

Virtual Reality Technology in Psychological Interventions for Adolescent Cancer Patients: A Scoping Review

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Abstract: This scoping review was conducted to systematically synthesize the research progress on virtual reality technology in psychological interventions for adolescent cancer patients, clarify the content, types, outcome indicators and effects of such interventions, and provide a reference for improving the psychological well-being of this patient population. Relevant studies were systematically searched from PubMed, Embase, Web of Science, the Cochrane Library, China National Knowledge Infrastructure (CNKI) and Wanfang Database, with the search period ranging from the inception of each database to January 17, 2026, and the included literature was analyzed and summarized. A total of 10 studies were finally included, which revealed that the applied virtual reality technologies covered non-immersive and immersive types, virtual reality relaxation therapy served as the primary intervention content, and the main outcome indicators involved anxiety, depression, fear, pain and tension. The results indicate that psychological interventions based on virtual reality technology for adolescent cancer patients feature diverse contents and broad application prospects, and can effectively improve the psychological health status of these patients; however, there is considerable heterogeneity in the intervention content elements and outcome measurement tools across existing studies, and there are certain limitations in their practical application. Future research should fully consider the unique characteristics of adolescent cancer patients and explore standardized implementation procedures for the application of virtual reality technology in their psychological interventions.

Between 2018 and 2020, the overall average incidence rate of cancer in children and adolescents in China was 126.48 per million, with an incidence rate of 137.64 per million among adolescents ^[1]. As a distinct patient group, adolescent cancer patients not only endure the burden of the disease itself during diagnosis and treatment but also face multiple pressures, including academic disruption and restricted social interactions. Existing studies have shown that compared to the general population, adolescent cancer patients have a 29% higher incidence of anxiety and a 57% higher incidence of depression. Many experience significant psychological distress during treatment, which further impacts their quality of life and treatment adherence ^[2]. Virtual reality (VR) is a computer technology that integrates multisensory simulation, capable of creating highly realistic three-dimensional environments that provide users with a strong sense of immersion ^[3]. In recent years, VR technology has been increasingly applied in adolescent healthcare. Related research

indicates that intervention methods such as VR relaxation therapy and exposure therapy demonstrate promising potential in reducing pain and alleviating anxiety in adolescents [4, 5]. However, current psychological nursing practices for adolescent cancer patients still primarily focus on emotional assessment and pharmacological interventions. Researchers like Bradford et al. found that regular psychological assessments help reduce the risk of anxiety recurrence. Still, sufficient evidence is lacking regarding VR's specific role in long-term emotion management and its standardized application pathways [6]. Therefore, exploring effective psychological interventions tailored to adolescents' developmental characteristics is crucial. With the ongoing development of digital health technologies, particularly the emergence of immersive, interactive VR, new avenues for addressing the psychological care needs of these patients have emerged. Nevertheless, current research in this area lacks systematic integration across intervention model design, assessment tool selection, and validation of intervention effects, leaving the overall research system incomplete. Based on this, following the scoping review methodological framework proposed by Tricco et al., this paper systematically synthesizes the current application status, implementation effects, and existing problems of VR technology in psychological interventions for adolescent cancer patients, aiming to provide a scientific basis for developing digital psychological intervention programs that meet the needs of adolescents and promote their psychological well-being.

1. Methods

1.1. Research Objective

This study aims to address the following two questions:

- (1) To identify the application scenarios and main characteristics of virtual reality (VR) technology in adolescent cancer patients;
- (2) To summarize the types of VR interventions, intervention content, implementation effects, and evaluation indicators.

1.2. Literature Inclusion and Exclusion Criteria

Inclusion Criteria:

- (1) Study participants were adolescent cancer patients aged ≤ 18 years;
- (2) Interventions involved virtual reality technology;
- (3) Study types were original studies, including randomized controlled trials and quasi-experimental studies.

