

Table 2. Summary Findings of Studies Included in Systematic Review

Study	Record Type	Study Design	Population	Intervention	Control	Outcome Measures	Summary Findings	Effect size d	Risk of Bias
Mohammad 2019 [29]	Full report	RCT	Jordanian breast cancer patients (n=80) 80 female 51.99 yrs. (SD=10.34)	Environment-Based Relaxing Immersive VR with TAU (n=40)	TAU (n=40)	VAS (Pain) SAI	VR plus morphine significantly reduces pain and anxiety symptoms in breast cancer patients receiving chemotherapy	VAS*** -1.91 SAI*** -2.17	Some concerns
Chirico 2020 [30]	Full report	RCT	Italian breast cancer patients (n=94) 94 female 55.18 yrs. (SD=5.70)	Environment-Based Relaxing Immersive VR (n=30)	TAU (n=34) & MT (n=30)	SV-POMS (Italian version) SAI	VR significantly reduces anxiety and improves mood states more effectively than MT during chemotherapy	SV-POMS Depression - 0.41*** Tension - 0.51*** Anger -0.18*** Fatigue - 0.23*** Confusion - 0.31 SAI -3.12***	High

Giap 2019 [31]	Abstract	Preliminary Study (Pre-post with control)	American cancer patients	Environment-Based Relaxing Immersive VR	NI VR & Placebo	PFS PHQ-9	Preliminary results suggest VR interventions reduce pain and depression symptoms, while improving fatigue and cognitive function	CD	N/A
Glennon 2018 [32]	Full report	RCT	American cancer patients (n=97) 45 female 50.20 yrs. (SD=12.60)	Environment-based Relaxing Immersive VR	TAU (n=48)	NPS Anxiety Scale	VR non-significantly reduces pain and anxiety symptoms	NPS -0.25 Anxiety -0.27	Low
Scates 2020 [33]	Full report	Pre-post (No control)	American cancer patients (n=50) 35 female	Environment-based Relaxing Immersive VR	-	Range of single-items	VR significantly increases relaxation, feelings of peace and positive distraction during chemotherapy	Relaxed: 0.23*, High distracted: 0.69***, Frustrating: -0.19*	

Nasirzadeh 2020 [34]	Full-text	Repeated measures (No control)	Iranian Haemodialysis patients (n=58) 28 female 45.70 yrs. (SD=0.32)	Environment-based Relaxing Immersive VR scenes)	-	VAS (Pain)	Significant decrease in pain symptoms following VR intervention compared to guided visualisation	Pain: -0.46***	High
Ashley 2021 [35]	Full-text	Crossover design	Oncology patients receiving intravenous chemotherapy (n=33) 25 female 59.03 yrs (SD=13.2)	Environment-based Relaxing Immersive VR	Standard treatment room	Houston Methodist Cancer Service's Distress Screening Assessment Tool; Numerical pain scale	No Significant differences between conditions in terms of change in outcomes	Change in pain: Control = -0.25; VR = 0.19 Distress: Control = -0.42; VR = -0.19	Some concerns
Garcia 2016 [36]	Abstract	RCT	Spanish cancer patients (n=52) 44 female 52.00 yrs.	Environment-Based Relaxing Immersive VR (n=38)	TAU (n=14)	HADS	VR significantly reduces anticipatory anxiety associated with chemotherapy	CD	N/A

			(SD=11.00)						
van Ooteghem 2019 [37]	Abstract	Prospective intervention study (Pre-post No control)	Belgian cancer patients (n=21)	Environment-based Relaxing Immersive VR	-	VAS (Anx.)	VR can reduce anxiety but is not an appropriate treatment for all patients	CD	N/A
Burrows 2020 [38]	Abstract	Preliminary feasibility study (Pre-post No control) [Ongoing]	American Haemodialysis patients (n=20) 4 female 50.30 yrs. (SD=13.1)	Environment-based Relaxing Immersive VR	-	Simulator Sickness Questionnaire	Significant decrease in sickness symptoms	N/A	N/A
Schneider 2003 [39]	Full report	Crossover study	American breast cancer patients (n=16) 16 female 57.7 yrs. (SD=6.80)	Game-based Relaxing Immersive VR	-	SAI SDS PFS	VR significantly reduces patient anxiety during cancer treatment, while symptom distress and fatigue reduces non-significantly	SAI -0.44* SDS -0.12 PFS -0.03	Low

