Virtual Reality and Mental Health

A Review of Current Findings and Needed Expansions

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KEYWORDS

• Virtual reality • Metaverse • Psychotherapy • Mental health • Mental disorders

KEY POINTS

- Virtual reality (VR) is an immersive interactive technology increasingly used to assess, treat, and prevent a wide range of mental health conditions.
- VR enables patients to repeatedly practice skills in realistic simulations, improving generalization to real-world situations.
- Evidence supports using VR exposure therapy for anxiety disorders, with growing support for its use in eating disorder, posttraumatic stress disorder (PTSD), and substance use.
- Implementation challenges remain, including cost, accessibility, therapist training, and tailoring interventions to diverse populations and settings.

INTRODUCTION

The idea of people living part of their life in such computer-generated alternate realities has been a staple of fiction for over 50 y, with authors, such as Stanislaw Lem, William Gibson, and Neal Stephenson, all contributing to the idea of digital worlds later popularized for the masses in movies, such as *Tron* and *The Matrix*. But over the past 3 decades, living part of your life in a virtual reality (VR) has moved firmly from the realm of science fiction to science fact. In one scene from *The Matrix*, Neo plugs into a simulated virtual world for the first time, instantly acquiring complex martial art skills and learning to bend reality to his will. While today's VR environments do not yet offer that level of transformation, the core idea that immersive, interactive simulations could allow individuals to confront fears, practice new skills, and reshape their reality is compelling. Increasingly powerful computers, software advancements, and plummeting costs have brought VR into the mainstream, where it is now used widely in education, entertainment, and, increasingly, mental health care.

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Abbreviations	
ADHD	attention deficit hyperactivity disorder
ASD	autism spectrum disorder
CBT	cognitive-behavioral therapy
ERP	exposure with response prevention
GAD	generalized anxiety disorder
MDD	major depressive disorder
OCD	obsessive-compulsive disorder
PTSD	posttraumatic stress disorder
SAD	social anxiety disorder
SMI	serious mental illness
SUD	substance use disorder
VR	virtual reality
VRET	virtual reality exposure therapy

The recent surge in clinical interest in VR for mental health has been driven by rapid technological advances. Modern head-mounted displays allow for full immersion in computer-generated 3D environments that dynamically respond to the user's movements via head and body tracking. Many systems now integrate auditory and haptic feedback alongside visual input, enhancing the sense of presence and realism. Despite not being "real," these environments can generate authentic physiologic and psychologic responses.[1,2] These technologic improvements, driven in part by investments from global tech companies, have expanded the potential for VR to be used as a tool for assessing, treating, and even preventing mental illness.[3]

By incorporating VR technology into mental health care, clinicians can offer patients a safe and controlled space to engage with challenging real-world scenarios. Through repeated exposure and guided practice within virtual environments, individuals can rehearse adaptive behaviors, build confidence, and generalize skills to daily life. For example, patients can enter anxiety-provoking situations or social interactions and repeatedly rehearse behavioral responses with therapist support while trying out new strategies. Importantly, patients tend to respond positively to VR in health care settings, reporting comfort and familiarity with the technology.[4] In this review, we provide an overview of how VR is currently being used to assess and treat a range of diagnostic categories (e.g. anxiety or eating disorders) and across different age groups (e.g. children to older adults). We also highlight gaps in the literature and discuss future directions for clinical application, development, and dissemination.

VIRTUAL REALITY FOR MENTAL ILLNESS TREATMENT

Anxiety and Depressive Disorders

As a group, the anxiety disorders are by far the most well-studied type of problems in the VR literature,[3] with the literature dating back to the early 1990s. Cognitive-behavioral therapy (CBT) with a heavy emphasis on exposure with response prevention (ERP) is the most well-supported treatment for these problems[5] and has been the primary treatment model translated to a VR format. In one systematic review from 2020, a staggering 80 of 93 identified studies using CBT in a VR environment were for anxiety and anxiety-related conditions,[6] with a heavy focus on using VR to do ERP. VR exposure therapy (VRET) follows the general approach of traditional exposure therapy, with the only difference being that feared objects or situations are presented within a virtual environment. The VR technology is used alongside a therapist, allowing for virtual exposure to various situations that may either be difficult or costly to encounter in real life (e.g. flying, fear of driving) or could potentially be

dangerous (e.g. various animals). VRET offers certain benefits over in vivo ERP, including a greater degree of therapist control to customize the exposure, reduced risk of privacy intrusions, and being considered less frightening than in vivo exposure therapy.[7] Interestingly, even though it is not "real," similar attrition rates are seen between the 2 modalities of delivery.[8]

