breast cancer, aged between 18 and 70 years	RCT	EG: 38 (100%) CG: 39 (100%)	EG: 52.29 ± 7.68 CG: 51.03 ± 7.97	Post chemotherapy	EG: D: Oculus Go VR headset VE: A stereoscopic visual scene (Tuscany Garden) T: F: 30 minutes, 6 times (3 months) CG: Standard care
Ioannou et al [2023]	Patients with histopathological diagnosis of cancer, aged ≥18 years, and on active chemotherapy treatment	Crossover RCT	50 (42.0%)	57 ± 15.5	During chemotherapy	EG: D: VIVE VR Headset, a head-mounted display (HMD) VE: A sunny environment with a waterfall flowing from snowy mountains into a lake. Sound of falling water and bird sounds were incorporated over a relaxing soundtrack T: F: 20 minutes, once CG: standard care
Fabi et al [2023]	Histological diagnosis of stage I to III breast or ovarian cancer, aged ≥18 years, ECOG 0 to 2, life expectancy ≥12 months	RCT	EG: 22 (NA) CG: 22 (NA) CG: 22 (100%)	EG: BC: 50 (57-71); CG: 50 (56-61) CG: BC: 50 (59-69); CG: 52 (51-62)	During chemotherapy	EG: D: VR headset Oculus Go VE: Relaxing and engaging content, such as concerts, walks in the European capitals, mountain nature trails, isolated and fascinating places, pristine, exotic beaches, and yoga sessions T: F: 30 minutes, once CG: Standard care
Pediatric patients (≤18 years)						
Gershon et al [2004]	Children with cancer, aged 7-19 years, receiving a port access for chemotherapy	Pilot RCT	EG: 22 (NA) CG: 22 (NA) CG: 22 (NA)	12.7 ± NA	Pre chemotherapy	EG: D: A head-mounted display with stereo earphones VE: Virtual Gorilla program, created as an educational tool for children visiting the gorilla habitat at Zoo Atlanta T: F: 10 minutes, once CG: standard care
Wong et al [2021]	Pediatric patients with cancer, aged 6-17 years	RCT	EG: 54 (44.4%) CG: 54 (40.7%)	EG: 10.5 ± 3.8 CG: 10.2 ± 3.5	In chemotherapy phases	EG: D: Google cardboard goggles fitted to Apple and Samsung smartphones VE: VR cartoons over VR museum or VR water worlds and "Mimion" movies T: F: 10 minutes, once CG: standard care
Gerceker et al [2021]	Children or adolescents with cancer aged 6-17 years undergoing Huber needle insertion for routine chemotherapy	RCT	EG: 21 (38.1%) CG: 21 (38.1%)	NA	Pre chemotherapy	EG: D: Samsung Gear Oculus headset, connected to the Samsung Galaxy S7 Edge VE: Swimming with marine animals underwater (Ocean Rift), riding a rollercoaster (Roller VR), and exploring the forest through the eyes of woodland species (In the eye of animal) T: F: 10 minutes, once CG: standard care
Erdős & Horvath [2023]	Children with cancer aged 10-18 years receiving chemotherapy	Crossover RCT	29 (27.5%)	15.28 ± 2.44	During chemotherapy	EG: D: The Samsung Gear VR (with Samsung Galaxy S7 Edge) and the Oculus Go VE: VR game Night sky (Digital games) T: F: 10 minutes, once CG: Standard care
Wong et al [2022]	Children with cancer, aged 6-12 years, who receiving first chemotherapy	Exploratory - RCT	EG: 9 (44.4%) CG: 10 (50%)	EG: 10.33 ± 1.50 CG: 9.11 ± 1.60	During chemotherapy	EG: D: Google Cardboard goggles VE: Minion mini movies, Doreamon mini movie, and a spider journey 3D cartoon T: 30 minute (1 st session), 5 minute (2 nd session), 5 minute (3 rd session), 3 time

Table 2. Assessment of methodological quality of included trials (RCTs evaluated using RoB 2.0)