Schneider 2004 [40]	Full report	Crossover study	American breast cancer patients (n=20) 20 female 42.6 yrs. (SD=7.90)	Game-based Relaxing Immersive VR	-	SAI SDS PFS (adapted)	VR significantly reduces symptom distress and fatigue, while anxiety reduces non- significantly	SAI -0.17 SDS -0.30* PFS -0.41**	Low
Schneider 2007 [41]	Full report	Crossover study	American cancer patients (n=123) 95 female 53.97 yrs. (SD=10.89)	Game-based Relaxing Immersive VR	TAU – Delayed VR	SAI ASDS-2 PFS (adapted)	VR significantly reduces perception of time, while reducing anxiety and symptom distress non- significantly during cancer treatment	SAI -0.40 ASDS-2 -0.30 PFS 0.19	Low
Lewandowski 2021 [42]	Full text	RCT	Patients with inflammatory bowel disease treated with vedolizumab intravenous infusion (n = 90) 36 female	Game-based Relaxing Immersive VR	TAU	Stress and anxiety related to medical procedure	Significant improvement in well-being and psychological comfort, feeling of relaxation, a sense of influence on the treatment process, improved perception of the way the drug works, improved positive attitude while waiting for the next administration of the	CD	Low

			Mean (SD) age = 34.7 (9.9) years			drug, and increased motivation for treatment. No significant change for: feeling of prolonged infusion time or its shortening, feeling of calmness, feeling that a lot depends on the patient during treatment, and feeling of calmness when approaching the next dose			
Niki 2019 [43]	Full report	Pre-post (No control)	Japanese terminal cancer patients (n=20) 6 female 72.30 yrs. (SD=11.90)	Environment- based Relaxing Immersive VR	-	ESAS (Japanese version)	VR significantly improves pain and fatigue, and improves anxiety, depression and wellbeing among palliative care inpatients.	ESAS Depression - 1.08*** Anxiety - 0.86*** Wellbeing 0.98***	High
Pizzoli 2019 [44]	Full report	Crossover Study	Italian breast cancer patients (n=16) 16 female 47.70 yrs.	Environment- based Relaxing Immersive VR	-	SAM VAS (Pain)	VR significantly improves emotional valence, arousal and relaxation levels in cancer patients.	SAM Relaxation 2.55** Pleasure 1.74** Arousal 1.25**	Some concerns

(*SD*=7.24)

Ferguson 2020 [53]	Full text	Feasibility study (Pre-post No control)	American dementia patients (n=25) 22 female 85 yrs.	Environment- based Relaxing Immersive VR	-	PAIN-AD	VR can provide meaningful activity and enhance quality of life in dementia patients.	N/A	N/A
Rose 2019 [54]	Full text	Feasibility study (Pre-post No control)	British dementia patients (n=8) 2 female 69.63 yrs.	Environment- based Relaxing Immersive VR	-	OERS OAS-MNR SASBA	VR is acceptable and leads to increase feelings of pleasure and alertness in dementia	N/A	N/A
Tabbaa 2019 [55]	Full text	Feasibility study (Pre-post No control)	British dementia patients (n=8)	Environment- based Relaxing Immersive VR	-	OAS-MNR OERS Semi- structured interview	VR is a feasible intervention to increase feelings of pleasure and alertness in dementia patients	N/A	N/A

Coelho 2020 [56]	Full text	Feasibility study (pre-post no control)	Dementia (n=9) 6 female 85.6 yrs	Environment-based Relaxing Immersive VR	-		Feasible and enjoyed by participants	N/A	N/A
Kelleher 2022 [51]	Full text	Feasibility (no control)	Stage IV colorectal cancer (n = 20) 6 female Mean (SD) age: 56.55 (10.73) yrs,	Environment-based Relaxing Immersive VR	-		VR is acceptable, feasible and safe.	N/A	N/A
Appel 2020 [57]	Full text	Feasibility	Dementia (n=10) 87 yrs	Environment-based Relaxing Immersive VR	-		Patients with dementia appear to tolerate immersive VR. It is feasible to evaluate this non-pharmacological intervention in acute care hospitals.	N/A	N/A
Groninger 2021 [45]	Full text	RCT	Patients with ACC/AHA Stage C or D heart failure	Environment-based	Guided imagery	Pain, distress, FACIT	Significant decrease in pain for intervention but not comparison group.	Change in pain scores: Intervention: -1.12;	Low