While VRET is often used as a complement rather than a replacement for therapy, growing evidence supports its efficacy as a primary treatment.[9] Meta-analyses and trials suggest that VR exposure therapy can be as effective as in vivo exposure for many anxiety-related conditions, including specific phobias,[10] social anxiety disorder (SAD),[11] generalized anxiety disorder (GAD),[12] and posttraumatic stress disorder (PTSD).[13] Although research examining the efficacy of VRET in panic disorder and agoraphobia has been limited, there is preliminary evidence that VRET with CBT is as effective as CBT plus in vivo exposure.[12] Still, some studies suggest that in vivo exposure may lead to greater symptom reduction than VRET,[11,13] showing a need for more comparative research.

Social anxiety disorder

SAD is characterized by an excessive fear of negative evaluation and rejection in social situations. A core component of effective treatment involves repeated exposure to feared social interactions while reducing safety behaviors and avoidance. VRET provides a controlled and flexible platform for delivering such exposures.

In VRET for SAD, individuals engage in simulated social scenarios, including public speaking, making purchases and returns at a store, attending a job interview, or initiating a conversation with a stranger. Several reviews and meta-analyses have shown that VRET can lead to significant reductions in social anxiety symptoms.[11,12,14–17] When VRET is compared to in vivo exposure, though, the findings are mixed.[11,12,18] In one study,[19] participants with SAD were randomized to receive VRET, in vivo exposure, or waitlist control. Both in vivo exposure and VRET led to symptom improvement, but in vivo exposure therapy produced greater reductions in social anxiety at post-treatment and 3-mo follow-up. These findings suggest that while VRET is a viable alternative to in vivo approaches, it may be less effective for some patients.

Beyond VRET, some interventions have explored the integration of VR with full CBT protocols. In a feasibility trial of a 16-session VR-based CBT program, participants demonstrated improvements in both social anxiety and depressive symptoms.[15] These results support the broader use of VR to simulate therapeutic tasks using a CBT framework. VRET is a promising treatment for SAD, offering a flexible and effective alternative to in vivo exposure. Further research is needed to determine who would most benefit from VRET and whether it can match the long-term efficacy of real-world social exposures.

Generalized anxiety disorder

GAD is characterized by chronic and excessive worry across multiple domains of life. Despite the high prevalence and burden of GAD, relatively few studies have examined the use of VR interventions to address this condition. Unlike VR applications for phobias or social anxiety, which tend to focus on direct exposure to feared stimuli, VR approaches for GAD have primarily focused on relaxation, mindfulness, and reducing physiologic arousal. In these studies, patients have been immersed in calming virtual environments (e.g. beaches, forest, and Zen gardens) while they are guided through progressive muscle relaxation or breathing exercises. Studies examining the effectiveness of VR for GAD have produced promising results.[12,20,21] In a trial combining VR-based relaxations and graded exposure, for instance, participants with GAD experienced symptom

improvements across anxiety and worry domains.[20] In one study,[22] participants completed multiple VR relaxation sessions followed by exposure to individualized worry-related cues. The VR condition led to significant reductions in anxiety symptoms over time, suggesting that VR may help simulate and manage GAD symptoms.

Early work is emerging, highlighting how VR can enhance traditional interventions. For example, VR simulations can elicit worry and distress comparable to imagining catastrophic scenarios,[23] providing a potential avenue for future exposure-based treatments tailored to GAD. These simulated worry inductions could eventually support cognitive restructuring and habituation strategies within a structured CBT framework. However, research in this area remains in its early stages.

