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Scene designs and user experience of VR interventions to manage symptoms among cancer populations: a systematic review of qualitative studies

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Purpose: This study systematically reviewed how virtual reality (VR) interventions have been understood in symptom management from perspectives of both intervention designers and individuals with cancer, and we derived a model of VR interventions for cancer symptom management.
Methods: A systematic review of qualitative studies was conducted across five databases, including the Cochrane Library of Systematic reviews, PubMed, PsycInfo, ScienceDirect, and Scopus. Studies were identified and evaluated using the standard Joanna Briggs Institute Critical Appraisal Checklist for Qualitative Research.
Results: A total of 20 qualitative studies was included in this review. We found seven categories in terms of how VR interventions were designed: 1) immersion and presence as therapeutic support for distraction, 2) multi-sensory content for positive emotion restoration, 3) interactivity and embodiment for engagement and motivation, 4) personalization for resonance, 5) real-world versus computer-generated content, 6) integration with clinical workflow, and 7) purposes of using VR. Seven categories reflecting how VR was perceived by individuals with cancer were identified: 1) ease of use, 2) perceived usefulness for treatment support, 3) enjoyment, satisfaction, and hedonic quality, 4) symptom and functioning benefits, 5) innovativeness and openness to technology, 6) cybersickness and tolerability, and 7) accessibility and flexible use. Based on these categories from designers and participants' perspectives, three themes of distinct VR mechanisms in symptom management interventions were identified: 1) distraction, 2) self-efficacy improvement, and 3) emotion restoration.
Conclusion: Based on qualitative evidence of how cancer patients and researchers actually experience VR, we developed a conceptual framework to advance the understanding of the unique nature and implementation of VR interventions in cancer symptom management.

Systematic Review Registration: https://www.crd.york.ac.uk/PROSPERO/view/CRD42025642992, identifier CRD42025642992.

KEYWORDS

cancer survivors, intervention, qualitative studies, symptoms, systematic review, virtual reality

1 Introduction

Advancements in cancer treatments have significantly improved patient outcomes, leading to a dramatic increase in the 5-year survival rate for all types of cancer from 49% to 69% between 2013 and 2020 (Siegel et al., 2025). However, during and after treatments, the risk of experiencing symptoms is high, such as pain, fatigue, anxiety, dyspnea, sleeplessness, nausea, and vomiting (Tewes et al., 2021). Some symptoms can be managed with effective treatments, while other late effects may linger long after treatments are completed (Harris et al., 2022). Several systematic reviews and meta-analyses have demonstrated that virtual reality (VR) interventions show promise for symptom management in oncology (Burrai et al., 2023; Lu et al., 2024; Rutkowski et al., 2021; Yan et al., 2025; Zhang et al., 2022). Virtual reality enables lifelike simulated experiences while reducing exposure to real-world risks, offering unique possibilities for therapeutic intervention. At the same time, the medium-based format provides both opportunities and limits for VR intervention development (Bell et al., 2024; Harris et al., 2020; Personeni and Savescu, 2023; Slater, 2009; Slater et al., 2020). Therefore, understanding the nature of VR as a medium, including its strengths and weaknesses, is essential for advancing VR science in health and medical interventions. Our fundamental research interest is, throughout the process of VR intervention design, application, and usage in cancer patients, how designers and users understand the uniqueness of VR for cancer symptom management?

A recent systematic review and meta-analysis examined the different components of VR interventions used in current studies based on the unique medium-based VR features, with current standards in VR advancements, and tested how patients' characteristics, treatment context, and VR design features (immersion[1], scene type, interaction method, and intervention lengths) moderate the efficacy of interventions (Yan et al., 2025). This evidence showed that the VR format—how it is designed and delivered (e.g., content, scene type, level of immersion, length)—impacts its therapeutic effects. However, previous reviews draw almost exclusively on quantitative outcome trials and provide limited insight into how VR interventions have been understood for symptom management from both intervention developers' and users' (cancer patients) views.

One previous systematic review explored such qualitative evidence and summarized the general experiences and perceptions of patients receiving VR therapy in palliative care (Huang et al., 2024); however, qualitative evidence specific to cancer patients is still needed. Importantly, how the VR therapy has been understood in symptom management, in terms of its medium-based nature, is not clear. The content design, scenery styles, immersive types, and interaction methods constitute the medium-based properties of VR and warrant further exploration to advance the research of VR interventions in symptom management science. Because individual qualitative studies of VR in symptom management for cancer patients are diverse and fragmented across settings, we aim to propose a framework to illustrate the complexity of building and implementing a program of VR interventions for symptom management among individuals with cancer on treatment. Understanding the nature and implementation of VR is the primary driver of this review.

The research questions that guided our exploration include: 1) how VR has been designed in the interventions; 2) how cancer patients as users experience VR interventions, including a) which design features they perceive as helpful or harmful, and b) how VR fits into the realities of treatment; and based on these explorations, our fundamental inquiry is 3) how this evidence illuminates the distinct nature and form of VR intervention? To address these research interests, our study aims to: 1) systematically synthesize qualitative evidence on a) intervention developers' strategies on VR designs and b) cancer patients' experiences, and 2) potentially develop a logic model of VR for cancer symptom management based on the concepts and lines of argument and raise questions for future researchers.

2 Methods

This systematic review was registered in PROSPERO (CRD42025642992). The search strategies and inclusion criteria were reported in previously published work focusing on quantitative data (Yan et al., 2025); this review focuses on qualitative evidence. Five databases were searched, including the Cochrane Library of Systematic reviews, PubMed, PsycInfo, ScienceDirect, and Scopus. Initial search included qualitative studies from an open-ended date to March 2025 and an additional search was conducted till October 2025. Eligible studies were qualitative research, mixed-methods or feasibility studies including a qualitative component; conducted among adults with cancer on active cancer treatment; using VR interventions; and those evaluating symptoms as study outcomes. We reported the review in accordance with the Reporting the Synthesis of Qualitative Research (ENTREQ) statement guideline (Tong et al., 2012) and appraised study quality using the standard Joanna Briggs Institute Critical Appraisal Checklist for Qualitative Research (JBI-QARI) (Institute, 2017).

A qualitative evidence synthesis was conducted using an inductive approach to form a conceptual framework (Charmaz,

1 The term "immersion" is used inconsistently in VR research. It may refer either to a user's psychological absorption or to objective characteristics of the system itself (e.g., the completeness and fidelity of sensory and interactive capabilities) [70].

TABLE 1 Joanna Briggs Institute (JBI) Critical Appraisal of included studies.

Author, year	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
Oyama et al. (1999)	Y	Y	Y	Y	Y	U	U	Y	U	Y
Schneider et al. (2003)	Y	Y	Y	Y	Y	U	U	U	U	Y
Schneider et al. (2004)	Y	Y	Y	Y	Y	U	U	U	Y	Y
McGarvey et al. (2010)	Y	Y	Y	Y	Y	U	U	Y	Y	Y
Baños et al. (2013)	Y	Y	Y	Y	Y	U	U	U	Y	Y
Hoffman and Brintnall (2017)	Y	Y	Y	Y	Y	U	U	Y	Y	Y
Sichi et al. (2019)	Y	Y	Y	Y	Y	U	U	Y	U	Y
Garrett et al. (2020)	Y	Y	Y	Y	Y	U	U	Y	Y	Y
Johnson et al. (2020)	Y	Y	Y	Y	Y	U	U	Y	Y	Y
Dang et al. (2021)	Y	Y	Y	Y	Y	U	U	U	Y	Y
Janssen et al. (2022)	Y	Y	Y	Y	Y	U	U	Y	Y	Y
Kelleher et al. (2022)	Y	Y	Y	Y	Y	U	U	Y	Y	Y
O'Gara et al. (2022)	Y	Y	Y	Y	Y	U	U	U	Y	Y
Reynolds et al. (2022)	Y	Y	Y	Y	Y	U	U	U	Y	Y
Ryu and Price (2022)	Y	Y	Y	Y	Y	U	U	Y	Y	Y
Greenway et al. (2023)	Y	Y	Y	Y	Y	U	U	Y	Y	Y
Rolbiecki et al. (2023)	Y	Y	Y	Y	Y	U	U	Y	Y	Y
Gerlach et al. (2024)	Y	Y	Y	Y	Y	U	U	U	Y	Y
Kriegler et al. (2024)	Y	Y	Y	Y	Y	U	U	U	Y	Y
Sommer et al. (2024)	Y	Y	Y	Y	Y	U	U	U	Y	Y

The JBI, qualitative appraisal tool evaluates whether the study's qualitative design, data collection, analysis, interpretation, reflexivity, ethics, and conclusions are coherent and trustworthy. The 10 questions assess congruity between the methodology and the study's philosophical perspective, research question, data collection methods, data analysis, and interpretation of findings. They also evaluate whether the researcher's background and potential influence are addressed, whether participants are adequately represented, whether ethical considerations are reported, and whether the conclusions flow logically from the findings.
Abbreviations: U, unclear; Y, yes.