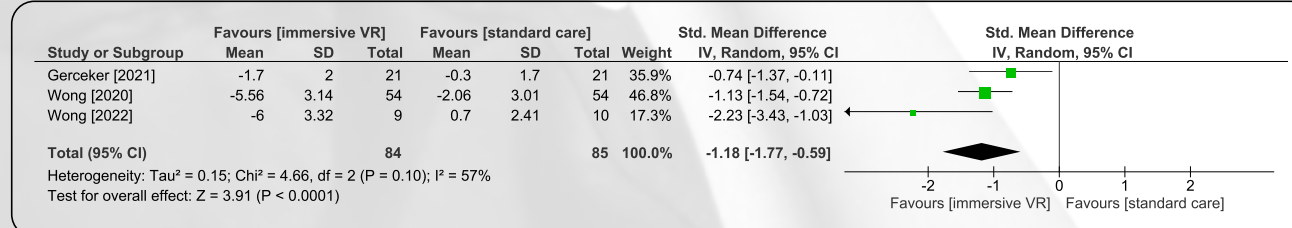
Study	D1	D2	D3	D4	D5	Overall
Oyama et al [2000]	Some concerns	Low	Low	Low	Low	Some concerns
Schneider et al [2004]	Some concerns	Low	Low	Low	Low	Some concerns
Gershon et al [2004]	Some concerns	Low	Low	Low	Low	Some concerns
Schneider et al [2007]	Low	Low	Low	Low	Low	Low
Mohammad & Ahmad [2018]	Low	Low	Low	Low	Low	Low
Chirico et al [2020]	Some concerns	Some concerns	Low	Low	Low	Some concerns
Wong et al [2021]	Low	Low	Low	Low	Low	Low
Verzwyvelt et al [2021]	Some concerns	Low	Low	Low	Low	Some concerns
Gerceker et al [2021]	Low	Low	Low	Low	Low	Low
Zhang et al [2022]	Low	Low	Low	Low	Low	Low
Ioannou et al [2022]	Low	Low	Low	Low	Low	Low

Figure 2. Forest plot comparing immersive virtual reality versus standard care; primary outcomes: anxiety and depression; (A) Anxiety in adult patients; (B) Anxiety in pediatric patients; (C) Depression in adult patients; (D) Distress in adult patients.

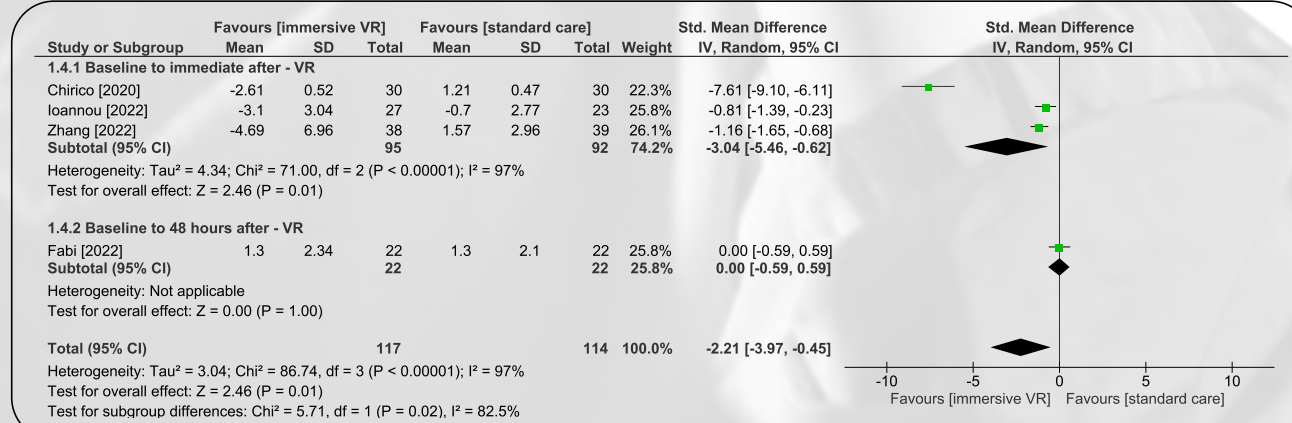
A. Anxiety [adult]



B. Anxiety [pediatric]



C. Depression [adult]



D. Distress [adult]

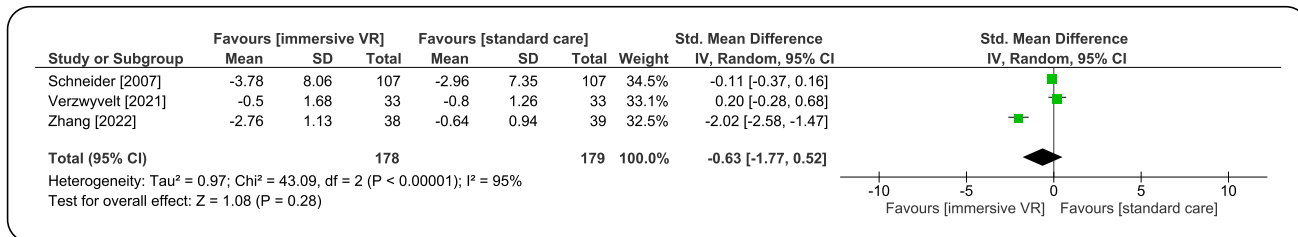


Figure 3. Forest plot comparing immersive virtual reality versus standard care; primary outcome: fatigue in adult patients.