To date, few studies have tested VR-based treatments for GAD using randomized controlled trial designs or long-term follow-ups. Further research is needed to determine optimal protocols, therapeutic mechanisms, and whether VR relaxation or exposure offers added benefit over existing evidence-based approaches. As the field evolves, it will be critical to align VR content with the unique cognitive and emotional process that characterizes GAD.

Specific phobias

Specific phobias are characterized by an intense and persistent fear of clearly identifiable objects or situations, including heights, flying, spiders, or enclosed spaces, leading to distress or avoidance that disrupts daily functioning. The gold-standard treatment for specific phobias is exposure therapy, which involves the gradual and controlled confrontation of feared stimuli.

VR offers a new method for delivering exposure therapy, enabling clinicians to create realistic, customizable, and repeatable scenarios. These virtual environments allow individuals to confront feared stimuli within a safe, clinician-built context. Numerous studies have demonstrated the efficacy of VRET for specific phobias.[10,12,24,25] For instance, individuals with arachnophobia who were gradually exposed to increasingly realistic spiders using VRET showed reductions in phobia symptoms, with improvements maintained at 6-mo follow-up.[24] Similarly, VRET for fear of flying is as effective as traditional mental imagery exposure,[25] comparable to in vivo exposure, and more effective than bibliotherapy and relaxation training.[12] Importantly, treatment gains have been shown to persist for up to 3 y post-treatment, highlighting the potential of VR-based interventions.

VR has also been used to reduce situational anxiety in contexts like dental procedures.[26,27] In one study, patients immersed in a calming virtual environment before dental surgery reported reduced pre-operative anxiety compared to those receiving treatment as usual.[12] These findings suggest that even brief VR-based interventions can meaningfully reduce anticipatory anxiety in high-stress environments. Overall, the evidence for VRET in specific phobias is among the strongest in the broader VR mental health literature. Future work may focus on optimizing dosage, testing across more diverse populations, evaluating cost-effectiveness, and planning for dissemination.

Posttraumatic stress disorder

PTSD is characterized by intrusive memories, avoidance of trauma-related stimuli, negative changes in cognition and mood, and heightened arousal following exposure to a traumatic event. Types of CBT that heavily integrate repeated exposure to trauma-related memories and cues are considered the gold standard treatment. However, many patients and clinicians remain hesitant to use traditional exposure approaches due to concerns about overwhelming distress or the potential for re-traumatization.[28]

VRET has emerged as a promising alternative to exposure treatments for PTSD. In early studies with combat veterans, VR environments were designed to simulate deployment-related contexts and were paired with imaginal exposure to traumatic memories. Several randomized controlled trials (RCTs) have compared VRET to traditional exposure therapies and find that VRET produces outcomes similar to prolonged exposure therapy.[13,29] In one study, 80% of veterans who completed VRET no longer met diagnostic criteria for PTSD.[29] In a separate RCT, prolonged imaginal exposure was more effective than VRET at both 3-mo and 6-mo follow-ups.[13] A meta-analysis of RCTs found that VRET had a moderate effect size in reducing PTSD symptoms and was comparable in efficacy to trauma-focused CBT.[30] Taken together, these findings suggest that while VRET holds significant promise, particularly for those reluctant to engage in traditional exposure, more research is needed to clarify its comparative effectiveness and for whom it works best.

Beyond combat-related trauma, some VR platforms have been developed to support treatment for a broader range of traumatic experiences. One such system, *EMMA's World*, uses customizable virtual environments that incorporate personalized images, music, and sounds to support patients in processing traumatic events, such as domestic violence, natural disasters, and motor vehicle accidents. In clinical studies,[31] VRET using *EMMA's World* produced symptom reductions on par with traditional exposure therapies, supporting the idea that VR can be flexibly adapted to diverse trauma presentations. Other studies have also examined secondary outcomes of VR interventions for individuals with PTSD. For example, in a trial targeting aggressive driving among veterans, a VR-based simulation helped reduce aggressive behaviors, state anxiety, and self-reported anger problems.[32] These findings highlight the broader potential of VR to support recovery not only through processing but also targeting transdiagnostic mechanisms and everyday functioning.