Exclusion Criteria:

- (1) Study content unrelated to VR technology or not involving psychological interventions for adolescent cancer patients;
- (2) Literature not written in Chinese or English;
- (3) Duplicate publications;
- (4) Full text unavailable.

1.3. Literature Search Strategy

A systematic search was conducted across PubMed, Embase, Web of Science, the Cochrane Library, CNKI, and the Wanfang Database. The search period spanned from the inception of each database to January 17, 2026. A combination of MeSH terms and free-text words was used, and the reference lists of included studies were also searched. Using PubMed as an example of an English database, the search strategy is shown in Figure 1. Taking CNKI as an example for Chinese

databases, the search formula was:

(SU = "Digital Health Technology" + "Artificial Intelligence" + "Wearable Devices" + "Internet" + "Electronic Health Records" + "Virtual Reality Technology" + "Information Technology" + "Big Data" + "Digital Intelligence Technology") AND (SU = "Cancer" + "Tumor") AND (SU = "Psychology" + "Anxiety" + "Depression" + "Sleep Disorder" + "Mental Disorder") AND (SU = "Adolescent").

1.4. Literature Screening and Data Extraction

1.4.1. Literature Screening

Initially retrieved literature was imported into EndNote software, and duplicates were removed. Subsequently, two researchers independently screened titles and abstracts based on the pre-established inclusion and exclusion criteria, followed by full-text review for final inclusion. Disagreements during screening were resolved through discussion with a third researcher.

1.4.2. Literature Data Extraction

Two researchers, both trained in systematic, evidence-based nursing, independently extracted data from the included studies. Discrepancies or queries during extraction were discussed and resolved with a third researcher. Extracted information included authors, country, publication year, study participants, study design, sample size and grouping, intervention frequency, intervention measures, duration per intervention session, and outcome indicators.

2. Results

2.1. Literature Search Results and Basic Characteristics of Included Studies

A total of 392 relevant studies were retrieved. After a stepwise screening process, 10 studies were ultimately included. The detailed literature screening process is shown in Figure 2. The included studies were predominantly randomized controlled trials. Participants were adolescent cancer patients with various disease types, including leukemia, central nervous system tumors, and lymphoma. The basic characteristics of the included studies are presented in Table 1.

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neoplasms[MeSH] OR "cancer survivors"[MeSH] OR "cancer pain"[MeSH] OR  
cancer*[Title/Abstract] OR Tumor*[Title/Abstract] OR Neoplasia*[Title/Abstract]  
AND  
"mental health"[Title/Abstract] OR "mental health"[MeSH] OR "mental health  
recovery"[MeSH] OR "psychiatric nursing"[MeSH] OR "psychiatric rehabilitation"[MeSH] OR  
psychology[MeSH]  
AND  
"Digital Health"[Mesh] OR "Internet"[Mesh] OR "Internet Use"[Mesh] OR "Cell Phone"[Mesh]  
OR "Cell Phone Use"[Mesh] OR "Artificial Intelligence"[Mesh] OR "Generative Artificial  
Intelligence"[Mesh]  
AND  
"Child"[Mesh] OR "Pediatrics"[Mesh] OR "Adolescent"[Mesh] OR "childhood"[Title/Abstract]
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Figure 1 PubMed Search Strategy