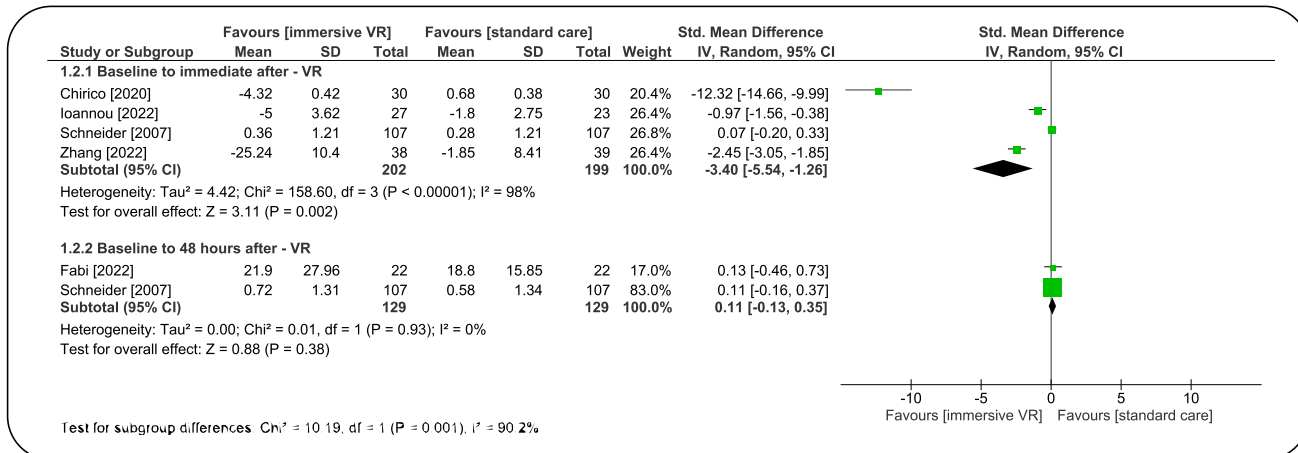
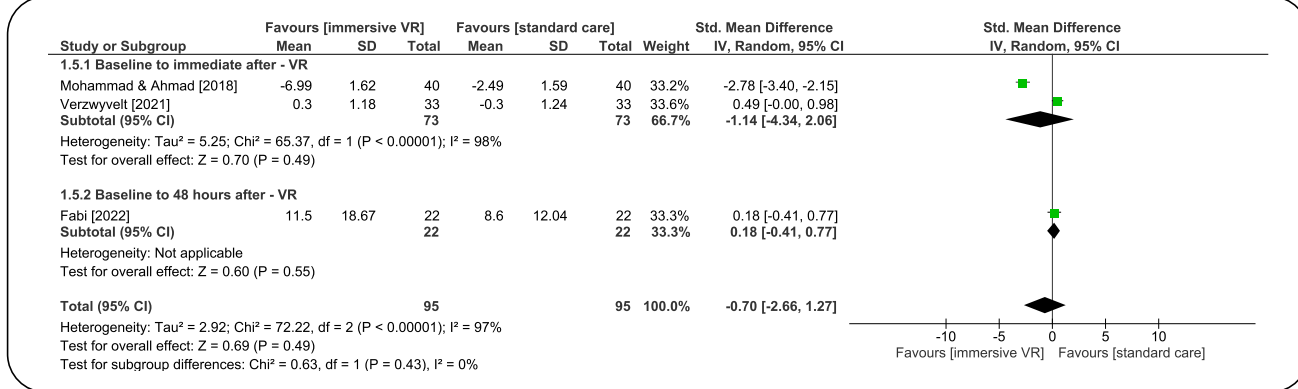
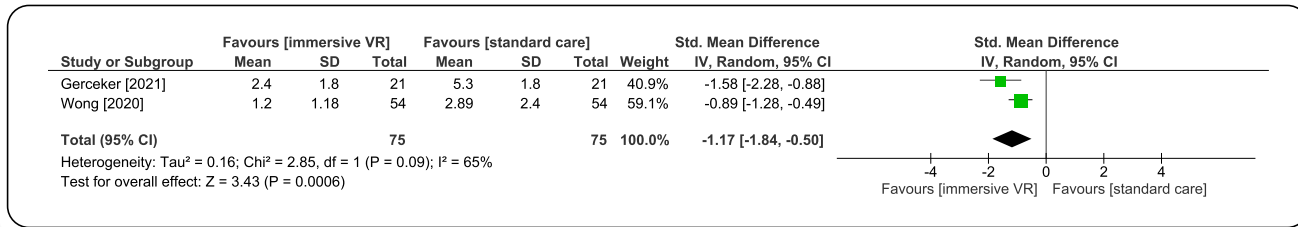


Figure 4. Forest plot comparing immersive virtual reality versus standard care; secondary outcome: pain; (A) pain in adult patients; (B) pain in pediatric patients

A. Pain [adult]



B. Pain [pediatric]



Conclusions

IVR effectively reduced anxiety, depression, fatigue, and blood pressure in adult cancer patients and reduced pain and anxiety in pediatric patients. IVR is possible to distract patient discomfort while receiving chemotherapy. However, more robust RCTs are still needed to strengthen future studies on IVR.

Keywords: immersive virtual reality; chemotherapy; meta-analysis