2006). First, we extracted and summarized key information on VR format-related design features and users' experiences from each study. Second, we compared these findings across studies to identify similarities and differences. Third, we translated concepts across studies by aligning similar ideas described using different terms. Finally, we used an inductive approach to generate overarching themes from the data. As we interpret the meanings and examine the impact, our goal is to move beyond the concepts and descriptive categories presented in the studies. We applied open, line-by-line coding, followed by constant comparison within and across studies. Through focused and axial coding, we identified concepts and developed higher-level categories that described contextual conditions, mechanisms, and proposed/perceived impacts. This process was used to generate an explanatory model of how, for whom, and under what conditions VR-based interventions address symptom management in cancer care, including the working mechanisms and behavioral process of using VR for symptom management. Throughout the synthesis, we used reflexive memos to document analytic decisions and consider how study quality and context shape our confidence in the resulting model.

Because our study interest is the nature of VR from both designer/researcher and consumer/participant perspectives, we drew data not only from the reported results but also from the introductions, methods, and discussions that researchers described in the publications. For VR customer experience, we extracted information based on user acceptance model (Sagnier et al., 2020). Two reviewers independently extracted data.

3 Results

A total of 20 qualitative studies were included in this review. The results for quality evaluation of included studies can be found in Table 1. The most common quality issues were the lack of disclosure of the researchers' cultural or theoretical backgrounds and their influence on the research, as addressed in Questions 6 and 7, though such information was often not reported.

3.1 Study characteristics

Detailed study characteristics can be found in Table 2. Sample sizes in these studies spanned N = 6 to N = 58 participants. The mean age of participants across studies ranged from 42.6 to 67.4 years. Four studies focused on breast cancer, one on lung cancer, one on

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TABLE 2 Study characteristics.

Author, year, country	Qualitative methods	Aims	Sample size	Age Mean (SD)	Cancer type	Treatment	Settings
Oyama et al., 1999, Japan	A written questionnaire and an interview	To report the effectiveness of a virtual forest walk system in supporting cancer patients	22	Range 33–75	Breast cancer, ovarian cancer	NI	Hospital
Schneider et al., 2003, United States	Open ended questionnaire	To elicit the evaluation of the intervention	16	57.7 (6.8)	Breast	Chemotherapy	Outpatient clinic
Schneider et al., 2004, United States	Open ended questionnaire	To explore the use of a VR intervention as a distraction to decrease symptom distress (to elicit the evaluation of the intervention)	20	42.6 (7.9)	Breast	Chemotherapy	Outpatient clinic
McGarvey et al., 2010, United States of America	Open ended question	To assess the acceptability and ease of use of HAAIR program and its effects in decreasing alopecia-related distress	45	51.3 (10.4)	Breast, ovarian, lung, blood, melanoma	Chemotherapy	Hospital
Baños et al. (2013)	Open ended questions	To evaluate the feasibility and benefits of VR intervention to increase positive emotions, and to examine patients' satisfaction and perceived utility	19	60.9 (14.5)	Breast, lung, stomach, rectum, bladder	NI	Hospital
Hoffman and Brintnall (2017)	Open ended questions	To explore the acceptability of an exercise program using VR to manage cancer related fatigue	37	67.4 (9.7)	Lung	Surgery	Home
Sichi et al., 2019, Italy	Semi-structured interviews; focus groups	To assess if VR improves patients' quality of life and which types of videos were more beneficial	58	50 (NI)	Cancer	NI	Home
Garrett et al. (2020)	Focus groups (in person + online), semi structured interview	To understand participants' experience of using VR-based intervention for chronic cancer pain	12	58.4 (6.7)	Abdominal, breast, bone, colon, kidney, lung, non-Hodgkin's lymphoma, throat	Treatment with standard care cancer therapies	Home

(*Continued*)

TABLE 2 Continued

Author, year, country	Qualitative methods	Aims	Sample size	Age Mean (SD)	Cancer type	Treatment	Settings
Johnson et al. (2020)	Focus group	To evaluate a VR video for patients with radiation therapy	7	Range 54–67	Gastrointestinal, genitourinary, gynaecologic	Radiotherapy	Radiation oncology review clinic
Dang et al. (2021)	A semi-structured interview	To assess the feasibility of an avatar-based intervention to facilitate life review in patients with advanced cancer	12	Range 24–65^{+}	Genitourinary, gastrointestinal, myeloma, breast. lung neuroendocrine, sarcoma	NI	supportive care clinic of a cancer center
Janssen et al. (2022)	Observation notes and semi-structured interviews	To explore the feasibility and acceptability of VR intervention for patients with chemotherapy	19	NI	NI	Chemotherapy	A large metropolitan healthcare organization
Kelleher et al. (2022)	Semi-structured qualitative exit interview	To understand patients' preferences, thoughts, and feelings of the VR intervention	20	56.6 (10.7)	NI	Chemotherapy	A cancer institute
O'Gara et al. (2022)	Interviews	To assess the feasibility and acceptability of a VR intervention for cancer patients on treatment	21	48.7 (16.9)	Lower gastrointestinal, haematological, gynaecological, head and neck, breast, genitourinary, other	NI	A specialist center
Reynolds et al. (2022)	Open-ended questions	To test the efficacy and acceptability of a VR intervention on quality of life, fatigue, pain, depression, and anxiety in patients with metastatic breast cancer at home	40	52.0 (11.4)	Breast	Chemotherapy only, hormone therapy only, hormone and target therapy, radiation and hormone therapy	Home
Ryu and Price (2022)	Semi-structured interviews	To evaluate the psychosocial benefits of an avatar life-review project	12	NI	NI	NI	A palliative care outpatient clinic
Greenway et al. (2023)	Focus groups, interviews	To assess the acceptability of a VR platform	6	NI	Head and neck	NI	Hospital

(*Continued*)

TABLE 2 Continued

Author, year, country	Qualitative methods	Aims	Sample size	Age Mean (SD)	Cancer type	Treatment	Settings
Rolbiecki et al. (2023)	Semi-structured interviews	To explore the feasibility and acceptability of a VR and neurofeedback intervention on cancer-related pain and anxiety	15	52.4 (11.8)	NI	Chemotherapy	An ambulatory infusion clinic
Gerlach et al. (2024)	Focus groups (patients and healthcare professionals) and interviews (patients)	To evaluate the feasibility and safety of an individualized VR intervention in palliative cancer inpatients	17	65.5 (13.0)	NI	NI	Hospital
Kriegler et al. (2024)	Questionnaire and additional questions	To evaluate the effects of an intrafraction mindfulness VR on radiation therapy experience and distress	52	64.3 (NI)	NI	Radiation therapy	A cancer institute
Sommer et al. (2024)	Open-ended questions	To evaluate the feasibility and utility of a VR intervention to expose patients scheduled for breast cancer surgery to the operating room environment and a simulation of anesthetic induction	7	56 (10.6)	Breast	Surgery	Hospital

If the mean and standard deviation were not reported in the publication, they were estimated using the provided median, range, sample size, and percentages. All values were rounded to one decimal place.
Abbreviations: SD, standard deviation; NI, no information; VR, virtual reality.

head and neck cancer, and the remaining studies included mixed cancer types. Six studies included patients undergoing chemotherapy, two involved radiotherapy, and two involved surgeries. In four studies, VR interventions were used at participants' homes, and the majority were in hospital or clinical settings. For qualitative methods, ten studies used open-ended written questions, eight used interviews, and five used focus groups, including three studies that combined interviews and focus groups.

