Hapres | Advances in Geriatric Medicine and Research

agmr.hapres.com

Review

Effects of Virtual Reality and Music Therapy on the Psychosocial Outcomes of Adult Cancer Patients: A Systematic Review

Cheng Kian Kelvin Tan [1], Irene Cho [2]

[1] S R Nathan School of Human Development, Singapore University of Social Sciences, Singapore 599494, Singapore

[2] Department of Economics and Cognitive Science, University of Chicago, Chicago, IL 60637, United States; mingyeulirene@uchicago.edu (IC)

* Correspondence: Cheng Kian Kelvin Tan, Email: kelvintanck@suss.edu.sg; Tel.: +65-6240-8948

ABSTRACT

According to the World Health Organisation (WHO), there are nearly 20 million new cancer cases in 2022. In a rapidly ageing world, coupled with improved lifespan, the total number of cancer diagnoses is likely to increase. Cancer patients face significant stress and fatigue from managing the condition and treatment. In mitigating these challenges, the care sector is embarking on use of non-pharmacolgical therapeutic interventions. Virtual Reality technology and music are feasible tools for improving mental wellbeing, relaxation and pain reduction. The systematic review was conducted across five databases between June 2024 and July 2024. Twelve shortlisted studies were examined, which used nature-based, interactive and non-interactive, and meditative VR interventions, VR interventions combined with physiotherapy, background music, or drugs; and standalone music interventions. The studies were conducted in various cancer populations, including advanced cancer patients, end-stage cancer patients in hospice care, breast cancer patients with chronic pain, cancer survivors with chronic cancer-related pain, and metastatic breast cancer patients. Most studies used a range of pre- and post-intervention measurements of anxiety, depression, pain, and other symptoms, and some included control groups or control conditions. The review provides a comprehensive synthesis of research on VR and music as psychosocial interventions for adult cancer patients. mixed results for the effects of these interventions on anxiety, depression, pain, fatigue, sleep, and other psychophysical outcomes. Overall, VR and music may be the basis of promising interventions for cancer patients, but further research is needed.

KEYWORDS: cancer; elderly; community; music; virtual reality; anxiety; depression

Received: 28 February 2025
Accepted: 12 May 2025
Published: 16 May 2025

ABBREVIATIONS

IARC, international agency for research on cancer; World Health Organization, WHO; HADS, hospital anxiety and depression scale; SAI, state anxiety inventory; DASS, depression, anxiety, and stress scale; GAD, general anxiety disorder test; CNSVS, CNS vital signs; AVLT, auditory verbal learning test; TMT-A, Trail-Making Test-A; TMT-B, Trail-Making Test-B; PCI, perceived cognitive impairment; ACA, perceived cognitive ability; VFT, verbal fluency test; BPI, brief pain inventory; VAS, visual analog scale; CSQ, coping strategies questionnaire; ESAS, edmonton symptom assessment system; EQ-5D-5L, EuroQol-5 Dimensions-5 Levels; FACIT-Fatigue, functional assessment of chronic illness therapy—fatigue scale; INS, inclusion of nature in the self; ISI, insomnia severity index; SAS, self-rating anxiety scale; SDS, self-rating depression scale; PSQI, Pittsburgh sleep quality index; WHOQOL-BREF, World Health Organization quality of life brief version

INTRODUCTION

According to the latest estimates from the World Health Organisation (WHO), there were nearly 20 million new cancer cases and 9.7 million cancer deaths in 2022. Lung cancer was the most common cancer globally, with 2.5 million new cases, accounting for 12.4% of the total. Female breast cancer ranked second, with 2.3 million cases (11.6%), followed by colorectal cancer with 1.9 million cases (9.6%). The estimates also indicate that approximately 1 in 5 people will develop cancer during their lifetime [1].

The IARC predicts that over 35 million new cancer cases will occur in 2050, representing a 77% increase from 2022. This rapidly growing global cancer burden is attributed to increased exposure to risk factors, such as air pollution, and to major changes in population demographics [2]. Specifically, by 2050, the number of individuals aged 60 years and older is expected to double globally, from 1 billion in 2020 to 2.1 billion, and the number of individuals aged 80 years or older is projected to triple during this period, reaching 426 million [3].

Age is the most important risk factor for cancer overall and for many individual cancer types. Cancer incidence rates steadily increase with age, rising from fewer than 25 cases per 100,000 people in those under 20 to about 350 per 100,000 among individuals aged 45–49, and exceeding 1,000 per 100,000 in those aged 60 and older [4]. By 2030, 70% of all cancer diagnoses are expected to occur in adults aged 65 and older. Consequently, although age-specific cancer mortality is decreasing due to improved prevention, the total number of cancer diagnoses and death rates continues to rise, with population ageing being the primary cause [5].

In adopting a multidimensional problem solving approach, studies will provide insight into the psychosocial wellbeing of participants [6].

Cancer patients face significant stress due to physically demanding treatments and the resulting permanent health impairments, disabilities, fatigue, and pain that persist even after the cancer has been treated [7]. Fatigue is the most commonly reported symptom of cancer and cancer treatments and is often cited as causing the greatest interference with daily activities. Estimates of fatigue rates among cancer patients vary widely, ranging from 4% in breast cancer patients before chemotherapy to 91% in those who have undergone surgery and chemotherapy and are awaiting bone marrow transplantation. Additionally, an estimated one third to one half of patients undergoing cancer treatment experience pain that can persist even when no signs of cancer remain [8]. The fatigue, pain, and other physical ailments experienced by cancer patients and survivors often hinder their ability to perform routine activities of daily living, including bathing, using the toilet, dressing, preparing meals, and feeding themselves. The impact on daily living can contribute to emotional distress and mental health issues among cancer patients, potentially leading to significant social problems, such as an inability to work and reduced income [7].

In addition to these physical stressors, the emotional stress of living with a cancer diagnosis and the fear of recurrence can exacerbate or introduce new psychological distress [7]. A study conducted at a U.S. cancer centre, which included nearly 4500 patients aged 19 and older, found that significant psychological distress was reported by 29% to 43% of those with the 14 most common types of cancer [9]. Moreover, even patients who do not exhibit these clinical syndromes may still experience substantial psychological stress, such as worries, fears, guilt, loss of control, anger, sadness, and confusion [10]. Common psychological issues among these patients include anxiety, mood disturbances, fear of recurrence, concerns about body image, and difficulties in communication with family members [7].

Virtual Reality and Music as Non-Pharmacological Therapeutic Interventions

Non-pharmacological interventions are defined as science-based and non-invasive interventions that aim to prevent, treat, or cure health problems. They have a measurable impact on health, quality of life, and behavioural markers and are associated with biological and/or psychological processes identified in clinical studies. Among the types of non-pharmacological interventions are psychological interventions, such as stress management and relaxation techniques (i.e., meditation, mindfulness practices) and cognitive-behavioural interventions (i.e., problem-solving, cognitive restructuring, role-playing) [11].