			(n=88)	Relaxing				comparison: -	
			35 females	Immersive				0.72	
			56 yrs	VR					
Jozwik 2021 [46]	Full text	RCT	Phase II cardiac rehabilitation (n=77) 42 females Mean (SD) 64.70 (8.03) yrs	Environment-based Relaxing Immersive VR	TAU	HADS, PSQ, tension	Significant difference between groups in terms of change over time on HADS, PSQ, tension. Improvement in all outcomes for intervention group compared with deterioration for TAU group.	Change Intervention: HADS-A -0.14 HADS-D 0.33** PSQ -0.38*** Tension 0.36***	Some concerns
								Comparison: HADS-A 0.29** HADS-D 0.05 PSQ 0.39*** Tension 0.35***	
Maciolek 2020 [47]	Full text	RCT	Cardiac rehabilitation (n=65) 21 females	Environment-based Relaxing Immersive VR	Guided relaxation	STAI	Reduction anxiety-trait in both groups. Reduction in anxiety-state in the experimental group compared with the comparison group	Anxiety-trait intervention - 0.32** control - 0.52***	Some concerns

			mean (SD) age 59.8 (11.8) years					Anxiety-state intervention - 0.47** control - 0.12	
Rutkowski 2021 [48]	Full text	RCT	Chronic Obstructive Pulmonary Disease (n = 50) 41 females Mean (SD) VR: 64.4 (5.7) Control: 67.6 (9.4)	Environment- based Relaxing Immersive VR	TAU	PSQ HADS	Mood improvement and reduction in anxiety and stress in intervention group. VR therapy is more effective than the traditionally used Schultz autogenic training.	Difference between groups in terms of change scores: Tension -0.38 PSQ -0.35 HADS-D -0.84 HADS-A 0.63	Some concerns
Reynolds 2022 [49]	Full text	RCT pilot study	Women with metastatic breast cancer (n=40) Mean (SD) 52.03 (11.40) yrs	Environment- based Relaxing Immersive VR (happy Place)	Environ ment- based relaxing Immersiv e VR (Ripple)	FACIT BPI DASS	Intervention has potential to produce meaningful and sustained reductions in symptoms of fatigue and improve quality of life.	Change across all time points: FACIT-F -0.83 BPI -0.40 DASS Depression - 0.90 DASS Anxiety - 0.64	N/A

								DASS Stress - 0.84	
Szczepanska-Gieracha 2021 [50]	Full text	RCT pilot study	Coronary artery disease patients with elevated anxiety or depression symptoms (n=34) 20 females Mean (SD) 68.91 (6.26) yrs	Environment-based Relaxing Immersive VR	Standard relaxation	HADS PSQ Tension	VR therapy significantly reduced the severity of depressive symptoms, anxiety, and stress levels.	Intervention: HADS-A 0.75** HADS-D 0.89** PSQ -0.67* Tension 1.31***	N/A - - - -
								Control: HADS-A 0.10* HADS-D 0.15 PSQ 0.15 Tension 0.23	

O'Gara 2022 [52]	Full text	Feasibility	Participants were in cancer treatment, recovery or palliative care for cancer (n=21) 14 females Mean (SD) age 48.7 (16.87) yrs	Environment-based Relaxing Immersive VR	-		Intervention is acceptable. Feasible/safe to deliver in the oncology setting	N/A	N/A
Shaw et al. 2019 [58]	Abstract	Feasibility study	American MS patients (n=8)	Mixed Game-based or Environment-based Relaxing Immersive VR	-	PANAS PROMIS	VR is an acceptable intervention that improves affect and mood in MS patients	N/A	N/A

Shaw et al. 2019 [59]	Abstract	Feasibility study	American MS patients (n=4)	Mixed Game-based or Environment- based Relaxing Immersive VR	-	PANAS	VR is an acceptable treatment that improves affect and mood in MS patients	N/A	N/A
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Table 2 Key:

CD – could not determine; VAS – Visual analogue scale; Sub Exp – Subjective experience; SAI – State anxiety inventory; SV-POMS – Profile of mood states - short version; HADS-A – Hospital anxiety and depression scale – anxiety subscale; HADS-D - Hospital anxiety and depression scale – depression subscale; PFS – Piper fatigue scale; PHQ-9 – Patient health questionnaire; NPS – Numerical pain scale; BAI – Beck’s anxiety inventory; ESAS – Edmonton symptom assessment scale; SAM – Self-assessment Manikin; SDS – Symptom distress scale; ASDS-2 – Adapted symptom distress scale-2; PAIN-AD – Pain assessment in advanced dementia scale; OERS – Observed emotion rating scale; OAS-MNR – Overt aggression scale – Modified for Neurorehabilitation; SASBA – St. Andrew’s sexual behaviour assessment; PANAS – Positive and negative affect scale; PA – positive affect; NA – negative affect; PROMIS – Patient reported outcome measurement information system. * $p < 0.05$ ** $p < 0.01$ *** $p < 0.001$