While more research is needed, particularly longitudinal studies, VRET represents a promising tool in the treatment of PTSD. It offers a structured, engaging alternative for patients and clinicians who may be reluctant to engage in exposure, while also opening the door to customized interventions for a wide range of traumatic events.

Obsessive-compulsive disorder

Obsessive-compulsive disorder (OCD) is characterized by intrusive, unwanted thoughts, and repetitive behavior or mental acts aimed at reducing distress or preventing feared outcomes. The gold-standard treatment is CBT focusing on ERP, which involves confronting fears without engaging in compulsive acts. However, ERP can be distressing for patients and challenging for clinicians to implement,[33] leading to underutilization in practice.

OCD is an ideal candidate for VR interventions, yet research in this area remains limited. Despite this potential, relatively few studies have examined VRET for OCD.[12,34–36] In one study, individuals with contamination-related OCD symptoms who received 3 sessions of VRET reported a reduction in anxiety and the urge to wash their hands.[35] Another study administered 12 sessions of VRET focused on contamination fears,[36] including virtual exposure to dirty walls and toilet seats, resulting in significant symptom improvement. Taking virtual exposure to the next level, innovative methods have explored the incorporation of tactile feedback into VRET. In one trial,[37] patients watched a virtual hand being smeared with feces while receiving synchronized tactile stimulation on their real hand, simulating direct exposure to contaminants. This approach elicited strong affective responses and engagement, suggesting new avenues for immersive exposure interventions. Given the central role of

exposure in treating OCD, the paucity of VR research provides an opportunity for more trials to evaluate feasibility, efficacy, and long-term outcomes.

Major depressive disorder

Major depressive disorder is characterized by persistent low mood, diminished interest, or pleasure, and a range of cognitive and physical symptoms that interfere with daily functioning. Given that social engagement and behavioral activation are central components of treatment, VR may be best positioned as a complementary tool. For instance, VR can serve as a low-stakes environment for rehearsing social interactions or practicing behavioral activation strategies.

Compared to anxiety-based disorders, the application of VR in the treatment of depression is still in its nascent stages, with only a modest number of studies conducted to date.[3,9,38,39] Early research has explored how immersive VR environments might enhance engagement, promote self-compassion, and support behavioral activation. In one notable study,[40] an immersive VR scenario was used to foster self-compassion among individuals with depression. Participants first embodied an adult avatar to comfort a crying virtual child then re-experienced the scene from the child's perspective, receiving their compassionate gestures. Across 3 weekly sessions, participants showed significant reductions in depressive symptoms, suggesting that embodied self-compassion through VR could be a novel strategy for alleviating depression symptoms. Other exploratory work has tested the potential of VR to counteract hopelessness and anhedonia by encouraging future-oriented thinking and curiosity. For example, in the *Edge of the Present* VR program, participants explored a virtual space in which each act of curiosity (e.g. opening a door or window) revealed a brighter and more immersive landscape. In a sample of 79 individuals with depression, this program significantly reduced hopelessness from pre-intervention to post-intervention.[41]

Though these early findings are innovative and promising, most of the research on VR depression remains limited to small-scale studies, often without control groups or long-term follow-up. The nature of depression, including reduced motivation, social withdrawal, and low energy, also presents unique challenges for engagement with VR-based interventions. Some studies have explored whether avatars or virtual social interactions can help reduce loneliness or simulate supportive interpersonal experiences; however, concerns remain about whether VR could risk substituting for rather than strengthening real-world social connections. While the application of VR in treating major depressive disorder (MDD) is still in its early stages, initial studies suggest promising avenues for future research. Larger, well-controlled trials targeting therapeutic mechanisms are needed to determine effectiveness, refine therapeutic mechanisms, and assess long-term outcomes.

Serious Mental Illness and Other Mental Disorders

Serious mental illnesses (SMIs), such as schizophrenia, psychosis, substance use disorder (SUD), and eating disorders, often involve chronic functional impairment, difficulties with insight, and barriers to treatment engagement. Compared to anxiety disorders, the use of VR in treating SMIs is still emerging. Researchers have begun to explore how immersive VR environments might be used to enhance insight, understand the cognitive underpinnings of the condition, simulate real-world challenges, and support interventions across these conditions.