One emerging field of research is the use of virtual reality (VR) technology in non-pharmacological health care applications. As developments in mobile phones and head-mounted displays make virtual reality (VR) more accessible, it is rapidly becoming an appealing tool for

the health care industry [12]. VR consists of a three-dimensional, computer-generated environment viewed through a head-mounted display and a tracker that updates the image based on the users' movements. This allows images to change naturally with head motion, providing a sense of immersion. Numerous studies have demonstrated the efficacy of VR interventions in managing psychosocial symptoms, with the majority focusing on VR-based exposure therapies for the treatment of mental disorders and phobias [13,14], VR experiences for pain reduction [15,16], and VR relaxation experiences for people with mental health conditions [17–19].

Scientific research has shown that music can influence physiological processes that enhance physical and mental well-being. Music therapy is defined as the clinical and evidence-informed use of music interventions to accomplish individualised goals within a therapeutic relationship [20]. Studies on patients diagnosed with mental disorders such as anxiety, depression, and schizophrenia have identified visible improvement in patients' mental health after general music and music therapy interventions [20–23].

Given these insights, there is a compelling rationale to integrate VR and music therapy into psychosocial treatments for cancer patients and survivors as non-pharmacological interventions for any disorders or distress they may experience. In this paper, we review studies that have examined the use of VR and music interventions for adult cancer patients (who are not undergoing cancer treatments like chemotherapy during the intervention) and cancer survivors. We focus on how these interventions impact outcomes related to psychosocial well-being, such as anxiety, depression, cognitive function, pain, fatigue, and sleep. The review presents findings on the systems used as interventions, the psychological and psychophysical effects associated with these interventions, and the limitations of these studies.

MATERIALS AND METHODS

Search Strategy

The review was conducted across five databases, namely PubMed, Web of Science, Scopus, Elsevier, and ProQuest, between June 2024 and July 2024. The following keywords were used: ((cancer) AND (elderly)) AND (community) AND (music) OR (virtual reality) AND ((anxiety) OR (depression)) AND NOT ((education) OR (performance) OR (pediatric) OR (cardiac) OR (dental) OR (oral) OR (pregnant) OR (surgical) OR (perioperative) OR (balance) OR (autism) OR (schizophrenia) OR (classroom) OR (covid)). Keywords were used to search titles, abstracts, and the full text of the articles that had the keywords in the titles or abstracts.

Inclusion and Exclusion Criteria

We included articles that (1) involved VR and/or music interventions for cancer patients and/or survivors; (2) provided qualitative and/or quantitative outcome measures; due to the limited number of studies. Our exclusion criteria were (1) review papers, books, or book chapters; (2) studies published before July 2014; (3) studies involving paediatric participants; (4) studies that administered the VR and/or music intervention during cancer treatment (e.g. during chemotherapy); (5) studies published in languages other than English'; and (6) studies that used technological interventions other than VR, such as augmented reality.

Screening and Data Extraction

Titles and abstracts identified in the initial search were screened to exclude unrelated articles. The full-text screening was performed in two steps. First, the text of each article was searched for the keywords and studies that did not include any of the keywords were dropped from the sample. Second the inclusion/exclusion criteria were applied to the remaining papers. We then collected detailed information from each article in the final sample. Specifically, we extracted the following data: study information (first author, year of publication), demographics (number of subjects, gender distribution, age), study design (control group, exclusion criteria, target population, target problem, experiment description, stimulated sense), intervention (VR/music device), and outcomes (psychological measurement indicators, results extracted from physiological measurements, follow-up findings).

RESULTS

Included Studies

Our initial keyword search identified 6109 articles: 800 from PubMed, 3325 from ProQuest, 1984 from Web of Science, and none from Elsevier or Scopus. After the complete screening process, the sample consisted of 12 articles (summarised in Tables 1 and 2) examining the effects of VR and/or music interventions on various psychosocial outcomes for cancer patients. The studies examined the use of VR and/or music therapy in various cancer populations, including advanced cancer patients, end-stage cancer patients in hospice care, breast cancer patients with chronic pain, cancer survivors with chronic cancer-related pain, and metastatic breast cancer patients. The studies used a range of pre- and post-intervention measurements of anxiety, depression, pain, and other symptoms, and some included control groups or control conditions.

Table 1. Populations in the reviewed studies.

Study	Participants	*N*	Age Range and/or Mean ± SD	Female/Male
[24]	Advanced cancer patients assisted at home	53	55.7 ± 10.7	31/22
[25]	End-stage cancer patients in hospice care	195	67.75	86/109
[26]	Breast cancer patients with chronic pain	80	51	80/0 (only female participants)
[27]	Cancer patients	54	Undisclosed	29/23 (2 participants did not disclose sex)
[28]	Women with cognitive difficulties after chemotherapy for breast cancer	38	Undisclosed	Only female
[29]	Patients with primary cancer diagnosis	9	43.3 ± 8.9	5/4
[30]	Stage IV colorectal cancer patients with moderate-to-severe pain	20	32–80 56.55 ± 10.73	6/14
[31]	Metastatic breast cancer patients	38	52.03 ± 11.40	Only female
[32]	Metastatic breast cancer patients	38	52.03 ± 11.40	Only female
[33]	Breast cancer patients who have undergone breast surgery and are undergoing physiotherapy rehabilitation	52	28–77 56.02 ± 10.62	Only female
[34]	Advanced cancer patients assisted at home	14	47.2 ± 14.2	11/3
[35]	Breast cancer patients	80	30–70 51.99 ± 10.34	Only female

Table 2. Characteristics of the reviewed studies.

Study	Pre- and Post-Intervention Measurement of Psychosocial Characteristics	Control Group/Control Condition	Study Aim
[24]	Yes	Yes	Assess the effects of VR relative to tablet-controlled intervention on anxiety, depression, pain, and short-term psychophysical symptoms in advanced cancer patients assisted at home.
[25]	Yes	Yes	Retrospectively analyse the effect of music therapy on patients with end-stage cancer in hospice care.
[26]	Yes	No	Compare the effectiveness of morphine versus tramal combined with VR therapy in reducing pain and anxiety in female patients with breast cancer.
[27]	Yes	Yes	Analyse the acceptability, feasibility, and tolerance of PNI Thrive, a 10-min VR guided meditation application, as an adjuvant digital therapeutic aid for cancer patients in a clinical setting.
[28]	Yes	Yes	Evaluate the effect of VR-based nature exposure on cognitive performance in women with cognitive difficulties after chemotherapy for breast cancer.
[29]	Yes	No	Examine the potential effects of VR-assisted cognitive rehabilitation intervention on the health outcomes of patients with cancer.