A detailed characterization of the VR design features across included studies was described in Supplementary Table S1, including the immersion type, display format, sensory components, devices and software of VR interventions used for cancer symptom management. The reviewed interventions ranged from non-immersive screen- or wall-based systems to immersive head-mounted displays, including systems using wide-angle multi-screen displays, desktop interfaces, television-based programs, smartphone-based headsets, Oculus/Meta/Pico/Samsung Gear VR devices, and WebXR or game-engine platforms. Some studies described their sensory or interactive features, such as stereo sound, music, guided narration, nature sounds, scent, gentle breeze, motion capture, head tracking, whereas others provided limited information on these features.

3.2 Synthesis of the qualitative data

We found seven categories in terms of how VR interventions were designed (Table 3), and seven categories for how VR was perceived (Table 4). The extracted codes from each study can be found in Supplemental Materials (Supplementary Tables S1, S2).

3.2.1 How VR has been designed

Category 1: Immersion and presence as therapeutic support for distraction. Two concepts of design features were identified: immersion (Dang et al., 2021; Garrett et al., 2020; Gerlach et al.,

TABLE 3 How VR has been designed: categories of VR design.

Concepts	Definition	Codes	Behavioral pathway/ Usage pattern	Contributing study
Category 1 Immersion and Presence as means of distraction				
Immersiveness	How fully the virtual environment surrounds the user	Immersive HMD, realness	Distraction Higher immersion (HMD/360° video/stereoscopic display) is assumed to increase presence and attentional capture, which can • Reduce awareness of the treatment environment • Enhance distraction and emotional engagement	Schneider et al., 2003; Schneider et al., 2004; Sichi et al., 2019; Garrett et al., 2020; Johnson et al., 2020; Dang et al., 2021; Janssen et al., 2022; Kelleher et al., 2022; O'Gara et al., 2022; Reynolds et al., 2022; Rolbiecki et al., 2023; Gerlach et al., 2024; Kriegler et al., 2024; Sommer et al., 2024
Tracking/Haptic feedback	Technologies that track users' movements and/or provide touch-like sensations in sync with VR.	Sensor, motion capture system, tracking, hand controllers, haptic devices	Synchronizing body movement and tactile cues with the virtual world strengthens presence and embodiment, deepening distraction and engagement with the VR experience	Sichi et al., 2019; Dang et al., 2021; Ryu and Price, 2022
Category 2 Sensory richness for positive emotion restoration				
Nature based scenes	VR scenes depicting natural environments that are calm, aesthetically pleasing, and non-threatening	Real natural scenes (gardens, mountains, beaches, snowy day); Computer-generated calming graphics (underwater, sea, scenic landscapes)	Support restoration and relaxation by offering "soft fascination" and compatible sensory input that gently absorbs attention without overloading it	Oyama et al., 1999; Schneider et al., 2003; Schneider et al., 2004; Baños et al., 2013; Kelleher et al., 2022; O'Gara et al., 2022; Reynolds et al., 2022; Rolbiecki et al., 2023; Kriegler et al., 2024
Artistic exploration	VR experiences showing art galleries, exhibitions, or concerts	Art exhibition, concert	Provide engaging but non-threatening focal points that can uplift mood, support meaning-making, and divert attention away from symptoms and procedures	Sichi et al. (2019)
Comfort zones	VR scenes of everyday urban or domestic environments that feel familiar and lived-in	A town, home or living room environments, relatedness	Evoke familiarity, comfort, and a sense of "normal life," which may reduce loneliness and anxiety by connecting patients to everyday contexts	Hoffman and Brintnall, 2017; Gerlach et al., 2024
Clinical education	360° video recordings of actual clinical spaces and procedures	360° hospital/RT room/procedure walk-throughs	Reduce uncertainty and anticipatory anxiety by familiarizing patients with procedures	Johnson et al., 2020; Greenway et al., 2023; Sommer et al., 2024
Fantasy	Fully computer-generated fantasy or game-like worlds	computer-generated fantasy or game worlds (alien world, puzzles, mystery, etc.)	Attention restoration, stress recovery	Garrett et al., 2020; Janssen et al., 2022
Nature sounds	Ambient soundscapes derived from natural environments	Nature/environmental sounds (waves, birds, etc.)	Provide compatible sensory input that matches a calm affective target	Rolbiecki et al., 2023; Gerlach et al., 2024
Clinical sounds	Realistic audio from the clinical environment presented within VR.	machine sounds, RT room sounds, realistic treatment noise	Reduce uncertainty and anticipatory anxiety by familiarizing patients with procedures	Sommer et al. (2024)

(*Continued*)

TABLE 3 Continued

Concepts	Definition	Codes	Behavioral pathway/ Usage pattern	Contributing study
Relaxing music	Music selected or designed to promote calmness and emotional soothing	Relaxing/calming music	Support restoration and relaxation	Garrett et al., 2020; Reynolds et al., 2022; Kelleher et al., 2022; Rolbiecki et al., 2023; Gerlach et al., 2024
Category 3: Interactivity and agency for engagement and motivation				
Guided experience	VR content paired with structured narration or guidance	Structured narrative/voiceover (guided art observation, guided meditation, guided RT walk-through)	Provide active coping opportunities (e.g., breathing with guidance, choosing preferred place)	Baños et al., 2013; Johnson et al., 2020; O'Gara et al., 2022; Rolbiecki et al., 2023
Self-navigation	The patient can choose or move between different environments or viewpoints	Patient can choose environments or navigate among options	Increase engagement and sense of control	Oyama et al., 1999; Hoffman and Brintnall, 2017; Sichi et al., 2019; Garrett et al., 2020; Kelleher et al., 2022; Reynolds et al., 2022; Greenway et al., 2023; Gerlach et al., 2024; Kriegler et al., 2024; Sommer et al., 2024
Interactive gameplay	The patient actively interacts with VR tasks or games	Patient actively plays a game, solves puzzles, moves avatar, using controller or other setup device	Possibly enhance distraction and self-efficacy in managing anxiety and distress	Garrett et al., 2020; Janssen et al., 2022
Tracking-based embodiment	Mapping users' head/body/hand movements into the virtual body or viewpoint	Basic head tracking in HMDs and Gear VR; or motion capture with full-/partial-body setups	Strengthens embodiment ("being in" the scene) and agency, which can deepen engagement and potentially amplify the emotional and calming impact of VR.	Dang et al., 2021; Ryu and Price, 2022
Category 4: Personalization for resonance				
Patients' choice of environment	Patients can select preferred VR environments that match their tastes and needs	Patient can choose environment (beach, mountain, city, living room, etc.)	Increase relevance and emotional resonance	Oyama et al., 1999; Schneider et al., 2003; Schneider et al., 2004; Baños et al., 2013; Garrett et al., 2020; O'Gara et al., 2022; Reynolds et al., 2022; Rolbiecki et al., 2023; Gerlach et al., 2024; Kriegler et al., 2024
Patients' choice of audio/self	Patients can tailor audio characteristics or content to their preferences and identity	Choice of male/female voiceover or content type	Enhance acceptability, comfort, and perceived usefulness, which can lead to better symptom relief and adherence	Dang et al., 2021; Ryu and Price, 2022
Category 5: Real-world vs. computer-generated content				
Market-ready app	Off-the-shelf consumer VR wellness or game applications repurposed for clinical use	Generic wellness or game apps (Guided Meditation VR, commercial games, Wii Fit, Oculus store apps)	Provide readily available content for distraction, motivation, and training while reducing development cost and enabling rapid deployment	Schneider et al., 2003; Schneider et al., 2004; Sichi et al., 2019; Garrett et al., 2020; Janssen et al., 2022; Kelleher et al., 2022; Reynolds et al., 2022; Rolbiecki et al., 2023; Kriegler et al., 2024
Clinically-developed content	VR content created specifically for clinical and cancer-care contexts	Custom 360° videos or environments developed for cancer care (RT/chemo walk-throughs, observation tailored to hospital context)	Real clinical content may normalize and demystify treatment, reducing fear of the unknown	McGarvey et al., 2010; Johnson et al., 2020; Greenway et al., 2023; Sommer et al., 2024

(*Continued*)