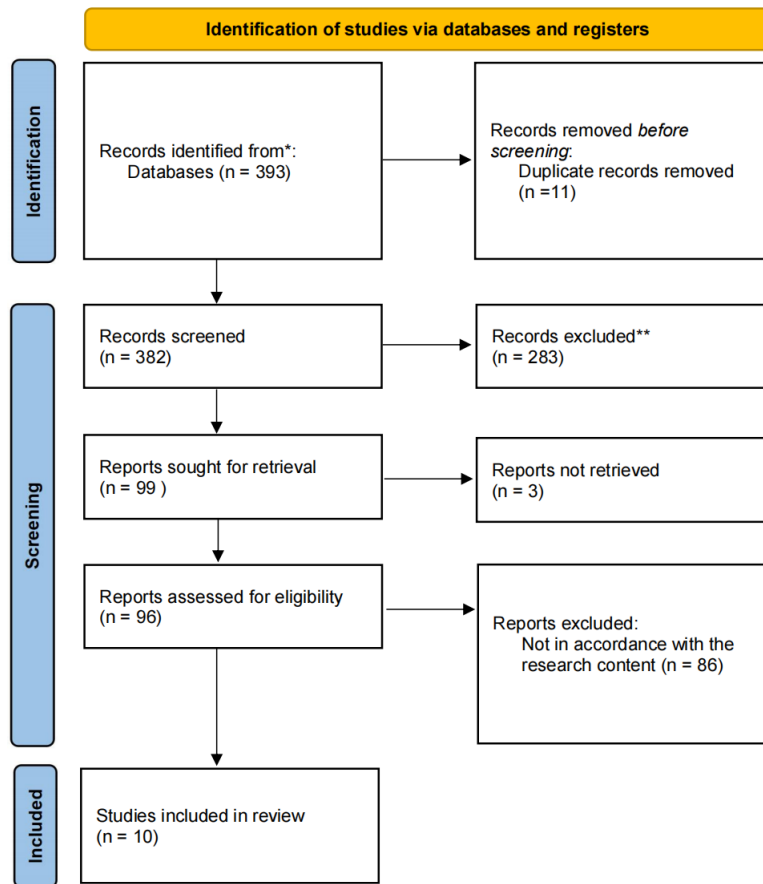


Figure 2 Literature Screening Flowchart

2.2. Types and Content of Virtual Reality Technology in Psychological Interventions for Adolescent Cancer Patients

In this study, all included literature employed virtual reality relaxation therapy. The participants were adolescent cancer patients. VR relaxation therapy was primarily applied during procedures such as needle insertion [7, 8], chemotherapy [9, 10], percutaneous interventional procedures [5], and the perioperative period [10]. Interventions were typically administered by physicians, nurses, researchers, and psychological counselors. Most interventions took place in hospital wards and outpatient clinics. The majority used immersive virtual reality technology, with sessions occurring 1 to 3 times daily, lasting 5 to 20 minutes each. The intervention mainly included animated cartoons combined with experiential themes such as "swimming underwater with marine animals," "riding a roller coaster," and "yoga meditation," often integrating interactive role-playing modes to enhance VR game relaxation [8, 9, 11].

Table 1: Basic characteristics of included studies (n=10)

Studies included	Country	Year	Sample size (intervention group/control group)	Intervention	Control	Outcome
Hoag et al. [11]	USA	2022	50 (25/25)	VR game	Standard care	1, 3, 4
Wonget al. [5]	China	2021	108 (54/54)	VR video	Standard care	1, 4

Wonget al. ^[7]	China	2024	128 (64/64)	VR video	Standard care	1
Ger çeker et al. ^[9]	Turkey	2021	42 (21/21)	Standard care and VR game	Standard care	1, 4, 5
Ger çeker et al. ^[8]	Turkey	2024	41 (21/20)	Standard care and VR game	Standard care	1
Gershonet al. ^[10]	USA	2004	59 (37/22)	VR game	Standard care	1, 4
Reitze et al. ^[12]	Germany	2024	38 (17/21)	VR game	Standard care	1, 4
Thybo et al. ^[13]	Denmark	2022	106	Standard care and VR game	Standard care	4
Savaş et al. ^[14]	Turkey	2024	62 (31/31)	VR game	Standard care	1, 4, 5

Note: 1=Anxiety, 2=Depression, 3=Tension, 4=Pain, 5=Fear

2.3. Outcome Indicators and Effects

Outcome indicators in the included studies primarily involved pain, anxiety, fear, tension, and depression. Six studies ^[5, 9-13] measured pain symptoms in adolescent cancer patients; eight studies ^[5, 7-13] measured anxiety symptoms; two studies ^[9, 13] measured fear; one study ^[11] mentioned measuring tension. Results from eight studies ^[5, 7-12, 14] indicated that VR technology reduced anxiety levels in adolescent cancer patients. Results from six studies ^[5, 9-13] showed a significant decrease in pain levels among adolescent cancer patients following VR psychological interventions. One study ^[11] indicated VR was effective in alleviating tension. No significant adverse reactions were reported in the included studies.