Table 2. *Cont.*

Study	Pre- and Post-Intervention Measurement of Psychosocial Characteristics	Control Group/Control Condition	Study Aim
[30]	Yes	No	Examine the feasibility, acceptability, safety, and impact of a 30-min. virtual underwater/sea environment (VR Blue) for reducing pain and pain-related symptoms in advanced colorectal cancer patients.
[31]	Yes	No	Explore whether VR nature experiences are associated with physical and psychological benefits for women with metastatic breast cancer who are disconnected from nature.
[32]	Yes	No	Assess whether VR should be pursued as a feasible and acceptable adjunctive therapy to alleviate physical and psychological symptoms in women with metastatic breast cancer.
[33]	Yes	Yes	Compare the effectiveness of various distractive interventions during scar massage sessions (listening to music vs. contemplative VR vs. immersive VR) on women who have undergone breast surgery.
[34]	Yes	No	Assess the effect of an immersive VR-based intervention conducted at home on anxiety, depression, and pain over 4 days and evaluate the short-term effect of VR sessions on cancer-related symptomatology.
[35]	Yes	Yes	Assess the effectiveness of immersive virtual reality distraction technology in reducing pain and anxiety among female patients with breast cancer.

Intervention Design and Modality

Virtual intervention

In Table 3, eleven studies [24,26–35] examined the effects of a VR intervention. With the exception of two studies [28,29] that did not specify the VR environment shown to participants, all of the studies used VR environments consisting of relaxing experiences of nature, such as underwater scenes, outdoor camping, beaches, waterfalls, and mountain ranges. One study [27] featured an outer space environment and also included scenes of the destruction of cancerous cells and, for religious participants, the Star of Bethlehem.

Music intervention

While several studies incorporated music into their interventions, only two studies [25,33] specifically examined the effects of music on patients. Dong and Qu [25] analysed the effect of music therapy on patients with end-stage cancer in hospice care, using lively, melodious, and relaxing tunes chosen according to the patients' personal music preferences for daily listening. In contrast, Buche et al. [33] compared the effectiveness of listening to music, specifically Vivaldi's 'Spring' from The Four Seasons, with a VR intervention during a physiotherapy session for breast cancer patients.

VR and music combined intervention

Four studies [27,30–32] combined VR and music in their interventions. Although none of these studies specifically aimed to evaluate the effects of music, they incorporated soothing/relaxing background music into the VR interventions.

Table 3. Experimental designs of the reviewed studies.

Study	Conditions	Type of VR and/or Music Device	Virtual Environment	Music Played	Duration
[24]	Tablet (control group) vs. VR	Mirage Solo VR headset	On the first day, participants had access to only non-interactive VR with natural and relaxing scenarios. From the second day on, they had the option to use interactive VR content.	None	VR was supplied at the home of participants for 4 days with no set usage time or number of sessions. The average usage time over this time period was 47 minutes per participant.
[25]	Routine hospice care (control group) vs. routine hospice care + music	Undisclosed	None	Approximately 7 to 10 suitable songs were selected from the music library, with personal music preferences taken into consideration. The music selected was primarily light music, folk songs, and ballads with lively, melodious, and relaxing tunes. The music decibel level was 30 to 40 decibels.	The frequency of music therapy was once a day, with a duration of 30 to 60 minutes.
[26]	Morphine (exp1) vs. Tramal + VR (exp2)	Head-mounted display	Choice between deep sea diving 'Ocean Rift' or sitting on the beach 'Happy Place'	None	First, the analgesic (Morphine/Tramal) was administered. Then, at the peak analgesic time, a 15-minute VR exposure session was initiated.
[27]	VR vs. control group	Meta Quest 2 VR headset	Outer space environment, deep breathing exercise, visualisation of the destruction of cancerous cells, and mandala or Star of Bethlehem	Ethereal background music and a male voiceover for the guided meditation	10-minute VR session.

Table 3. *Cont.*

Study	Conditions	Type of VR and/or Music Device	Virtual Environment	Music Played	Duration
[28]	Undisclosed	Undisclosed	Undisclosed	Undisclosed	Outcomes were assessed at baseline (T1), at 4 weeks (T2), and at 8 weeks after baseline (T3).
[29]	VR cognitive impairment assessment + VR	Undisclosed	Undisclosed	Undisclosed	Ten 30-minute VR sessions over a period of 2 weeks.
[30]	Single VR therapy session accompanied by music	VR headset; headphones	Underwater/sea environments	Relaxing nature music	Single 30-minute VR session.
[31]	Ripple before Happy Place (exp1) vs. Happy Place before Ripple (exp2)	Pico Goblin VR headset; Panasonic RP-HT161 headphones	Happy Place: a tranquil, animated camping scene. Ripple: a collection of three short 360° VR nature scenes (beach, waterfall, and mountain range)	Soothing music	Participants were instructed to use the VR every day for a minimum of 10 minutes for each week-long VR experience; average duration was 12.8 min ± 5. There was a 1-week washout period between each VR experience to minimise carryover effects between the two interventions.
[32]	Ripple before Happy Place (exp1) vs. Happy Place before Ripple (exp2)	Pico Goblin VR headset; Panasonic RP-HT161 headphones	Happy Place: a tranquil, animated camping scene. Ripple: a collection of three short 360° VR nature scenes (beach, waterfall, and mountain range)	Soothing music	Participants were instructed to use the VR every day for a minimum of 10 minutes for each week-long VR experience; average duration was 12.8 min ± 5. There was a 1-week washout period between each VR experience to minimise carryover effects between the two interventions.

Table 3. *Cont.*

Study	Conditions	Type of VR and/or Music Device	Virtual Environment	Music Played	Duration
[33]	Participatory VR (exp1) vs. contemplative VR (exp2) vs. musical listening (exp3) vs. no distraction (control condition)	Oculus Go headset; Hi-Fi Beats by DR.DRE SOLO HD audio headset	Nine relaxing visual environments with two immersive modes: contemplative and immersive. In the latter, participants could use joysticks to shape their own environment (ex. plant flowers).	'Spring' from Vivaldi's Four Seasons	Participants experienced each experimental condition once. The VR and music sessions took place for 10 minutes at the beginning of the physiotherapy session. On average, physiotherapy sessions lasted for 30 minutes.
[34]	Non-interactive VR + interactive VR	Mirage Solo VR headset	Non-interactive: different natural and relaxing scenarios, such as a seascape. Interactive: surrounded by a calm underwater environment, users had to reproduce with the controller a displayed 'Kanji'—a Japanese ideogram that represents concepts like friendship, courage, and strength.	None	VR was supplied at the home of participants for 4 days with no set usage time or number of sessions.
[35]	Morphine (control) vs. VR + morphine	Head-mounted display; headphones	Choice between deep sea diving 'Ocean Rift' or sitting on the beach 'Happy Place'.	None	The VR session started 15 minutes after morphine was administered and lasted for 15 minutes.

Note: exp1= first experimental group; exp2 = second experimental group (exp2); exp3 = third experimental group.