TABLE 3 Continued

Concepts	Definition	Codes	Behavioral pathway/ Usage pattern	Contributing study
Real video captured	VR content based on real-world footage captured with 360° cameras	Real nature scenes, art installations	Real nature content may simulate "being there" in restorative environments	Gerlach et al. (2024)
Computer-generated environments	VR scenes built entirely with computer graphics rather than real footage	Animated landscapes, fantasy worlds, abstract calming environments	Allows flexible, safe exploration and tailored design elements; can deliver powerful distraction and tailored visual cues even when real locations are impractical to film	Baños et al., 2013; Dang et al., 2021; Kelleher et al., 2022; O'Gara et al., 2022; Ryu and Price, 2022; Greenway et al., 2023
Category 6: Integration with clinical workflow				
Integrated with treatment process	VR use is timed and located to align directly with medical procedures or treatment sessions	VR during RT session, during chemo infusion, or pre-op preparation	Make VR feasible at the bedside/ RT unit/chemo chair	Schneider et al., 2003; Schneider et al., 2004; McGarvey et al., 2010; Hoffman and Brintnall, 2017; Johnson et al., 2020; Janssen et al., 2022; Kelleher et al., 2022; Rolbiecki et al., 2023; Kriegler et al., 2024; Sommer et al., 2024
Physiological monitoring	Use of physiological or behavioral sensors connected to VR sessions	Vital signs system, EEG, motion captureetc.	Allow monitoring of stress/ engagement and potentially enable adaptive or safety-aware VR interventions tailored to patients' current state	Oyama et al., 1999; Dang et al., 2021; Ryu and Price, 2022; Rolbiecki et al., 2023
Category 7: Purposes of Using VR				
Emotional support and improved quality of life	VR is experienced as emotional support that boosts positive feelings and reduces negative emotions, helping patients feel better overall during cancer care	Feeling emotionally supported; more positive mood; less fear/ sadness; feeling "looked after"	Patients use VR as an emotional "buffer," turning to it during or around treatment sessions to lift mood, soothe distress, and feel cared for, which supports ongoing emotional adjustment and quality of life	Oyama et al., 1999; Baños et al., 2013; O'Gara et al., 2022; Reynolds et al., 2022; Rolbiecki et al., 2023; Gerlach et al., 2024; Kriegler et al., 2024
Symptom relief through distraction and presence	VR absorbs attention in an immersive world so patients notice pain, fatigue, and treatment-related distress less, and sometimes feel procedures are shorter and more tolerable	Distraction from anxiety, pain, or fatigue; time feels shorter; "being somewhere else"; blocking hospital stimuli	During treatments or peak symptom times, patients focus on the virtual environment instead of bodily sensations, reducing perceived symptom intensity and making procedures feel quicker and more manageable	Schneider et al., 2003; Schneider et al., 2004; Sichi et al., 2019; Garrett et al., 2020; Janssen et al., 2022; Rolbiecki et al., 2023; Gerlach et al., 2024
Self-efficacy and coping	VR helps patients feel more capable—of tolerating treatment, exercising despite symptoms, and managing pain—by giving them doable challenges and clear experiences of success	Self-efficacy; sense of control; feeling able to cope; building confidence; practicing skills; challenge and accomplishment	Patients engage with VR tasks or experiences that they can successfully complete, reinforcing mastery and control; over time, these successes generalize to greater confidence in handling treatment, symptoms, and daily challenges	Schneider et al., 2003; McGarvey et al., 2010; Hoffman and Brintnall, 2017; Kelleher et al., 2022

(*Continued*)

TABLE 3 Continued

Concepts	Definition	Codes	Behavioral pathway/ Usage pattern	Contributing study
Preparation, education, and understanding of treatment	VR is seen as a more understandable, realistic way to learn about complex treatments (chemo, radiotherapy, surgery), which helps reduce fear and increases preparedness	Seeing what will happen; demystifying treatment; clearer information; feeling prepared; less uncertainty	Patients use VR before or early in treatment to preview procedures and environments; this step-by-step exposure clarifies expectations, reduces uncertainty, and promotes calmer, more informed participation in care	Johnson et al., 2020; Greenway et al., 2023; Sommer et al., 2024
Life review, identity, and meaning-making	VR and avatars let patients replay and reshape important life moments in a playful, less threatening way, supporting meaning-making, identity work, and spiritual reflection	Revisiting life stages; telling life stories; using avatars; safe distance to explore difficult topics; spiritual growth	Patients revisit personal memories, roles, or life themes in VR, often narrating or reflecting on them; this guided exploration helps them process emotions, reaffirm identity, and construct meaning in the context of illness	Dang et al., 2021; Ryu and Price, 2022
Sanctuary from treatment	VR gives patients a temporary escape into comforting, often nature-based environments that provide calm, ease, and a break from medical surroundings and worries	Escaping the hospital; entering a "comfort zone"; safe space; reminiscence; good distraction from the monotony (of chemotherapy)	Patients dip into VR "getaways" during or between treatments to mentally leave the hospital setting, immerse themselves in calming landscapes, and use this temporary escape to reduce stress and restore emotional balance	Janssen et al., 2022; O'Gara et al., 2022; Rolbiecki et al., 2023; Gerlach et al., 2024
Accessible and flexible support platform	Patients and clinicians see VR platforms as a flexible way to access information, support, and peer interaction without needing frequent in-person visits	Easy access; less travel; support at home; online/shared environments; removal of traditional barriers to exercise	Patients access VR content from home or clinic on demand, using it for information, skills practice, or shared virtual spaces with clinicians/peers, extending support beyond the hospital and fitting around busy schedules	Hoffman and Brintnall, 2017; Greenway et al., 2023

Abbreviations: HMD, head mounted display; RT, radiation therapy; VR, virtual reality.

2024; Janssen et al., 2022; Johnson et al., 2020; Kelleher et al., 2022; Kriegler et al., 2024; O'Gara et al., 2022; Reynolds et al., 2022; Rolbiecki et al., 2023; Schneider et al., 2003; Schneider et al., 2004; Sichi et al., 2019; Sommer et al., 2024) and tracking/haptic feedback (Dang et al., 2021; Ryu and Price, 2022; Sichi et al., 2019). The concept of immersion found in these studies is more related to cognitive or psychological absorption (Dang et al., 2021; Garrett et al., 2020; Gerlach et al., 2024; Janssen et al., 2022; Johnson et al., 2020; Kelleher et al., 2022; Kriegler et al., 2024; O'Gara et al., 2022; Reynolds et al., 2022; Rolbiecki et al., 2023; Schneider et al., 2003; Schneider et al., 2004; Sichi et al., 2019; Sommer et al., 2024). In contrast, tracking and haptic feedback in these studies are technological features indicating different levels of immersive capability of their VR systems (Dang et al., 2021; Ryu and Price, 2022; Sichi et al., 2019). In the designs of studies, these two features helped foster presence, or the sense of being situated and engaged in the virtual environment, thereby diverting attention from the treatment environment and reducing perceived anxiety, pain, and distress.

Category 2: Multi-sensory content for positive emotion restoration. From a designer's perspective, researchers used VR's rich sensory input to support emotional restoration. We identified eight concepts that recurred across the included studies: 1) nature-based scenes (Baños et al., 2013; Kelleher et al., 2022; Kriegler et al., 2024; O'Gara et al., 2022; Oyama et al., 1999; Reynolds et al., 2022; Rolbiecki et al., 2023; Schneider et al., 2003; Schneider et al., 2004), 2) artistic exploration (Sichi et al., 2019), 3) comfort zones (Gerlach et al., 2024; Hoffman and Brintnall, 2017), 4) clinical education (Greenway et al., 2023; Johnson et al., 2020; Sommer et al., 2024), 5) fantasy (Garrett et al., 2020; Janssen et al., 2022), 6) nature sounds (Gerlach et al., 2024; Rolbiecki et al., 2023), 7) clinical sounds (Sommer et al., 2024), and 8) relaxing music (Garrett et al., 2020; Gerlach et al., 2024; Kelleher et al., 2022; Reynolds et al., 2022; Rolbiecki et al., 2023). In these studies, visually and acoustically rich but soothing VR content—ranging from nature scenes, art, and familiar "comfort zones" to clinical walk-throughs, fantasy worlds, and calming soundscapes—provided immersive but non-overstimulating experiences that reduced uncertainty, fostered relaxation, and restored positive emotion.

Category 3: Interactivity and embodiment for engagement and motivation. The third category was interactivity and embodiment for engagement and motivation, involving four concepts: 1) guided

TABLE 4 How VR has been perceived: categories of customer experience.