Eating disorders

Eating disorders, including anorexia nervosa, bulimia nervosa, and binge eating disorder, are marked by disturbed eating behaviors, distorted body image, and significant

psychologic distress. Standard treatments typically include CBT, nutritional rehabilitation, and targeted interventions to address body image concerns. In this context, VR has emerged as a promising adjunctive tool,[12,42,43] primarily focused on 2 domains: body image disturbance and maladaptive eating behaviors.

To address body image distortion, VR environments allow patients to interact with realistic, customizable 3D representations of their own bodies. These immersive experiences provide real-time visual feedback and emotional engagement, enabling patients to confront and reprocess distorted self-perceptions with guidance from a therapist. For instance, among women with binge eating disorder, VR-enhanced body image interventions led to greater increases in body satisfaction compared to CBT alone.[44] Similarly, studies have shown that VR-based CBT programs improved body satisfaction, reduced binge eating episodes, and promoted weight loss in individuals with obesity and binge eating disorder, with effects sustained up to 1 y post-treatment[45]

In addition to body image work, VR has been employed in cue exposure interventions targeting eating behaviors.[46] Patients are immersed in emotionally salient virtual environments, such as restaurants, grocery stores, or kitchens, which are designed to trigger cravings and habitual responses. These scenarios enhance validity and provide opportunities to practice response prevention strategies in a safe, clinician-guided setting. Early research suggests that VR cue exposure reduces binge eating frequency, decreases food cravings, and improves body image among individuals with bulimia nervosa and binge eating disorder.[12,46]

Beyond symptom-level interventions, VR has also been used to support broader treatment goals like enhancing self-efficacy, motivation for change, and emotion regulation through virtual embodiment.[47,48] For example, patients may virtually try on clothes, view themselves at different weights, or engage in simulated weigh-ins while exploring emotional and cognitive responses with a therapist. Preliminary studies in anorexia nervosa suggest that such experiences may reduce body size overestimation and increase body ownership.[47–49] While still an emerging area, VR interventions show promise as a supplement to evidence-based treatment for eating disorders. Future research should focus on identifying the components that drive therapeutic change, clarifying the mechanisms of action, and determining the best way to personalize these interventions for individual patient needs.

Schizophrenia and related-psychotic disorders

Psychotic disorders, such as schizophrenia, are characterized by symptoms including delusions, hallucinations, disorganized thinking, and impaired social functioning. Individuals with psychosis often experience paranoid ideation and consequently avoid social interactions, limiting opportunities for engagement and treatment. CBT for psychosis frequently incorporates exposure to social situations alongside reduction of safety behaviors. VRET has emerged as a promising tool to facilitate these interventions within a controlled, acceptable, and immersive setting.

VR environments can simulate everyday social scenarios that trigger anxiety, suspicious thoughts, and avoidance behaviors. Multiple studies have demonstrated that VR-based CBT (VR-CBT) reduces paranoid ideation, decreases safety behaviors, and improves social functioning.[12,50] For example, an RCT involving 116 patients with psychotic disorders found that VR-CBT significantly reduced paranoid ideation and anxiety, with effects maintained at 6-mo follow-up compared to treatment as usual In this trial, participants interacted with various avatars in virtual social settings while collaborating with therapists to challenge maladaptive thoughts, address safety behaviors, and test harm expectancies. Over 16 sessions, participants showed

meaningful improvements in social functioning and paranoia relative to a waitlist control group.[50] A pilot study delivering group CBT in a virtual world to individuals with early psychosis reported increased emotion recognition and reduced anxiety and depression symptoms.[51]

Beyond exposure therapy, VR is used to assess paranoid ideation by manipulating social cues (eg, perceived hostility in neutral interactions), environmental factors (eg, crowd density), and testing causal models of paranoia.[52] One trial found that VR-CBT was more effective than VR exposure alone in reducing delusional beliefs and associated distress, underscoring the importance of targeting cognitive distortions directly.[53] VR has also been employed for social skills training in inpatient settings, offering patients safe opportunities for role-play and interpersonal feedback.[50] Across these diverse applications, VR provides a flexible and immersive platform to evoke and explore psychotic symptoms, enhance therapeutic engagement, and facilitate generalization to real-world social functioning (Freeman and colleagues, 2017).