Outcome Assessment of the VR Intervention (Psychological)

Anxiety and depression

Eight studies (summarised in Table 4) evaluated the effect of VR on reducing anxiety [24,26,31–35]. Two studies used the Hospital Anxiety and Depression Scale (HADS) [24,34], three studies used the State Anxiety Inventory (SAI) [26,33,35], two studies used the Depression, Anxiety, and Stress Scale Short Form (DASS-SF) [31,32], and one study used the General Anxiety Disorder Test (GAD) [29]. All of the described assessments were subjective, self-reported measures. Of the eight studies, five reported a statistically significant reduction in anxiety among participants receiving the VR intervention [24,31–33,35]. Reynolds et al. [32], using a sample of metastatic breast cancer patients, compared baseline measurements with measurement taken at the end of the week-long VR experience and in a follow-up measurement 48 hours after the end of the experience. Anxiety decreased between the pre- and post-intervention measurements but was only significantly lower than at baseline in the follow-up measurement. The studies that did not report statistical significance were Zeng et al. [29], Moscato et al. [34], and Ahmad et al. [26]. Ahmad et al. [26] compared the effects of VR combined with Tramal, a weak opioid, with those of morphine, a strong opioid, alone. They found no significant difference between the two experimental groups, and both groups experienced a significant reduction in anxiety. Thus, combining VR with weak opioids like Tramal was demonstrated to be nearly as effective as using strong opioids like morphine for reducing anxiety in breast cancer patients.

Table 4. Reported outcomes of the reviewed studies.

Study	Outcome Assessment (Psychological)	Outcome Assessment (Psychophysical)	Assessment Tools	Main Results
[24]	HADS	BPI, ESAS	HADS * ESAS *	A significant reduction in anxiety was observed only in the VR group. The ESAS scores showed a significant reduction in tiredness in the VR group.
[25]	SAS, SDS, WHOQOL-BREF	PSQI, T lymphocyte subsets, Natural killer cells	T lymphocytes * Natural killer cells * SAS * SDS * WHOQOL-BREF * PSQI *	For patients with end-stage cancer, music therapy improved their immune status, quality of life, and sleep and ameliorated their anxiety and depression.
[26]	SAI	VAS		When combined with VR, the use of weak opioids such as Tramal had nearly the same effect as strong opioids such as morphine in reducing pain and anxiety in breast cancer patients.
[27]	Mean Overall Feeling Score, Mean Calmness Score, Mean Relaxation Score, Mean Refreshment Score, Mean Empowerment Score, Mean Overall Health Score, Mean Overall Mental Health Score	Systolic blood pressure, Diastolic blood pressure	Mean Overall Feeling Score * Mean Calmness Score * Mean Relaxation Score * Mean Refreshment Score * Mean Empowerment Score * Mean Overall Health Score Mean Overall Mental Health Score * Systolic blood pressure * Diastolic blood pressure *	The results showed a significant increase of mental and physical health post-VR treatment for the intervention group. Although patients with only one VR-guided therapy session improved their outcomes, patients who had more VR sessions improved at a higher rate than those with fewer sessions.

Table 4. *Cont.*

Study	Outcome Assessment (Psychological)	Outcome Assessment (Psychophysical)	Assessment Tools	Main Results
[28]	CNSVS, Self-reported cognitive function, Depression	Fatigue, Sleep	CNSVS *	VR-based nature exposure was a feasible intervention that improved cognitive outcomes in cancer patients and survivors after chemotherapy.
[29]	AVLT, TMT-A, TMT-B, PHQ-9, GAD-7, ISI, PCA, PCI, VFT	ISI	AVLT * TMT-A * TMT-B * PCI * PCA * ISI *	The VR-based cognitive intervention significantly improved perceived cognitive impairment and ability, verbal learning memory, and information processing speed, and reduced the severity of sleep disorders.
[30]	CSQ, Chronic Pain Self-Efficacy Scale	BPI, VAS	BPI * VAS * CSQ *	Participants showed significant pre-post-intervention improvements in pain and pain-related symptoms.
[31]	INS, DASS-21, FACIT-Sp-12	BPI-SF, EQ-5D-5L, FACIT-Fatigue	FACIT-Fatigue * DASS-21 * EQ-5D-DL *	Feeling connected with nature was associated with better physical and psychological status in patients with metastatic breast cancer and VR nature interventions might be beneficial for this clinical population.
[32]	DASS Total, DASS Depression, DASS Anxiety, DASS Stress	BPI, EQ-5D-5L, FACIT-Fatigue	EQ-5D-5L exp1*, exp2* FACIT-Fatigue exp1*, exp2* BPI exp1*, exp2* DASS Total exp1*, exp2* DASS Anxiety exp1*, exp2* DASS Stress exp1*, exp2* DASS Depression exp1*, exp2*	Significant improvements post-intervention and/or 48 h later were demonstrated for quality of life, fatigue, pain, depression, anxiety, and stress. There were very marginal differences between the two experimental groups, suggesting that the effects of the Ripple and Happy Place VR experiences did not differ in any measure.

Table 4. *Cont.*

Study	Outcome Assessment (Psychological)	Outcome Assessment (Psychophysical)	Assessment Tools	Main Results
[33]	ITC-SOPI, SAM, SAI	None	ITC-SOPI exp1*, exp2*, exp3* SAM exp1*, exp2*, exp3* SAI exp1*, exp2*, exp3*	The three distractions made it significantly easier to underestimate the elapsed time for physiotherapy sessions, increased positive emotions (i.e., joy and happiness), and decreased anxiety regardless of time perception. Participatory VR created a feeling of more intense spatial presence.
[34]	HADS	BPI, ESAS, EDA, HR, SKT, AI	ESAS *	Anxiety, depression, and pain did not change significantly between days 1 and 4. 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 relative to pre-intervention scores.
[35]	SAI	VAS	VAS exp1* SAI exp1*	One session of the immersive VR combined with morphine made a significantly larger reduction in pain and anxiety self-reported scores, than morphine alone.

Patient Health Questionnaire (PHQ); Coping Strategies Questionnaire (CSQ); Brief Pain Inventory Short Form (BPI-SF); Functional Assessment of Chronic Illness Therapy-Spiritual Well-being (FACIT-Sp-12); Independent Television Commission–Sense of Presence Inventory (ITC-SOPI); Self-Assessment Manikin (SAM); Electrodermal Activity (EDA); Heart Rate (HR); Skin Temperature (SKT); Activity Index (AI). * indicates a statistically significant difference in the scores of this scale between or within groups in favour of the VR and/or music intervention group; exp1* indicates a statistically significant between groups difference in favour of the first experimental group; exp2* indicates a statistically significant between groups difference in favour of the second experimental group; exp3* indicates a statistically significant between groups difference in favour of the third experimental group.

Six studies evaluated the effect of VR on alleviating depression [24,28,29,31,32,34]. Two studies reported statistically significant reductions in depression [31,32]. Chin et al. [31] explored whether VR nature experiences were associated with physical and psychological benefits for women with metastatic breast cancer who were disconnected from nature. Using the DASS, they found that those with a weaker baseline connection with nature showed significant improvements in depression following the intervention, providing evidence that VR nature interventions are beneficial for this clinical population. Reynolds et al. [32] also used the DASS to measure changes in depression and found a significant decrease in depression between the pre- and post-intervention periods. However, the follow-up conducted 48 hours later did not show further statistically significant improvement. Giannelli et al. [24], Jung et al. [28], Zeng et al. [29], and Moscato et al. [34] found no significant reductions in depression levels after the interventions.