3. Discussion

3.1. Application of Virtual Reality Technology Effectively Reduces Psychological Fear in Pediatric Patients

Interventions tailored to different age groups of adolescents are developed based on their cognitive development characteristics and emotional regulation needs. The intervention design for experimental groups primarily focused on two types of VR technology applications. First, playing VR videos suitable for the age group. Leveraging VR's visual immersion, attention is diverted from negative stimuli, thereby alleviating fear. Second, constructing realistic virtual environments, such as underwater scenes or yoga meditation settings, for relaxation. These scenarios are combined with appropriate interactive games or guided meditation activities. Through multisensory experiences that combine visual perception and behavioral participation, directed attention and cognitive appraisal are restructured, helping pediatric patients shift from passive acceptance to active engagement in a state of flow, thereby reducing pain perception and fear intensity. Flow refers to the holistic sensation people feel when completely absorbed in an activity ^[15]. Current research has demonstrated its effectiveness in interactive educational games ^[16, 17]. Zhang Yunping et al. ^[18] noted that nursing educational games based on flow theory help nursing students concentrate, better master relevant nursing knowledge, and experience flow.

In the future, different types of VR intervention methods could be used for different pediatric patients to meet age-specific needs ^[19]. Our search results show that the application of flow theory in VR interventions is currently limited. It is recommended to research the use of digital and intelligent devices in health education to promote the psychological well-being of adolescent cancer patients.

3.2. Virtual Reality Technology is Widely Applicable, but Cultural Differences Must Be Considered

This study found that adolescents generally accept psychological interventions based on digital health technologies both domestically and internationally. However, cultural differences must be emphasized during the application. Some studies suggest that the effectiveness of VR interventions heavily depends on the specific cultural background^[2]. Therefore, future research should focus on cultural adaptability. This involves comprehensively evaluating the cultural specificities and social structures of the target population throughout the intervention design, implementation, and outcome assessment^[20]. The influence of cultural differences on VR technology utilization manifests in various aspects, including the introduction of intervention methods, family involvement patterns, perceptions of privacy and data security, and trust in technology and medical authority. For example, family-centered decision-making prevalent in collectivist cultures differs significantly from individualistic autonomous decision-making, necessitating the design of differentiated intervention participation frameworks for different cultural contexts. Accordingly, future localized research should prioritize cultural assessments and needs surveys, develop culturally adapted VR intervention content incorporating local adolescent values, narrative habits, and family interaction patterns, and conduct culturally sensitive evaluations. This approach would render VR psychological interventions both scientifically rigorous and humanistic, facilitating effective and feasible cross-cultural application^[21].

3.3. Virtual Reality Interventions Feature Diverse Content and Effectively Enhance the Psychological Well-being of Adolescent Cancer Patients

Our results indicate that the primary type of VR-based psychological intervention for adolescent cancer patients is VR relaxation therapy, available in both immersive and non-immersive forms. Findings demonstrate improvements in anxiety following VR interventions^[11, 14]. This suggests that VR technology can ameliorate anxiety and depression in adolescent cancer patients, thereby improving their quality of life^[22], consistent with findings from Ren Yayu et al.^[4]. Furthermore, adolescent cancer patients exhibited significantly reduced pain levels after VR-based psychological interventions^[10, 12, 13], indicating VR's potential in pain management, aligning with studies by Cui Miaomiao et al.^[23, 24].