Categories	Definitions	Codes	Behavioral pathway/ Usage pattern	Contributing studies
Ease of use	How comfortable and straightforward the VR system and devices are for patients to operate	Easy/comfortable to use; headset comfortable; intuitive controls; some ergonomic/weight/heat issues; occasional technical problems	When setup is simple and physically tolerable, patients can use VR independently and repeatedly, keeping focus on the experience itself rather than the technology	Schneider et al., 2003; Schneider et al., 2004; McGarvey et al., 2010; Baños et al., 2013; Hoffman and Brintnall, 2017; Sichi et al., 2019; Johnson et al., 2020; Dang et al., 2021; Janssen et al., 2022; Kelleher et al., 2022; O'Gara et al., 2022; Reynolds et al., 2022; Greenway et al., 2023; Gerlach et al., 2024; Kriegler et al., 2024; Sommer et al., 2024
Perceived usefulness for treatment support	Beliefs that VR meaningfully improves treatment experiences	Helpful for reducing pain/anxiety; improved overall treatment experience; less symptom calls; "good distraction from chemo"; useful educational tool	Seeing VR as truly helpful encourages uptake, adherence, and integration into care (e.g., during chemo/RT/surgery prep) because patients feel it meaningfully supports treatment	Oyama et al., 1999; Schneider et al., 2003; Schneider et al., 2004; McGarvey et al., 2010; Baños et al., 2013; Hoffman and Brintnall, 2017; Sichi et al., 2019; Johnson et al., 2020; Dang et al., 2021; Janssen et al., 2022; Kelleher et al., 2022; O'Gara et al., 2022; Reynolds et al., 2022; Greenway et al., 2023; Rolbiecki et al., 2023; Kriegler et al., 2024; Sommer et al., 2024
Enjoyment, satisfaction, and hedonic quality	The enjoyable, pleasant, and satisfying aspects of VR use	Enjoyable; pleasant; fun; entertaining; "nice to enjoy nature and reminisce"; would like to use again; very/quite satisfied	Positive emotions and enjoyment make patients more willing to engage with VR longer and more often, reinforcing its calming and motivational effects	Oyama et al., 1999, Schneider et al., 2004; McGarvey et al., 2010; Baños et al., 2013; Hoffman and Brintnall, 2017; Sichi et al., 2019; Garrett et al., 2020; Dang et al., 2021; Janssen et al., 2022; Kelleher et al., 2022; O'Gara et al., 2022; Reynolds et al., 2022; Rolbiecki et al., 2023; Gerlach et al., 2024; Kriegler et al., 2024; Sommer et al., 2024
Symptom and functioning benefits (pragmatic quality)	Practical impact on anxiety, stress, pain, fatigue, depression, time perception, and functioning after VR	Decreased anxiety, stress, tension, depression, pain, fatigue; increased relaxation, positive mood, energy, functional independence; better memory; improved QOL	VR functions as an emotional and symptom-modulating tool: short-term relief during sessions and, in some studies, benefits persisting for hours to days after use	Oyama et al., 1999; Schneider et al., 2003; Schneider et al., 2004; McGarvey et al., 2010; Baños et al., 2013; Hoffman and Brintnall, 2017; Garrett et al., 2020; Johnson et al., 2020; Dang et al., 2021; Janssen et al., 2022; Kelleher et al., 2022; O'Gara et al., 2022; Reynolds et al., 2022; Rolbiecki et al., 2023; Kriegler et al., 2024; Sommer et al., 2024
Innovativeness and openness to technology	Perception of VR as a novel, forward-looking, and exciting technology for care	innovative; interesting; looking forward to future VR development; endorsed as a useful new anxiety tool	Perceiving VR as innovative and engaging can increase curiosity and willingness to use it	Sichi et al., 2019; O'Gara et al., 2022; Kriegler et al., 2024

(*Continued*)

TABLE 4 Continued

Categories	Definitions	Codes	Behavioral pathway/ Usage pattern	Contributing studies
Cybersickness and tolerability	Side effects or discomfort such as dizziness, nausea, eye strain, or feeling unwell while using VR	No unusual side effects for most; some dizziness, nausea, eye strain; headset weight/fit issues; preference for shorter videos	Low or manageable adverse effects maintain feasibility; identifying and managing these issues is key to safe, sustained use in routine care	Schneider et al., 2003; Schneider et al., 2004; Baños et al., 2013; Garrett et al., 2020; Janssen et al., 2022; Kelleher et al., 2022; O'Gara et al., 2022; Reynolds et al., 2022; Rolbiecki et al., 2023; Gerlach et al., 2024; Sommer et al., 2024
Accessibility and flexible use	How VR fits into patients' lives and clinical pathways	Convenient home-based exercise, patient-operated VR at home, acceptable at-home VR treatment, access resources from home, integrated with chemo/RT sessions, suitable during lengthy procedures	Flexible, home- or clinic-integrated VR lets patients use support when and where they need it, reducing travel burden and allowing ongoing symptom management outside traditional visits	Hoffman and Brintnall, 2017; Janssen et al., 2022; O'Gara et al., 2022; Reynolds et al., 2022; Greenway et al., 2023; Kriegler et al., 2024; Sommer et al., 2024

Abbreviations: QOL, quality of life; RT, radiation therapy; VR, virtual reality.

experience (Baños et al., 2013; Johnson et al., 2020; O'Gara et al., 2022; Rolbiecki et al., 2023), 2) self-navigation (Garrett et al., 2020; Gerlach et al., 2024; Greenway et al., 2023; Hoffman and Brintnall, 2017; Kelleher et al., 2022; Kriegler et al., 2024; Oyama et al., 1999; Reynolds et al., 2022; Sichi et al., 2019; Sommer et al., 2024), 3) interactive gameplay (Garrett et al., 2020; Janssen et al., 2022), and 4) tracking-based embodiment (Dang et al., 2021; Ryu and Price, 2022). These were used to keep patients actively engaged, increase their sense of control, and strengthen coping and self-efficacy.

Category 4: Personalization for resonance. The fourth category was personalization for resonance, including two concepts of patients' choice of environment (Baños et al., 2013; Garrett et al., 2020; Gerlach et al., 2024; Kriegler et al., 2024; O'Gara et al., 2022; Oyama et al., 1999; Reynolds et al., 2022; Rolbiecki et al., 2023; Schneider et al., 2003; Schneider et al., 2004) and their choice of audio (Dang et al., 2021; Ryu and Price, 2022). Designers provided different environments (beach, mountain, city, living room, etc.) and voiceover (male/female, or content type) to increase relevance and acceptability.

Category 5: Real-world versus computer-generated content. The fifth category was real-world versus computer-generated content, and four concepts were found: 1) market-ready app (Garrett et al., 2020; Janssen et al., 2022; Kelleher et al., 2022; Kriegler et al., 2024; Reynolds et al., 2022; Rolbiecki et al., 2023; Schneider et al., 2003; Schneider et al., 2004; Sichi et al., 2019), 2) clinically developed content (Greenway et al., 2023; Johnson et al., 2020; McGarvey et al., 2010; Sommer et al., 2024), 3) real video captured (Gerlach et al., 2024), 4) computer-generated environments (Baños et al., 2013; Dang et al., 2021; Greenway et al., 2023; Kelleher et al., 2022; O'Gara et al., 2022; Ryu and Price, 2022). Some designers created their own content using real video captured footage or computer-generated graphics to provide more realistic or optimized environments for enhancing recovery; some developed clinical and cancer care content (radiation therapy/chemo walk-throughs; observation tailored to hospital context) to demystify treatment and reduce fear of the unknown, while others used off-the-shelf applications.

Category 6: Integration with clinical workflow. The sixth category of design considerations was integration with clinical workflow, including two identified concepts: 1) integrated with the treatment process (Hoffman and Brintnall, 2017; Janssen et al., 2022; Johnson et al., 2020; Kelleher et al., 2022; Kriegler et al., 2024; McGarvey et al., 2010; Rolbiecki et al., 2023; Schneider et al., 2003; Schneider et al., 2004; Sommer et al., 2024), and 2) physiological monitoring (Dang et al., 2021; Oyama et al., 1999; Rolbiecki et al., 2023; Ryu and Price, 2022), which makes VR feasible for bedside use and enables monitoring for safety and research purposes.