Cognitive function

Two studies examined the effects of VR on cognitive impairment and ability. Jung et al. [28] used self-reported assessments of cognitive function and CNS Vital Signs (CNSVS); the participants were women with cognitive difficulties following chemotherapy for breast cancer. CNSVS is a computerised neurocognitive test battery developed as a routine clinical screening instrument. It consists of seven tests: a test of verbal and visual memory, finger tapping, symbol digit coding, the Stroop Test, a test of shifting attention, and the continuous performance test. The participants showed significant improvement in CNSVS scores, indicating that VR-based nature exposure is a feasible intervention that can enhance cognitive outcomes in cancer patients and survivors after chemotherapy. Zeng et al. [29] used the Auditory Verbal Learning Test (AVLT), Trail-Making Test-A (TMT-A), Trail-Making Test-B (TMT-B), Perceived Cognitive Impairment (PCI), Perceived Cognitive Ability (ACA), and Verbal Fluency Test (VFT). They found significant improvements in all measures except for the VFT, indicating that VR-based cognitive interventions significantly improved perceived cognitive impairment and ability, verbal learning memory, and information processing speed.

Other psychological outcomes

Franklin et al. [27] used pre- and post-treatment surveys of their own design to assess psychological outcomes. Each patient was asked to evaluate and report their feelings about their condition, their health, and their outlook by responding to a survey questionnaire. The questionnaire used items rated on a scale of 0 to 6 to collect data on seven psychological/mental wellness-related areas: Overall Feeling, Calmness, Relaxation, Refreshment, Empowerment, Overall Health, and Overall Mental Health. Statistically significant improvements were recorded for the means of all seven categories post-VR treatment in the intervention group. Furthermore, although patients with only one VR-guided therapy session showed improved outcomes, those who had more VR sessions improved at a higher rate than those with fewer sessions.

Outcome Assessment of the VR Intervention (Psychophysical)

Pain

Seven studies examined the effects of VR interventions on pain intensity [24,26,30–32,34,35]. Three of these studies reported significant reductions in pain [30,32,35]. Kelleher et al. [30] investigated pain and pain-related symptoms in advanced colorectal cancer patients, finding that the pain experienced 'right now' decreased by 58.93% between the pre- and post-VR measurements, based on the results of the BPI. Additionally, tension decreased by 74.33%, as measured by the Visual Analog Scale (VAS). The study also assessed changes in cognitive variables related to pain, including pain catastrophising (the tendency to make negative self-statements and catastrophise when faced with pain) and pain self-efficacy (the confidence in one's ability to reduce pain and continue daily activities). A significant correlation was found between changes in pain catastrophising, as determined by the Coping Strategies Questionnaire (CSQ), and changes in relaxation. In Reynolds et al. [32], patients who received VR interventions had lower BPI scores post-intervention, but these reductions only reached statistical significance in the follow-up measurements. Mohammed and Ahmad [35] found that one session of immersive VR combined with morphine led to a significant reduction in pain, as measured by the VAS, compared with morphine alone in breast cancer patients. In contrast, no statistically significant reductions in pain were observed in Giannelli et al. [24], Chin et al. [31], or Moscato et al. [34], which used the BPI as the outcome measure, or in Ahmad et al. [26], which used the VAS. It is noteworthy that, similar to their findings for anxiety, Ahmad et al. [26] found no significant difference in pain reduction between morphine alone and Tramal combined with VR. However, both groups experienced a significant reduction in pain. Thus, combining VR with weaker opioids like Tramal was shown to be nearly as effective as using stronger opioids like morphine for reducing pain in breast cancer patients.

Multidimensional outcomes

Several studies used multidimensional assessment tools to evaluate the multiple symptoms experienced by cancer patients. Giannelli et al. [24] and Moscato et al. [34] used the Edmonton Symptom Assessment System (ESAS), a comprehensive self-report tool for assessing the severity of nine common cancer symptoms: pain, tiredness, nausea, depression, anxiety, drowsiness, appetite, well-being, and shortness of breath. Giannelli et al.'s [24] analysis of the ESAS data showed a significant improvement in tiredness for the VR group. Moscato et al. [34] reported significant improvements in pain, depression, anxiety, well-being, and shortness of breath immediately after using VR. Additionally, an analysis of the correlations between the usage time of a single VR session and pre-post differences in ESAS scores revealed significant negative correlations for anxiety, worst feeling of well-being, and shortness of breath. It is noteworthy that the ESAS items related to anxiety, depression, and pain showed significant improvement, even though these symptoms did not show significant improvement when measured by the HADS or BPI in the same study. Chin et al. [31] and Reynolds et al. [32] used the EuroQol-5 Dimensions-5 Levels (EQ-5D-5L), a self-report assessment of mobility, self-care, usual activities, pain/discomfort, and anxiety/depression, to measure quality of life. Chin et al. [31] reported a significantly greater quality of life following the VR nature intervention compared with the baseline. Reynolds et al. [32] found a small but statistically significant increase in quality of life between the pre- and post-intervention periods.

Fatigue and sleep

Three studies examined the effects of VR intervention on fatigue [28,31,32]. Two of these studies reported statistically significant improvements in fatigue, both using the Functional Assessment of Chronic Illness Therapy—Fatigue Scale (FACIT-Fatigue), a self-reported assessment of fatigue and its impact on daily activities and function [31,32]. In Chin et al. [31], there was a main effect of time on fatigue, with post-intervention fatigue being significantly lower than baseline fatigue. However, the interaction between time and connection with nature indicated a trend, with post hoc tests revealing that fatigue levels only improved in women with a weaker connection to nature (measured by Inclusion of Nature in the Self (INS) scores at baseline). In Reynolds et al. [32], fatigue significantly decreased between the pre- and post-intervention timepoints, and this improvement was maintained at a follow-up 48 hours later. Jung et al. [28] did not report significant improvements and did not disclose the outcome measure used to assess pre- and post-intervention changes in fatigue.

Two studies examined the effects of VR intervention on sleep [28,29]. Zeng et al. [29] used the Insomnia Severity Index (ISI) to assess the severity of sleep disorders in cancer patients, finding that the VR psychological intervention significantly reduced the severity of sleep disorders. Jung et al. [28], which did not disclose the outcome measure for sleep, did not find any significant improvements in sleep quality.

Other psychophysical outcomes

Two studies examined the effects of VR on a broad range of physiological outcomes [27,34]. Franklin et al. [27] measured patients' blood pressure before and after the VR-guided meditation intervention, observing a statistically significant decrease in both systolic and diastolic blood pressure in the intervention group relative to the control group. A decrease in systolic blood pressure in particular has meaningful medical benefits. The authors argued that this result is evidence of the calming effect of the intervention. However, they also noted that other factors may influence blood pressure outcomes (such as rest, relaxation, posture) and that the effect of a patient's current medication on blood pressure cannot be excluded. Based on the participants' medication histories, there was a list of medications with potential effects on blood pressure.