Substance use disorders

SUDs involve compulsive use of drugs or alcohol despite negative consequences, often driven by powerful reward-based learning. Cravings play a central role in the initiation and maintenance of SUDs across theoretic models, making cue reactivity a critical treatment target. Standard treatment approaches often include cue exposure therapy, where patients are repeatedly exposed to substance-related stimuli (e.g. sight or smell of alcohol or cigarettes) to diminish craving responses.

VR has been explored as a tool to enhance cue exposure by immersing patients in realistic, high-risk environments or triggering scenarios.[54–59] For alcohol use disorder, VR cue exposure therapy has shown greater reductions in craving compared to standard CBT alone.[12,57] In smoking cessation, results have been mixed, with some studies indicating that VR cue exposure is as effective as CBT for reducing cigarette consumption,[60] while others report no significant benefit.[61] Beyond traditional cue exposure, VR has been used innovatively to support behavior change through interactive tasks like "crushing" virtual cigarettes,[62] which may help reduce cravings when combined with face-to-face therapy. Although the evidence remains preliminary and limited by small sample sizes and methodological variability, these early findings suggest that VR could be a valuable adjunct for managing cravings, practicing skills, and preventing relapse in SUD treatment.

VIRTUAL REALITY ACROSS THE LIFESPAN

Children and Adolescents

While most VR research in mental health has focused on adults aged 20 to 40, a growing body of work is investigating its use with children and adolescents. Much of this research centers on anxiety-related disorders, though there is increasing interest in its application for neurodevelopmental conditions, such as autism spectrum disorder (ASD) and attention-deficit hyperactivity disorder (ADHD).

For anxiety-related disorders, VR offers a promising method of delivering exposure therapy in a safe, immersive environment. A 2021 systematic review of VR and applied games for childhood mental disorders identified only 3 studies using fully immersive VR paired with CBT, showing small to medium within-group effects on anxiety and phobia symptoms, but no differences compared to waitlist control.[63] Similarly, another review found just 4 clinical trials of VR exposure therapy for pediatric anxiety, concluding that while early findings are promising, more rigorous research is needed.[64] More recent work[65] identified 13 VR studies in child and adolescent mental health, 10 of which focused on anxiety-related conditions, along with emerging

applications for gaming disorder and anorexia nervosa. Interventions ranged from virtual exposure therapy to VR-assisted breathing training and body image work, highlighting the flexibility of VR in targeting multiple therapeutic mechanisms.

In neurodevelopmental populations, VR has been used to support cognitive functioning, social communication, attention, and emotion regulation. For example, in children with ASD, VR interventions have been associated with improvements in cognitive and emotional processing.[65–67] Outcomes varied by functional level, as individuals with high-functioning ASD tend to benefit more from VR-based social cognition training, showing gains in emotion recognition and theory of mind. Some evidence suggests that VR may be more effective for teaching daily living skills than for improving emotional or social functioning, though these findings remain preliminary.

Despite these early successes, developmental appropriateness remains a central challenge. Children and adolescents may perceive virtual environments differently from adults, and younger users may struggle to distinguish virtual experiences from reality. In some cases, heightened immersion could increase distress during exposure exercises. Designing VR interventions for youth, therefore, requires careful consideration of cognitive, emotional, and social development, as well as age-specific symptom presentation. In summary, current research on VR in youth mental health shows promise for anxiety-related and neurodevelopmental disorders. However, the field is still in its early stages. Future work should prioritize randomized controlled trials, investigate the development of tailored interventions, and provide clearer implementation guidelines to ensure that VR tools are both practical and suitable for children and adolescents.