Category 7: Purposes of using VR. The last category was the purposes that designers/researchers proposed for using VR interventions, including seven concepts: 1) emotional support and improved quality of life (Baños et al., 2013; Gerlach et al., 2024; Kriegler et al., 2024; O'Gara et al., 2022; Oyama et al., 1999; Reynolds et al., 2022; Rolbiecki et al., 2023; Ryu and Price, 2022), 2) symptom relief through distraction and presence (Garrett et al., 2020; Gerlach et al., 2024; Janssen et al., 2022; Rolbiecki et al., 2023; Schneider et al., 2003; Schneider et al., 2004; Sichi et al., 2019), 3) self-efficacy and coping (Hoffman and Brintnall, 2017; Kelleher et al., 2022; McGarvey et al., 2010; Schneider et al., 2003), 4) preparation, education, and understanding of treatment (Greenway et al., 2023; Johnson et al., 2020; Sommer et al., 2024), 5) life review, identity, and meaning-making (Dang et al., 2021; Ryu and Price, 2022), 6) sanctuary from treatment (Gerlach et al., 2024; Janssen et al., 2022; Oyama et al., 1999; Rolbiecki et al., 2023), and 7) accessible and flexible support platform (Greenway et al., 2023; Hoffman and Brintnall, 2017).

3.2.2 How VR was perceived by cancer patients

Seven categories emerged on how participants perceived VR.

Category 1: Ease of use. Participants reported that VR was generally easy and comfortable to use, with comfortable headsets and intuitive controls, although some participants noted ergonomic, weight, and heat-related discomfort, as well as occasional technical problems (Baños et al., 2013; Dang et al., 2021; Gerlach et al., 2024; Greenway et al., 2023; Hoffman and Brintnall, 2017; Janssen et al., 2022; Johnson et al., 2020; Kelleher et al., 2022; Kriegler et al., 2024; O'Gara et al., 2022; Reynolds et al., 2022; Schneider et al., 2003; Schneider et al., 2004; Sichi et al., 2019; Sommer et al., 2024).

Category 2: Perceived usefulness for treatment support. The second category is perceived usefulness for treatment support. Participants reported that VR was helpful for reducing pain/anxiety, improved overall treatment experience, served as a good distraction from chemo, and was a useful educational tool; nurses also observed fewer symptom-related calls among patients who used the VR intervention (Baños et al., 2013; Dang et al., 2021; Greenway et al., 2023; Hoffman and Brintnall, 2017; Janssen et al., 2022; Johnson et al., 2020; Kelleher et al., 2022; Kriegler et al., 2024; McGarvey et al., 2010; O'Gara et al., 2022; Oyama et al., 1999; Reynolds et al., 2022; Rolbiecki et al., 2023; Schneider et al., 2003; Schneider et al., 2004; Sichi et al., 2019; Sommer et al., 2024).

Category 3: Enjoyment, satisfaction, and hedonic quality. The third category is enjoyment, satisfaction, and hedonic quality. Virtual reality was perceived as enjoyable, pleasant, fun, entertaining, and "nice to enjoy nature and reminisce"; many expressed interest in using it again and reported being very/quite satisfied (Baños et al., 2013; Dang et al., 2021; Garrett et al., 2020; Gerlach et al., 2024; Hoffman and Brintnall, 2017; Janssen et al., 2022; Kelleher et al., 2022; Kriegler et al., 2024; McGarvey et al., 2010; O'Gara et al., 2022; Oyama et al., 1999; Reynolds et al., 2022; Rolbiecki et al., 2023; Schneider et al., 2004; Sichi et al., 2019; Sommer et al., 2024).

Category 4: Symptom and functioning benefits (pragmatic quality). The fourth category is symptom and functioning benefits. Participants reported decreased anxiety, stress, tension, depression, pain, fatigue; increased relaxation, positive mood, energy, functional independence; better memory; and improved quality of life (Baños et al., 2013; Dang et al., 2021; Garrett et al., 2020; Hoffman and Brintnall, 2017; Janssen et al., 2022; Johnson et al., 2020; Kelleher et al., 2022; Kriegler et al., 2024; McGarvey et al., 2010; O'Gara et al., 2022; Oyama et al., 1999; Reynolds et al., 2022; Rolbiecki et al., 2023; Schneider et al., 2003; Schneider et al., 2004; Sommer et al., 2024).

Category 5: Innovativeness and openness to technology. The fifth category is innovativeness and openness to technology. In some studies, participants described the VR interventions as innovative and interesting, showed interest in future developments, and viewed VR as a promising new tool for managing anxiety (Kriegler et al., 2024; O'Gara et al., 2022; Sichi et al., 2019).

Category 6: Cybersickness and tolerability. The sixth category is cybersickness and tolerability. There were no unusual side effects for most patients; however, some reported side effects such as dizziness, nausea, and eye strain, while others noted issues with headset weight and fit and preferred shorter videos (Baños et al., 2013; Garrett et al., 2020; Gerlach et al., 2024; Janssen et al., 2022; Kelleher et al., 2022; O'Gara et al., 2022; Reynolds et al., 2022; Rolbiecki et al., 2023; Schneider et al., 2003; Schneider et al., 2004; Sommer et al., 2024).

Category 7: Accessibility and flexible use. The seventh category is accessibility and flexible use. Virtual reality interventions were perceived as convenient for home-based use, with patients able to operate the system independently, access resources from home, and engage in treatment in an acceptable at-home format. Virtual reality was also reported to integrate well with chemotherapy and radiotherapy sessions and to be suitable during lengthy procedures (Greenway et al., 2023; Hoffman and Brintnall, 2017; Janssen et al., 2022; Kriegler et al., 2024; O'Gara et al., 2022; Reynolds et al., 2022; Sommer et al., 2024).

3.3 Mechanism of VR in symptom management interventions

Based on the identified categories from designers' and participants' perspectives, three themes of distinct VR mechanisms in symptom management interventions were identified.

Theme 1: Distraction. Distraction was designed and perceived as a working mechanism, through which VR shifted participants' attention, reduced awareness of anxiety, pain, fatigue, and distress, distorted perception of time, and fostered a sense of presence. The categories under this theme were: 1) immersion and presence, 2) multi-sensory content, and 3) symptom and functioning benefits. The typical concepts used in this theme were: 1) being somewhere else, 2) full immersion, 3) safe haven, and 4) altered sense of time (treatment feels shorter).

Theme 2: Self-efficacy improvement. Improved self-efficacy emerged as a mechanism across the studies, as participants reported that VR strengthened their sense of control in situations where they otherwise felt powerless, thereby supporting better coping. The categories include: 1) interactivity and 2) personalization. The concepts for this theme include: 1) self-efficacy, 2) in control, 3) guided companionship, 4) able to cope, and 5) interactivity.

Theme 3: Emotion restoration. Emotion restoration was found to be a therapeutic mechanism within the studies and showed effectiveness in promoting positive emotional states. The identified categories were: 1) enjoyment and 2) usefulness for treatment support. The concepts under this theme include: 1) meaningful places, 2) special memories, and 3) relatedness.

4 Discussion

Qualitative evidence on VR design and customer experience of VR interventions is limited, especially for VR interventions for symptom management among people with cancer. This systematic review uses an inductive approach to summarize such evidence from 20 studies and explore the unique nature of VR intervention for cancer symptom management. To our knowledge, this is the first study that summarizes the qualitative evidence to propose a conceptual model for VR's role in symptom management.

These VR interventions differ in immersion level, display format, content type, sensory features, and interactivity. The

differences in VR modality and design may help explain variation in presence, engagement, acceptability, tolerability, and symptom-management outcomes across studies. For example, immersive head-mounted displays with 360° scenes and head tracking may enhance presence, whereas non-immersive screen-based systems may be easier to tolerate for patients who are fatigued, nauseated, or physically frail. Personalized or interactive content may improve engagement and perceived relevance, while generic or passive content may be less compelling. These design differences may also influence mechanisms of symptom relief: nature-based relaxation environments may support calmness and emotional regulation, procedural simulations may reduce uncertainty, and interactive games may provide distraction from pain or distress. However, VR reporting was inconsistent across studies, and some key design features were missing or insufficiently described.