Moscato et al. [34] used a smart wearable wristband to evaluate the effects of the VR intervention on four physiological signals: electrodermal activity (EDA), heart rate (HR), skin temperature (SKT), and activity index (AI). These physiological parameters were chosen because they have been extensively used in emotion recognition research, specifically in association with stress, pain, and the evaluation of depressive and anxious symptoms. The study found no significant changes in these signals before, during, or after the VR sessions. Although not statistically significant, the EDA progressively decreased over the three phases, while HR, SKT, and AI were lower during the VR sessions than in the 10-minute time windows before and after the intervention.

Outcome Assessment of the Music Intervention (Psychological and Psychophysical)

Two studies examined the effects of music intervention on various outcomes in cancer patients [25,33]. Dong and Qu [25] assigned end-stage cancer patients in hospice care to either the conventional group (receiving routine hospice care) or the combination group (receiving both hospice care and music therapy). Before the study, there were no significant differences between the two groups in terms of immune indicators, anxiety and depression scores, quality of life scores, or sleep quality scores. After the intervention, patients in the combination group showed statistically significant improvements in all of the outcomes compared with the conventional group: higher immune status (as indicated by immune indicators lymphocytes CD3+ and CD4+), lower anxiety and depression scores (Self-Rating Anxiety Scale (SAS) and

Self-Rating Depression Scale (SDS)), improved sleep quality scores (Pittsburgh Sleep Quality Index (PSQI)), and higher World Health Organization Quality of Life Brief Version (WHOQOL-BREF) scores in all domains. Additionally, the degree of decline in the physical, psychological, and social relationship domain scores was smaller in the combination group than in the conventional group.

There participants in Buche et al. [33] were women with breast cancer who had undergone breast surgery. These women participated in four experimental conditions during scar massage sessions, one of which included listening to music. The study measured the interventions' effects on mood states and anxiety. It found an increase in positive emotional state and a decrease in negative emotional arousal after each session, as indicated by the Self-Assessment Manikin (SAM). Additionally, there was a statistically significant decrease in anxiety based on the SAI assessment.

Three studies (summarised in Table 5) assessed patient accessibility and satisfaction. Kelleher et al. [30] used a 10-item Client Satisfaction Questionnaire and post-VR interviews, which revealed the high acceptability of the VR intervention, with participants finding the headset easy and comfortable to use, and expressing a desire to engage with VR frequently, especially during times of high pain or anxiety. Reynolds et al. [32] assessed the likelihood of participants using VR again, reporting a mean score of 73.01 for its Happy Place simulation environment and 66.67 for the Ripple simulation environment, alongside qualitative feedback indicating that the participants found relaxation and nature to be enjoyable aspects of VR. Buche et al. [33] collected written feedback, noting strong support for VR use post-immersion, with few participants experiencing discomfort and many reporting a feeling of losing track of time during the sessions.

Table 5. Patient acceptability and satisfaction.

Study	Assessment Method	Outcome
[30]	The 10-item Client Satisfaction Questionnaire was used to assess acceptability post-VR Blue session. Items were rated on a 4-point scale from 1 = low acceptability to 4 = high acceptability	The results show excellent acceptability of the VR Blue protocol, with the mean rating reflecting 'high' acceptability.
	10–15 min post-VR exit interview on five categories related to the patients' VR experience: (1) Use of VR Technology; (2) Timing of VR Blue Session; (3) Enjoyment of VR Blue Session; (4) VR Blue Graphics; and (5) Areas for Improvement and Next Steps	Headset was easy to use (n = 19) and comfortable (n = 17); Prefer doine3g VR in home (n = 13), medical setting (n = 3), or either (n = 4); Length felt appropriate (n = 13); Would use VR Blue everyday (n = 6); Would use VR multiple times per week (n = 11); Would use VR Blue during times of particularly high pain, anxiety, or depression (n = 7) Enjoyed VR Blue (n = 19) and felt neutral (n = 1); Recommendations for improvement included cordless headset and higher resolution picture.
[32]	Mean likelihood of using VR again	Happy Place = 73.01; Ripple = 66.67
	Qualitative feedback about specific aspects participants 'liked' and 'did not like' about the VR experiences	Relaxation was helpful; it was enjoyable to spend time in nature.
[33]	A space was provided at the end of the booklet for patients to write about their experience	Patients were very supportive of using VR after their immersive experiences (M = 8.26 ± 1.31). Very few of them suffered from physical inconvenience following the immersion (n = 4, or 8.70%). The majority had the feeling of losing track of time during the VR experience (n = 26, or 60.87%).

DISCUSSION

Limitations

Population

The reliability of the reported findings in several studies was compromised by small sample sizes; for example, in Zeng et al. [29], n = 9 and in Moscato et al. [34] n = 14. In Zeng et al. [29], the small sample size was due to a dropout rate of 50%, which may have also introduced attrition bias. Small sample sizes can result in poor statistical power, making it challenging to detect true effects or differences, and may lead to results that are not replicable. Researchers should aim to increase sample sizes in future studies. Larger sample sizes would improve the statistical power and robustness of the findings, contributing to more reliable and valid research outcomes.

Furthermore, 6 of the 12 studies focused solely on breast cancer patients [26,28,31–33,35], and one study examined only colorectal cancer patients [30]. While these studies provide useful results for these specific cancer diagnoses, they are not generalisable to all cancer patients, especially the breast cancer studies, which exclusively examined female participants. Future studies could consider including larger and diverse patient groups to benefit more cancer patients.

Another major limitation was the lack of studies on cancer survivors who have already undergone treatments such as chemotherapy. Only two studies examined this population [28,33]. Future research should focus on this group, as targeted studies can provide important insights into psychosocial therapies for cancer survivors, about 25% of whom experience persistent problems, including anxiety, depression, and other psychological and psychosocial distress [36].

Lack of control group/variables

Seven of the studies lacked a control group, assessing only a single group at baseline and post-intervention [26,29–34]. It should be noted that Buche et al. [33] had a single group of participants undergo four experimental conditions, one of which was a control condition. The absence of a proper control group makes it uncertain whether the outcomes were caused by the intervention or other variables. Having a control group strengthens the validity of a study's conclusions and reduces the likelihood of erroneous interpretations.

In addition, several studies did no control some of the variables in their interventions, for example, by providing patients with VR systems in their homes without restrictions on usage time or number of sessions [24,29,31,32,34]. This introduces uncontrollable variables, such as patients' usage patterns and the context in which they used the VR. These factors may have affected the outcomes in various ways; for example, some participants might have used the intervention for durations that

were too short to yield significant improvements or in noisy environments that disrupted the intervention.

Furthermore, several studies that investigated the effects of VR included 'soothing', 'relaxing', or 'ethereal' background music during the intervention [27,30–32]. Accordingly, improvements attributed to the VR treatment may have been influenced by the music. There is a lack of studies specifically examining the independent effects of music interventions, further focused investigations in this area can yield new finding.

Study duration and lack of follow-up

Several studies had short study periods or administered the intervention only once to participants. Giannelli et al. [24] and Moscato et al. [34] evaluated the effects of VR over 4 days, Ahmad et al. [26] and Mohammed and Ahmad [35] each offered a single 15-minute VR session, Franklin et al. [27] administered a single 10-minute VR session, and Buche et al. [33] conducted one 10-minute intervention session for each experimental condition (VR and music included). More studies should be conducted over a longer period with multiple intervention sessions and checkpoints for measuring outcomes. This would allow researchers to assess the effects and changes over an extended timeframe.