Older Adults

Among older adults, VR has been most used for physical rehabilitation and health promotion, with interventions targeting posture, mobility, balance, pain management, and fall prevention.[68–72] Beyond these physical applications, an expanding body of work has explored VR's potential to support cognitive functioning and emotional well-being in aging populations. A significant portion of this research has focused on cognitive assessment, screening, and training for conditions, such as mild cognitive impairment (MCI) and Alzheimer's disease. In a review of 55 VR studies in clinical settings with older adults,[73] 24 targeted cognitive impairments, primarily through training interventions. These studies reported improvements in spatial cognition, executive functioning, memory, and activities of daily living.[73] Meta-analyses further support the use of VR in this population, with moderate effects on cognitive functioning and memory, and large effects on depressive symptoms.[74] Similarly, systematic reviews of VR interventions in long-term care settings report benefits for physical activity, balance, fall risk, fatigue, and sleep quality, though results on mood and cognitive outcomes are more mixed.[75]

In addition to cognitive training, VR has been used to enhance psychologic well-being and treat mood disorders in older adults. For example,[76] one study found that an immersive VR protocol incorporating Ericksonian psychotherapy, soothing music, and virtual nature scenes produced greater reductions in depression and anxiety symptoms than a relaxation-only control. Other studies have also shown that exposure to calming VR environments (e.g. forests, gardens, or beaches) can improve mood and reduce psychologic distress in older adults.[77]

A 2024 scoping review[78] categorized 40 VR studies with adults aged 65 to 80 as either function-oriented (e.g. cognitive or mood training) or entertainment-oriented (e.g. immersive enjoyment or travel). Among the 28 function-oriented studies, 24

reported positive psychologic outcomes. For instance, one study had participants complete a VR supermarket task that challenged memory, attention, and executive functioning. Meanwhile, entertainment-focused interventions, such as virtual city tours, also demonstrated mood-enhancing effects in 12 of 14 studies. Across all 40 studies, 36 reported positive outcomes, though few employed randomized designs or long-term follow-ups.

Despite promising findings, important gaps remain. Most research focuses on short-term effects, and relatively few studies extend evidence-based VR treatments from younger populations (e.g. anxiety-focused protocols) to older adults. Longitudinal, randomized controlled trials are needed to establish the durability of benefits and assess broader applicability in diverse clinical settings. Adapting VR for older adults must consider age-specific challenges, including accessibility, usability, and sensory limitations. Personalized approaches will be a key to maximizing the therapeutic impact of VR. While the field remains in its early stages, VR shows promise for improving cognitive, physical, and emotional outcomes in older adults. As evidence accumulates, future work should focus on long-term effectiveness, age-appropriate design, and strategies for implementing VR at scale in geriatric mental health care.

FUTURE DIRECTIONS

Despite promising early findings, significant gaps remain in the VR mental health literature. Many disorders, such as depression, SUDs, and OCD, lack well-powered, methodologically rigorous trials. Future research must prioritize larger, preregistered RCTs, and consistent reporting of technical and clinical components. Future work could also explore how VR can be optimally sequenced with other interventions. For example, VR-based exposure could be used as a preparatory stage before in vivo exposure, especially for patients with high avoidance or low readiness. Adaptive designs, such as Sequential Multiple Assignment Randomized Trials, could test whether initiating treatment with VR and escalating to in vivo exposure for nonresponders improves outcomes, engagement, and treatment adherence. Clarifying the therapist's role, whether fully integrated, hybrid, or semi-automated, will also be crucial for future scalability.

Interventions are most effective when rooted in a well-articulated clinical theory. As such, future VR development should also expand beyond "traditional" CBT to include dialectical behavior therapy, acceptance and commitment therapy, mindfulness-based interventions, and transdiagnostic approaches, such as the Unified Protocol. In some cases, VR may serve as a bridge to more intensive interventions, such as in vivo exposure, by offering a safer and more controlled context to rehearse coping skills. This expansion would enable broader tailoring of VR content to diverse treatment needs.