However, current psychological intervention methods remain largely based on VR visuals^[25]. Most psychotherapy research focuses primarily on analyzing visual scenes, lacking investigation into multi-sensory integration^[26]. Considering this, future efforts could diversify intervention types and adopt multi-modal integration approaches to offer patients more choices.

3.4. Heterogeneity Exists in Outcome Indicator Assessment Methods and Intervention Frequencies in VR-based Interventions for Adolescent Cancer Patients

Although all included studies focused on psychological outcomes in adolescent cancer patients, the definitions of outcome indicators were inconsistent. For instance, Wong et al. specifically referred to state anxiety^[7], whereas Thybo et al. did not clearly define the type of anxiety measured^[13]. Additionally, the applicability contexts and scoring logic of assessment tools varied. Visual Analog Scales require abstract rating skills, making them more suitable for adolescents aged 10 and older. In contrast, the Wong-Baker FACES Pain Rating Scale relies on concrete facial expressions and is more appropriate for younger children. Mismatches between tool selection and participant age may introduce bias, complicating cross-study comparisons. Future research could establish unified VR intervention implementation standards for patients with the same condition and at

similar treatment stages, specifying VR device interaction methods to ensure safety for pediatric patients. Core intervention content elements, such as session duration, frequency, and themes, need to be standardized to align with pediatric patients' psychological needs. For assessment scales, preference should be given to tools with adequate validity and reliability validated in adolescent populations to enhance the clinical reproducibility and comparability of VR intervention effects.

The study durations varied across the included literature. Due to differences in individual treatment protocols, intervention session lengths varied considerably, with the shortest single session lasting only 5 minutes and the longest 20 minutes; frequencies ranged from 1 to 3 sessions. This wide variation complicates the comparison of experimental results. Furthermore, differences in physical condition, natural environment, and medical settings of adolescent patients across experiments contributed to substantial heterogeneity in outcomes.

3.5. Limitations in the Application of VR-based Psychological Interventions for Adolescent Cancer Patients

The results of the studies reviewed suggest that no significant adverse effects directly related to VR interventions were reported; however, certain limitations exist. Firstly, some included studies were single-center and had relatively small sample sizes, potentially reducing statistical power and hindering the accurate assessment of true intervention effects. Secondly, participants were primarily recruited from tertiary hospitals, which generally offer higher-level medical resources and greater service accessibility than standard healthcare environments. This may lead to overestimation of intervention effects and limit the generalizability of findings. Subsequent studies should aim to expand sample sources, conduct multicenter research, and continuously refine study designs to evaluate intervention effects more objectively and accurately.

Additionally, many adolescent cancer patients in the included studies had disease types with high incidence and recurrence risk. Research indicates that regular follow-up positively impacts cancer patient prognoses ^[27]. However, most studies in this review did not include a post-intervention follow-up component. Given that cancer treatment often spans several years, the short observation periods in existing studies are insufficient to demonstrate the long-term value of these interventions fully. Future research should consider the disease characteristics and individual differences among adolescent patients to establish appropriate follow-up durations and frequencies, further validating the long-term effects of VR interventions.

4. Conclusion

This scoping review systematically synthesized the current state of application and research progress of virtual reality technology in psychological interventions for adolescent cancer patients, drawing on 10 relevant studies. The findings indicate that VR technology plays a positive role in promoting both the psychological and physical health of adolescent cancer patients undergoing psychological interventions. However, notable heterogeneity exists across studies in the intervention components and outcome measurement tools, which, to some extent, limits the generalizability and applicability of the findings. Future research should draw upon international experiences, adapt them to the Chinese context, and carefully consider the developmental characteristics of adolescent cancer patients to explore further standardized implementation pathways for VR-based psychological interventions tailored to this population. Concurrently, expanding sample sizes and research scopes will be essential to validate the effectiveness of VR psychological interventions further, thereby providing a more robust scientific foundation for improving the psychological well-being of adolescent cancer patients.

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