None of the studies, with the exceptions of Chin et al. (2022) [31] and Reynolds et al. [32], included follow-up testing. It should be noted that Chin et al. [31] was a secondary analysis of data collected by Reynolds et al. [32], so the data collection methodology was the same for both studies. The results of Reynolds et al. [32] highlighted the importance of conducting follow-up assessments: BPI, DASS Total, DASS Anxiety, and DASS Stress scores all improved and became significant only at a follow-up measurement conducted 48 hours after the intervention. This suggests that the full effects of the interventions may not be immediately apparent. Therefore, future studies should include follow-up assessments.

Lack of objective measures

In addition to assessing cognitive function and physiological indicators such as blood pressure and immune status, all of the studies used subjective measures such as self-assessments, scales, and indexes to evaluate psychosocial outcomes including anxiety, depression, pain, quality of life, sleep, feelings, calmness, relaxation, refreshment, and empowerment. These subjective measures have limitations, including variations in individual interpretation, difficulty in quantifying experiences, inconsistencies in reporting, and susceptibility to biases such as social desirability.

Future research would benefit from complementing questionnaires with objective measures such as EDA, which provides real-time data on

sympathetic nervous system activity that increases during physiological and emotional arousal. EDA was used in one of the studies reviewed [34].

Lack of studies examining the effects of a music intervention

While several studies incorporated music into their VR interventions, only two studies [25,33] specifically examined the effects of music on patients. As a result, there is no clear consensus or comprehensive understanding of the effects of music therapy on various psychosocial outcomes for cancer patients.

Recommendations for future research

Future studies in this field should address several key limitations identified in this review to enhance the robustness and applicability of their findings. First and foremost, there is a clear need to increase sample sizes. Many studies, such as those by Zeng et al. [29] and Moscato et al. [34], suffered from small sample sizes that undermined the statistical power and generalisability of their results. Increasing the number of participants will improve the reliability of results and enable researchers to detect true effects more accurately. Additionally, studies should aim for a more diverse participant pool beyond specific cancer types or treatment stages. Many studies focused exclusively on breast cancer patients or failed to include cancer survivors who had completed treatments like chemotherapy. Expanding research to a broader range of cancer diagnoses and stages will provide critical insights into the needs of different patient populations.

Another important area for improvement is the inclusion of control groups and the management of intervention variables. Several studies lacked proper control groups, making it difficult to attribute observed outcomes solely to the intervention rather than to external factors. Furthermore, the uncontrolled variables, such as patients' usage patterns of VR and the presence of background music, may have confounded the results. Future studies should include well-defined control groups and standardise intervention conditions to accurately isolate the effects of the VR treatment.

In addition, as commented upon by Buche et al. [33], it could be helpful to offer a familiarisation step for the use of VR before starting the actual intervention. This preliminary phase would reduce the surprise effect and the naive attractiveness of VR, leading to a more accurate measurement of the emotional states associated with its use. Studies that have implemented a familiarisation phase in their research protocol have all observed significant results in reducing anger, pain, anxiety, or symptom distress [33]. Therefore, we can assume that there is a link between familiarisation and the significant results obtained from immersive experiences.

The duration and follow-up periods of the interventions also warrant attention. Many studies used short intervention periods or single-session

protocols, which may not capture the full impact of the treatment. Additionally, the absence of follow-up assessments in most studies limits the understanding of the interventions' long-term effects. Future research should extend the duration of interventions and incorporate follow-up evaluations to assess the sustainability of the outcomes and provide a more comprehensive view of the interventions' impact over time.

Lastly, integrating objective measures into the assessments to complement the subjective assessments will enhance the reliability of the psychosocial outcome evaluations. While subjective measures are valuable, they are prone to biases and variability in interpretation. Incorporating objective indicators, such as EDA, can provide more reliable data on physiological and emotional responses and provide an understanding of the mechanisms through which the interventions affect these responses. Additionally, more research is needed to understand the specific impact of music interventions on psychosocial outcomes. Although some studies have included music as a component of VR interventions, there is limited research on its standalone effects, highlighting the need for focused studies in this area.

Addressing these recommendations will contribute to more rigorous, generalisable, and comprehensive research, ultimately enhancing our understanding of effective psychosocial interventions for cancer patients.

CONCLUSIONS

This systematic review provides a comprehensive synthesis of research on VR and music as psychosocial interventions for adult cancer patients. Twelve studies were examined, which used nature-based, interactive and non-interactive, and meditative VR interventions; VR interventions combined with physiotherapy, background music, or drugs; and standalone music interventions. The studies reported mixed results for the effects of these interventions on anxiety, depression, pain, fatigue, sleep, and other psychophysical outcomes. The review also provides a discussion of several limitations of these studies and recommendations for future studies. In future studies, objective physiological measures (e.g., biomarkers, electrodermal activity) can be incorporated alongside traditional assessments to validate findings more robustly. Adopting longer-duration interventions and incorporate regular follow-up evaluations will better assess long-term efficacy and sustained effects.

Overall, VR and music may be the basis of promising interventions for cancer patients, but further research is needed.

ETHICAL STATEMENT

Not applicable.

AUTHOR CONTRIBUTIONS

Both authors discussed the results and contributed to the final manuscript.

DATA AVAILABILITY

No data were generated from the study.

CONFLICTS OF INTEREST

The authors declare that they have no conflicts of interest.

ACKNOWLEDGMENTS

We appreciate the support of the SUSS (Singapore University of Social Sciences)-Nunchi Marine Age Well Programme.

REFERENCES

1. World Health Organization. Global cancer burden growing, amidst mounting need for services. Geneva (Switzerland): WHO; 2024. Available from: https://www.who.int/news/item/01-02-2024-global-cancer-burden-growing--amidst-mounting-need-for-services. Accessed on 8 June 2024.
2. International Agency for Research on Cancer. World cancer report: Cancer research for cancer prevention. Lyon: IARC. Available from: https://www.iarc.who.int/cards_page/world-cancer-report/. Accessed on 2020.
3. World Health Organization. Ageing and health. Geneva (Switzerland): WHO; 2022 Oct 1. Available from: https://www.who.int/news-room/fact-sheets/detail/ageing-and-health. Accessed on 8 June 2024.
4. National Cancer Institute. Age and cancer risk. Bethesda (US): NIH; 2021 Mar 5. Available from: https://www.cancer.gov/about-cancer/causes-prevention/risk/age. Accessed on 8 June 2024.
5. Kadambi S, Loh KP, Dunne R, Magnuson A, Maggiore R, Zittel J, et al. Older adults with cancer and their caregivers current landscape and future directions for clinical care. Nat Rev Clin Oncol. 2020;17(12):742-55.
6. Eiroa-Orosa FJ. Understanding psychosocial wellbeing in the context of complex and multidimensional problems. Int J Environ Res Public Health. 2020;17(16):5937.
7. Adler NE, Page AEK. Cancer care for the whole patient: Meeting psychosocial health needs. Washington (US): National Academies Press; 2008.
8. Carr D, Goudas L, Lawrence D, Pirl W, Lau J, DeVine D, et al. Management of cancer symptoms: Pain, depression, and fatigue. Rockville (US): Agency for Healthcare Research and Quality; 2002.
9. Zabora J, BrintzenhofeSzoc K, Curbow B, Hooker C, Piantadosi S. The prevalence of psychological distress by cancer site. Psychooncology. 2001;10(1):19-28.
10. Charmaz K. Experiencing chronic illness. In: Albrecht GL, Fitzpatrick R, Scrimshaw SC, editors. Handbook of social studies in health and medicine. London (UK): SAGE Publications; 2000. p. 277-92.