A major area of future research must focus on how effective VR interventions are designed and implemented. This requires a careful balance between technical fidelity and clinical relevance. A core ingredient for success is *presence*,[79,80] the user's subjective sense of being immersed in the virtual environment, which is enhanced through multisensory feedback (e.g. visual, auditory, and tactile inputs). This sense of presence is crucial in exposure-based therapies, where emotional engagement with feared stimuli is essential for clinical improvement. While some conditions, such as specific phobias, are relatively easy to replicate in VR (e.g. heights and spiders), others, like depression or psychosis, present greater design challenges due to their internal nature. Some use cases benefit from flexible, generic virtual environments, while others require highly tailored and symptom-specific settings that leverage haptic and multisensory simulations.[37]

Despite growing interest in therapeutic VR, few studies report sufficient technical detail (e.g. hardware, software, headset specifications, and frame rates), making it difficult to replicate interventions or translate them into routine care. Standardized reporting guidelines for VR development and implementation are needed to promote transparency, reproducibility, and scalability. At the same time, real-world implementation remains limited by cost, logistical barriers, and workforce constraints. Although hardware prices have decreased over the past decade, a complete VR system, including headsets, computers, software licenses, and necessary updates, can still cost upwards of $5,000. Customized content development and maintenance require additional technical expertise and financial investment. Most community mental health clinics lack the infrastructure (e.g. stable internet, dedicated clinical space, and integrated health records) to support VR-based care.

The scalable and sustainable adoption of VR in mental health will require cost-effective and user-friendly solutions. Training models must address therapist confidence, workload, and supervision needs, especially in the face of workforce shortages and high caseloads. Implementation strategies should be multilevel, considering leadership support, workflow integration, and patient safety. Just as importantly, therapeutic VR development must be an interdisciplinary effort, bringing together clinicians, researchers, designers, patients, and implementation scientists to ensure that VR interventions are not only clinically grounded but also useable and accessible across diverse settings.[81]

For VR to be effective and equitable, it must be responsive to the needs and experiences of both patients and providers.[82] Although early studies suggest high-patient acceptability and, in some cases, greater engagement than traditional therapy,[83] clinician buy-in remains a key barrier. Many providers express discomfort with VR, especially in exposure-based applications, citing concerns about safety, symptom exacerbation, or unfamiliarity with the technology.[28,84]

While VR holds great promise in mental health care, it is not a one-size-fits-all solution. Its utility will vary across populations, and future effectiveness will depend on how well VR interventions are tailored to the developmental, cultural, and contextual needs of diverse users.[82] For example, younger children may find virtual environments too overwhelming, while older adults may face sensory or usability challenges that limit engagement. These developmental considerations are often overlooked in early-stage research. Most VR mental health studies have focused on adults in high-income countries, raising concerns about generalizability and digital equity. In addition, VR-induced sickness will affect a subset of users. As the field moves forward, virtual environments must be designed not only to match clinical goals but also to reflect the lived realities, values, and capacities of people they were meant to serve. Ensuring that VR platforms are linguistically, culturally, and contextually appropriate will require substantial adaptations, ideally developed in partnership with the communities who will use them.

SUMMARY

VR has emerged as a novel, engaging, and increasingly efficacious tool for the treatment of mental illness.[12,16–18,30,52,63] The strongest evidence to date centers on exposure-based interventions for anxiety-related disorders, where symptom-provoking scenarios are recreated in immersive environments to promote habituation and reduce avoidance. Social and cognitive skills training using avatars has also shown promise,[19,73] particularly for individuals with psychotic and neurodevelopmental disorders.[12,50] Significant gaps remain in the application of VR to different

diagnostic categories, comorbid conditions, and across the lifespan, particularly among pediatric and older adult populations. Ultimately, advancing VR in mental health care will require a focus on developmental appropriateness, clinical effectiveness, ethical deployment, and real-world implementation. VR offers a unique opportunity to deliver mental health interventions with greater fidelity, flexibility, and immediacy. By simulating real-world challenges in controlled, repeatable environments, VR enables individuals to practice coping strategies, receive in-the-moment clinician guidance, and gradually build confidence. Across various clinical populations, VR-based therapies are generally well-received by patients and are often viewed as more engaging than traditional treatments. The most impactful VR interventions promote real-world behavior change, suggesting that immersive technology can play a meaningful role in advancing mental health care.

CLINICS CARE POINTS

Using VR in mental health treatment:

- Shows high promise in the treatment of various anxiety-related disorders, including specific phobias and social anxiety, with less research on depressive or severe mental illness.
- Has emerging evidence to support its use across the lifespan.
- Needs further research to clarify dose and mode of delivery (primary or adjunctive) for many problems.

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