We found seven categories of VR design strategies used by researchers, and seven categories of customer experience of VR interventions. Across studies, design features such as high immersion and presence, rich sensory input (particularly nature scenes and soothing audio), and flexible interactivity and personalization were used together to create an environment for individuals to recover and regain their control. Within this VR environment, patients reported feeling temporarily "inside" an alternative world instead of the treatment environment, which redirected attention away from aversive cues, shortened the perceived duration of procedures, and reduced anxiety, pain, and distress.

Nature-based and comfort-oriented environments offered "soft fascination" and emotional ease, supporting restoration of depleted attentional and emotional resources. Unfortunately, visual/audio design features were usually not reported in these publications, thus we cannot analyze the design of nature-based scenes further. In the literature, evidence has shown that fundamental visual-audio properties systematically shape people's emotional responses. For example, the color (Jacobson et al., 2024; Jonauskaite et al., 2020), contour (curvature vs. angularity) (Chuquichambi et al., 2022; Vartanian et al., 2024), symmetry (Bertamini et al., 2020), complexity (Redies and Bartho, 2023; Sun and Firestone, 2022), and lighting/composition(Stefani et al., 2024; Xie et al., 2022) have long been known to influence affective responses. Systematically testing how filming design features, such as shot size, depth of field, tertiary motion, lighting/exposure/contrast, and soundscape, influence perceptions and symptoms experience will move the field from "VR works/doesn't work" to which designs work best, for whom, and in what context.

From the participants' view, most reported that VR was easy to use and served as a useful form of treatment support. However, some also noted technical difficulties and a need for additional technological assistance. While certain concerns may reflect the use of earlier-generation VR hardware, others—such as heat generation and headset weight—remain limitations of current devices and highlight the need for continued technological refinement and closer attention to VR-specific adverse (Yan and Loerzel, 2025). Importantly, participants also expressed varying levels of engagement and differing opinions about the same intervention content. Our findings indicate that VR experiences provided immediate symptom relief and supported broader psychological recovery/enhancement. Guided experiences and tangible interactions helped patients rehearse coping strategies, feel more capable of tolerating treatment, and make sense of their illness through life review and meaning making. Virtual reality clinical walk-throughs reduced uncertainty and anticipatory anxiety by demystifying complex treatments, while at-home and web-based platforms increased accessibility between visits.

Based on these findings, three themes of VR mechanisms were derived. Distraction was mostly established as a mechanism and has been widely used in VR interventions to manage symptoms among cancer populations (Buche et al., 2023; Chirico et al., 2020; Fabi et al., 2022; Groninger et al., 2024; Ioannou et al., 2022; Menekli et al., 2022; Mohammad and Ahmad, 2019; Santana et al., 2023; Schrempf et al., 2022; Stansel et al., 2025; Uslu and Arslan, 2023). However, it is also important to note that this framework does not adequately account for effects that persist beyond VR use (Chuan et al., 2023; Li et al., 2024). Our synthesis suggests that VR-based interventions during active cancer treatment work through the "self-efficacy enhancing engagement" and "emotion restoration" pathway rather than through distraction alone. Self-efficacy is increasingly used as a key mechanism in VR therapy, supported by processes including enhancing motivation, skill mastery, immediate feedback, goal setting and achievement, engagement, sense of control over virtual environment, and repeated successful experiences (Basha et al., 2022; Feyzioğlu et al., 2020; Hoffman and Brintnall, 2017; Hoffman et al., 2017; Kelleher et al., 2022; McGarvey et al., 2010; Schneider et al., 2003), which map onto Bandura's four sources of self-efficacy (mastery, modeling, persuasion, physiological/affective states) (Bandura, 1997). Within the "real" but safe environments in VR, individuals may manage symptoms via improved self-efficacy, which warrants further investigation in future studies.

4.1 Nature of VR: a logic model

Sherman and Craig describe virtual reality as an interactive computer-generated simulation that tracks a participant's actions and provides multisensory feedback, e.g., computer-generated imagery shown in a head-mounted display, to create a sense of immersion or presence [78]. In this study, we explore VR as a medium for the treatment of symptoms within virtual environments. Our findings showed that the media features directly shape the effectiveness of interventions on patients' symptom experiences, such that the format of VR is as important as the content. In fact, VR has been defined using concepts from different disciplines of computer science, film art, and cognitive psychology. Some VR theorists have sought to define the unique conceptual domain of virtual reality by explaining the experience of *presence*—the perception of "being there" (Schubert, 2009) in a mediated environment—through two core constructs: **place illusion**, the sensation of being physically located within the virtual space, and **plausibility illusion**, the sense that events occurring in that space are genuinely happening to the user (Slater, 2009; Slater et al., 2022). These experiential qualities of "presence" are supported by *immersion*, defined as the sensory and interactive capabilities of the system, and coherence, defined as the internal consistency and reasonableness of the virtual environment (Skarbez et al., 2021; Skarbez et al., 2017). Presence is a distinctive concept because it captures the subjective, first-person quality of VR experience, which cannot be fully reduced to objective system properties, such as immersion or coherence (Murphy and Skarbez, 2020; Skarbez et al.,

2021; Slater and Wilbur, 1997). The concept of presence has aroused discussions and is considered one of the central properties of a VR experience (Murphy and Skarbez, 2020; Skarbez et al., 2017; Slater, 2003). Some researchers also argued that presence alone may not be the central explanatory concept for understanding VR experiences and their effects and proposed that *congruence* and *plausibility*—the degree to which elements of the virtual environment logically fit together and align with user expectations—may be more fundamental conditions for meaningful VR experiences (Latoschik and Wienrich, 2022). Other research emphasizes that plausibility, coherence, and congruence can independently influence how believable and effective a virtual experience feels (Hofer et al., 2020; Mal et al., 2023). The concepts of *copresence* (Skarbez et al., 2017), *illusion of ownership* (Slater et al., 2022), among others, further expanded our understanding beyond the fundamental quale of VR's unique experience.

In therapeutic contexts, this broader understanding helps explain why VR can be fundamentally different from earlier media for symptom management in cancer patients. A film may evoke emotion, a meditation app may guide relaxation, and social platforms may promote connection, but VR places the user in a separate experiential world (Slater et al., 2022) integrating these elements into a single, interactive experience (Bell et al., 2024; Slater, 2009). At the technical and design level, two foundational conditions are involved: immersion and coherence. The concept of immersion here refers to the system's ability to engage patients' senses—through head-mounted displays, spatial audio, and interactive tracking—so that their attention shifts away from the clinical setting and treatment-related discomfort toward the virtual experience (Cummings and Bailenson, 2016; Slater and Wilbur, 1997). Coherence refers to the consistency/clarity of the virtual scenario, meaning that the environment, events, and interactions behave in ways that are understandable and aligned with the expectations set for the patient (Latoschik and Wienrich, 2022; Skarbez et al., 2021). When immersion and coherence are effective, users may experience place illusion and plausibility illusion (Slater, 2009; Slater et al., 2022), and feel more deeply engaged with the virtual situation, which can activate therapeutic mechanisms. As a result, VR can support symptom management not merely by presenting content but by allowing individuals to experience coping strategies and emotional regulation within a believable simulated context. This may enhance engagement and therapeutic effects compared with traditional media. In summary, VR differs from earlier media and art forms in that it is not only something a person observes, but something the person can enter and experience as an enacted situation.