11. Castellano-Tejedor C. Non-pharmacological interventions for the management of chronic health conditions and non-communicable diseases. Int J Environ Res Public Health. 2022;19(14):8536.
12. Jerdan SW, Grindle M, van Woerden HC, Kamel Boulos MN. Head-mounted virtual reality and mental health: Critical review of current research. JMIR Serious Games. 2018;6(3):e14.
13. McCann RA, Armstrong CM, Skopp NA, Edwards-Stewart A, Smolenski DJ, June JD, et al. Virtual reality exposure therapy for the treatment of anxiety disorders: An evaluation of research quality. J Anxiety Disord. 2014;28(6):625-31.
14. Krijn M, Emmelkamp PMG, Biemond R, de Wilde de Ligny C, Schuemie MJ, van der Mast CAPG. Treatment of acrophobia in virtual reality: The role of immersion and presence. Behav Res Ther. 2004;42(2):229-39.
15. Maani CV, Hoffman HG, Morrow M, Maiers A, Gaylord K, McGhee LL, et al. Virtual reality pain control during burn wound debridement of combat-related burn injuries using robot-like arm mounted VR goggles. J Trauma. 2011;71(1):S125-30.
16. Malloy KM, Milling LS. The effectiveness of virtual reality distraction for pain reduction: A systematic review. Clin Psychol Rev. 2010;30(8):1011-8.
17. Habak S, Bennett J, Davies A, Davies M, Christensen H, Boydell KM. Edge of the present: A virtual reality tool to cultivate future thinking, positive mood and wellbeing. Int J Environ Res Public Health. 2020;18(1):140.
18. Tarrant J, Viczko J, Cope H. Virtual reality for anxiety reduction demonstrated by quantitative EEG: A pilot study. Front Psychol. 2018;9:1280.
19. Gorini A, Pallavicini F, Algeri D, Repetto C, Gaggioli A, Riva G. Virtual reality in the treatment of generalized anxiety disorders. Stud Health Technol Inform. 2010;154:39-43.
20. Rebecchini L. Music, mental health, and immunity. Brain Behav Immun Health. 2021;18:100374.
21. Fancourt D, Perkins R, Ascenso S, Carvalho LA, Steptoe A, Williamon A. Effects of group drumming interventions on anxiety, depression, social resilience and inflammatory immune response among mental health service users. PLoS One. 2016;11(3):e0151136.
22. Mössler K, Chen X, Heldal TO, Gold C. Music therapy for people with schizophrenia and schizophrenia-like disorders. Cochrane Database Syst Rev. 2011;(12):CD004025. doi: 10.1002/14651858.CD004025.pub3
23. Erkkilä J, Punkanen M, Fachner J, Ala-Ruona E, Pöntiö I, Tervaniemi M, et al. Individual music therapy for depression: Randomised controlled trial. Br J Psychiatry. 2011;199(2):132-9.
24. Giannelli A, Moscato S, Ostan R, Pannuti R, Chiari L, Biasco G, et al. Virtual reality for advanced cancer patients assisted at home: A randomized controlled interventional study. Psychooncology. 2024;33(7):e6368.
25. Dong J, Qu Y. Therapeutic effect of music therapy on patients with end-stage cancer: A retrospective study. Noise Health. 2024;26(121):82-7.

26. Ahmad M, Mohammad EB, Tayyem E, Al Gamal E, Atout M. Pain and anxiety in patients with breast cancer treated with morphine versus Tramal with virtual reality. Health Care Women Int. 2023;45(7):782-95.
27. Franklin DM, Silvestro C, Carrillo RA, Yang Y, Annadurai D, Ganesan S, et al. The impact of meditation aided by VR technology as an emerging therapeutic to ease cancer related anxiety, stress, and fatigue. Front Virtual Real. 2023;4:1195196.
28. Jung MS, Cha K, Kim M, Cui X. Beneficial effects of virtual reality-based nature exposure on cognitive performance in chemotherapy-treated breast cancer survivors experiencing cognitive difficulties. Oncol Nurs Forum. 2022;49(2):57-8.
29. Zeng Y, Zeng L, Cheng ASK, Wei X, Wang B, Jiang J, et al. The use of immersive virtual reality for cancer-related cognitive impairment assessment and rehabilitation: A clinical feasibility study. Asia Pac J Oncol Nurs. 2022;9(12):100079.
30. Kelleher SA, Fisher HM, Winger JG, Miller SN, Amaden GH, Somers TJ, 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. Palliat Support Care. 2022;20(4):471-81.
31. Chin S, Cavadino A, Akroyd A, Tennant G, Dobson R, Gautier A, et al. An investigation of virtual reality nature experiences in patients with metastatic breast cancer: Secondary analysis of a randomized controlled trial. JMIR Cancer. 2022;8(3):e38300.
32. Reynolds LM, Cavadino A, Chin S, Little Z, Akroyd A, Tennant G, et al. The benefits and acceptability of virtual reality interventions for women with metastatic breast cancer in their homes: A pilot randomised trial. BMC Cancer. 2022;22(1):360.
33. Buche H, Michel A, Piccoli C, Blanc N. Contemplating or acting? Which immersive modes should be favored in virtual reality during physiotherapy for breast cancer rehabilitation. Front Psychol. 2021;12:631186.
34. Moscato S, Sichi V, Giannelli A, Palumbo P, Ostan R, Varani S, et al. Virtual reality in home palliative care: Brief report on the effect on cancer-related symptomatology. Front Psychol. 2021;12:709154.
35. Mohammad EB, Ahmad M. Virtual reality as a distraction technique for pain and anxiety among patients with breast cancer: A randomized control trial. Palliat Support Care. 2018;17(1):29-34.
36. Ben-Ari E. Meeting Cancer Survivors' Psychosocial Health Needs: A Conversation with Dr. Patricia Ganz. Bethesda (US): National Cancer Institute; 2022 Jun 7. Available from: https://www.cancer.gov/news-events/cancer-currents-blog/2022/psychosocial-cancer-survivors-patricia-ganz. Accessed on 8 Jul 2024.

How to cite this article:
Kelvin Tan CK, Cho I. Effects of Virtual Reality and Music Therapy on the Psychosocial Outcomes of Adult Cancer Patients: A Systematic Review. Adv Geriatr Med Res. 2025;7(2):e250007. https://doi.org/10.20900/agmr20250007