The three identified mechanisms (distraction, self-efficacy improvement, and emotion restoration) are enabled by these VR properties in the context of cancer symptom management. Distraction occurs when immersive engagement redirects attention away from unpleasant sensations or worries, reducing perceived pain or distress (Dang et al., 2021; Garrett et al., 2020; Gerlach et al., 2024; Janssen et al., 2022; Johnson et al., 2020; Kelleher et al., 2022; Kriegler et al., 2024; O'Gara et al., 2022; Reynolds et al., 2022; Rolbiecki et al., 2023; Ryu and Price, 2022; Schneider et al., 2003; Schneider et al., 2004; Sichi et al., 2019; Sommer et al., 2024). Motivation and self-efficacy may increase when patients successfully interact with the environment—for example, practicing breathing exercises, completing calming tasks, or receiving encouragement from a virtual companion—thereby strengthening confidence in coping with symptoms (Dang et al., 2021; Garrett et al., 2020; Gerlach et al., 2024; Greenway et al., 2023; Hoffman and Brintnall, 2017; Janssen et al., 2022; Kelleher et al., 2022; Kriegler et al., 2024; Oyama et al., 1999; Reynolds et al., 2022; Ryu and Price, 2022; Sichi et al., 2019; Sommer et al., 2024). Emotion restoration can be supported by calming or meaningful environments, such as nature scenes (Baños et al., 2013; Kelleher et al., 2022; Kriegler et al., 2024; O'Gara et al., 2022; Oyama et al., 1999; Reynolds et al., 2022; Rolbiecki et al., 2023; Schneider et al., 2003; Schneider et al., 2004), that promote relaxation and positive affects. Distraction in VR is typically driven by immersion, embodiment, and sensory richness, whereas self-efficacy is more often fostered through interactivity and a sense of control. Emotion restoration draws on both sets of processes. The three mechanisms are not mutually exclusive; instead, they are interconnected. In fact, distraction alone is unlikely to yield sustained benefits; restorative effects depend on engagement that supports cognitive and emotional recovery, rather than mere attentional diversion (Kaplan and Kaplan, 1989). Together, these mechanisms explain how VR can reduce psychological/cognitive symptoms (Baños et al., 2013; Dang et al., 2021; Garrett et al., 2020; Hoffman and Brintnall, 2017; Janssen et al., 2022; Johnson et al., 2020; Kelleher et al., 2022; Kriegler et al., 2024; McGarvey et al., 2010; O'Gara et al., 2022; Oyama et al., 1999; Reynolds et al., 2022; Rolbiecki et al., 2023; Schneider et al., 2003; Schneider et al., 2004; Sommer et al., 2024), strengthen coping (Hoffman and Brintnall, 2017; Kelleher et al., 2022; McGarvey et al., 2010; Schneider et al., 2003), and improve quality of life (Dang et al., 2021; Reynolds et al., 2022; Ryu and Price, 2022; Schneider et al., 2004) for patients undergoing active treatment.

Due to its unique nature, VR can engage multiple senses in an integrated way, creating a more lifelike experience that requires little effort or practice for users to accept the presented scenes. The plausible, immersive, and intuitive nature of VR may make it an especially effective medium through which these mechanisms operate. This can be explained by the Attention Restoration theory (Kaplan and Kaplan, 1989; Kaplan, 1995), that soft fascination supports reflection and imagination while allowing attention to be engaged effortlessly. It is also important for therapeutic VR experiences to provide patients with "some form of symbolic value" (Huang et al., 2024), such as meaning, familiarity, or personal relevance. For VR designs, it is suggested that designers create a world with balanced realism yet leave "blank space" for viewers' imagination (Atherton and Wang, 2020; Lundstedt et al., 2023). The room for personal interpretation and meaning-making may be important to VR's therapeutic potential.

Virtual reality is not just a delivery channel for content; the specific design features can systematically shape how patients attend, feel, think, and cope during VR treatment. Thus, VR can be regarded as an independent platform with its unique opportunities within its format. Our logic model (Figure 1) explains how cancer patients with diverse clinical and personal characteristics engage with VR interventions incorporating different design features, and how these features activate specific mechanisms of action that lead to short-term and long-term outcomes. It demonstrates the pathways through which VR influences anxiety and other symptom burdens, coping, and quality of life.

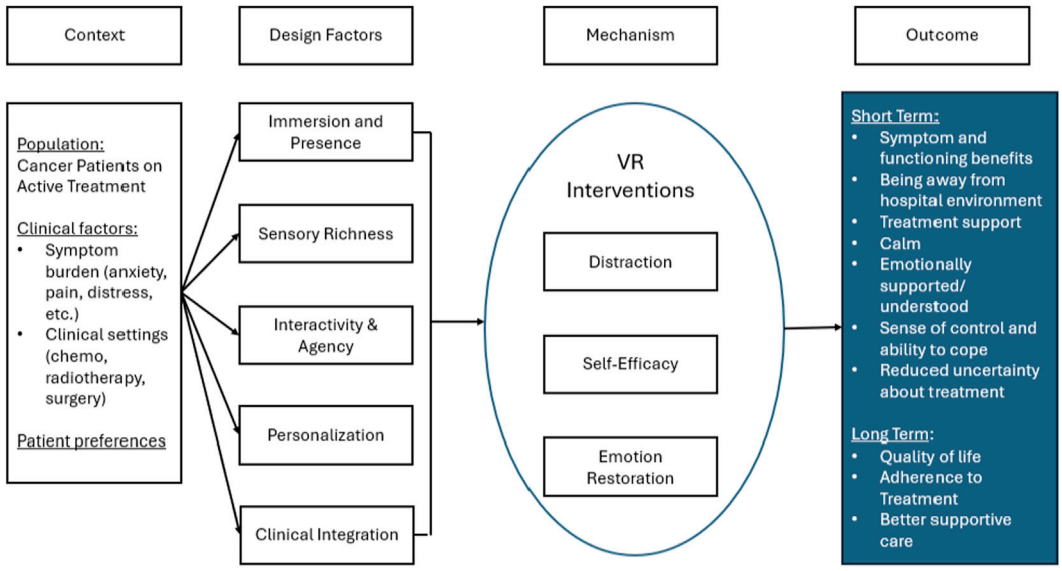

FIGURE 1
Logic model of VR framework.

5 Limitations

Our synthesis was limited by both the diversity of VR formats used across studies and the inconsistent reporting of key design features. The included studies ranged from non-immersive computer- or television-based programs to immersive head-mounted displays and wall-display systems, making direct comparisons across studies difficult. Although this heterogeneity provides useful insight into the breadth of VR applications in cancer care, it also limits direct comparisons across studies and constrains conclusions about the relative effectiveness, feasibility, and tolerability of specific VR modalities. In addition, visual and auditory design features, interaction mechanics, user control, sensory inputs, and implementation details were often sparsely or inconsistently reported. Future studies should provide more comprehensive reporting of VR design features, including immersion level, field of view, interactivity, sensory inputs, content source, user control, and hardware/software specifications. Such reporting would advance our understanding of which VR characteristics are most appropriate for specific symptoms, populations, and clinical contexts.

6 Conclusion

This systematic review brings together qualitative evidence on how researchers and cancer patients design and experience VR, and what features of VR matter for symptom management. Methodologically, we used an inductive approach to synthesize current qualitative evidence and to develop a model of how VR functions as a medium for symptom management in cancer care. This review intends to shift the conversation from asking whether "VR works" to understanding how, for whom, and under what design and clinical conditions VR can be better implemented to support cancer symptom management. Across diverse cancers, treatments, and devices, participants consistently described VR not only as a novel distraction, but as a self-efficacy-enhancing tool and a medium that supports coping, restores attention, and helps make treatment more understandable and tolerable. From this, we developed a conceptual framework, showing key design elements (immersion and presence, sensory richness, interactivity and embodiment, personalization and choice, and integration into clinical workflows), and interconnected mechanisms of distraction, self-efficacy, and emotional restoration in cancer symptom management. Also, this review highlights that VR is not uniformly beneficial: experiences varied; some participants reported discomfort, worry, or disengagement. These findings may suggest that personalized designing, validating video pools with cancer patients, and offering meaningful choices may be some practical strategies to maximize acceptability and effectiveness. Most importantly, how VR is designed and used—especially the choice of nature-based scenes, audio design, level of interactivity, and timing in the treatment pathway—is as important as its content.

Data availability statement

The original contributions presented in the study are included in the article/Supplementary Material, further inquiries can be directed to the corresponding author.

Author contributions

KY: Conceptualization, Data curation, Formal Analysis, Funding acquisition, Investigation, Methodology, Project administration, Writing – original draft, Writing – review and editing. GW: Methodology, Resources, Supervision, Validation, Writing – original draft, Writing – review and editing. LM: Formal Analysis, Investigation, Resources, Validation, Writing – original draft, Writing – review and editing. UM:

Investigation, Methodology, Resources, Supervision, Validation, Writing – original draft, Writing – review and editing. UO: Investigation, Methodology, Resources, Supervision, Validation, Writing – original draft, Writing – review and editing. AB: Funding acquisition, Resources, Validation, Writing – original draft, Writing – review and editing. DA: Writing – original draft, Writing – review and editing. VL: Supervision, Validation, Writing – original draft, Writing – review and editing.

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Conflict of interest

The author(s) declared that this work was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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