



Evaluating the Efficacy of Virtual Reality in Exposure Therapy for Phobias

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Abstract: Virtual Reality Exposure Therapy (VRET) is an effective treatment for phobias and anxiety disorders, using immersive, controlled exposure to feared stimuli. This PRISMA-guided review of 50 studies, mainly randomized controlled trials, found strong symptom reduction across phobia types, including situational, social, and medical fears, with outcomes often comparable to in vivo exposure and good acceptability, retention, and long-term gains, including in children. Advances such as AI, biofeedback, and consumer hardware have improved accessibility. Despite variability in some subtypes and limitations in standardization and study design, VRET remains a cost-effective and promising CBT-based intervention requiring further long-term research.

Keywords: *Virtual Reality Exposure Therapy, VRET, Phobias, Specific Phobias, Social Anxiety Disorder, Exposure Therapy, Systematic Review, Immersive Virtual Reality, Anxiety Disorders, Technological Advancements in Therapy*

1. Introduction

1.1 Virtual Reality

Virtual Reality (VR) is an immersive technology that uses computer-generated simulations, usually experienced through a head-mounted display (HMD), to create interactive three-dimensional environments that feel realistic to the user. A typical VR system combines specialized hardware and software to produce these immersive experiences. Core

hardware components include high-resolution head-mounted displays with wide fields of view and fast refresh rates to reduce motion blur, motion tracking systems that monitor head and body movement through sensors or cameras, and hand-held controllers or gloves that allow users to interact with the virtual environment. Increasingly, haptic devices such as vibration motors or force-feedback systems are also used to simulate touch sensations like pressure, resistance, or texture (Freeman et al., 2017).

Over time, VR has moved beyond niche uses and become widely applied across several fields. In education and professional training, it allows learners to practise skills in safe, controlled environments—for example, medical students performing virtual procedures, pilots rehearsing flight scenarios, or emergency personnel training for disaster response without real-world risk. In healthcare, VR has gained particular importance in psychological treatment, especially through Virtual Reality Exposure Therapy (VRET), where controlled virtual environments are used to safely expose individuals to anxiety-provoking situations. This approach has been applied to conditions such as phobias, social anxiety disorder, generalized anxiety, and post-traumatic stress disorder (PTSD), often showing results comparable to or better than traditional exposure methods (Carl et al., 2019; Cheng et al., 2025; Zeng et al., 2025).

Recent technological developments have further increased the accessibility and effectiveness of VR. Modern headsets are becoming lighter and more affordable, often including built-in eye-tracking features that improve visual efficiency and reduce processing demands. Advances in haptic technology, artificial intelligence-driven adaptive environments, and improved display quality have enhanced realism while reducing discomfort such as visual fatigue and cybersickness (Pedram et al., 2025). However, several challenges remain. Users may experience cybersickness, including nausea or dizziness, due to mismatches between visual and physical motion. There are also ongoing concerns related to data privacy, ethical issues around prolonged immersion, and barriers to access for individuals with physical limitations or limited financial resources (Slater & Sanchez-Vives, 2016).

1.2 Exposure Therapy

Exposure Therapy, a central component of cognitive-behavioral therapy (CBT), is a structured and evidence-based intervention that helps individuals reduce fear by gradually confronting feared objects, situations, thoughts, or sensations in a safe and controlled environment. Through repeated exposure, avoidance patterns decrease and distress levels gradually reduce over time (Foa & McLean, 2016).

Several techniques are used depending on the nature of the fear. In vivo exposure involves direct confrontation with feared objects or situations in real life, such as approaching a spider in cases of arachnophobia or gradually moving to higher floors for acrophobia. Imaginal exposure relies on guided visualization of feared scenarios and is often used when real-life exposure is unsafe or impractical, such as recalling traumatic memories in PTSD treatment. Interoceptive exposure focuses on intentionally creating physical sensations linked to panic, such as dizziness or shortness of breath, to reduce fear of bodily symptoms in panic disorder. Virtual Reality Exposure Therapy (VRET) uses immersive simulations to recreate feared environments in a controlled and repeatable manner, making it useful for treating fears such as flying, heights, animals, or public speaking while allowing precise adjustment of difficulty levels (Carl et al., 2019; Kuleli et al., 2025).

The effectiveness of exposure therapy is explained through several interconnected processes. Habituation refers to the gradual reduction in emotional and physical arousal with repeated exposure to the feared stimulus. Extinction learning occurs when the feared stimulus is repeatedly experienced without negative consequences, weakening the original fear response (Benito et al., 2024). Inhibitory learning suggests that new, safer associations develop and compete with earlier fear-based responses. At the same time, cognitive restructuring takes place as individuals realize that feared outcomes do not occur, leading to more realistic thinking. Repeated success in facing fears also builds self-efficacy, increasing confidence and reducing feelings of helplessness, which further supports long-term reduction in avoidance behaviors (Tryon, 2005).

1.3 Phobia

Phobias are classified under anxiety disorders in the DSM-5-TR and involve marked, excessive, and persistent fear or anxiety triggered by specific objects, situations, or activities that pose little real danger. They cause active avoidance or intense distress when confronted, leading to significant impairment in daily functioning. Specific phobias are subdivided into five types: animal (e.g., dogs, insects, snakes), natural environment (e.g., heights, storms), blood-injection-injury (e.g., blood, injections, medical procedures), situational (e.g., flying, enclosed spaces), and other. Social Anxiety Disorder involves intense fear of social or performance situations due to possible scrutiny or embarrassment, while agoraphobia centers on situations where escape or help may be unavailable in case of panic-like symptoms.

Specific phobias are among the most common mental disorders, with lifetime prevalence of 7–15% globally (higher in females) and 12-month rates of 7–9% (Wardenaar et al., 2017; National Institute of Mental Health, n.d.). Animal and height fears are the most

prevalent. Untreated phobias lead to chronic impairment, reduced quality of life, and increased risk of depression, other anxiety disorders, and substance misuse.

Diagnosis requires DSM-5-TR criteria: marked fear about a specific trigger, immediate anxiety response, recognition that the fear is excessive, persistence for at least six months, and significant distress or impairment. Treatment mainly relies on exposure therapy (in vivo, imaginal, or VRET), often combined with cognitive techniques, while medications like SSRIs or beta-blockers serve as adjuncts in severe cases.

2. Methodology

2.1 *Rationale of the Study*

Specific phobias and anxiety disorders cause major distress through intense fear, avoidance, and functional impairment. Although in vivo exposure is the gold-standard treatment, it is often limited by logistical challenges, safety concerns, high costs, and patients' reluctance to confront feared situations directly. Virtual Reality Exposure Therapy (VRET) offers a safe, immersive, and customizable alternative that simulates phobic stimuli without real-world risks. Despite growing evidence, a systematic evaluation is still needed to assess its effectiveness across phobia subtypes, its comparability to traditional exposure, and the role of recent technological advances. This review aims to fill these gaps and strengthen the evidence base for immersive interventions in phobia treatment.

2.2 *Research Objectives*

- a) To systematically evaluate the efficacy of Virtual Reality Exposure Therapy (VRET) in reducing symptoms across various phobia subtypes.
- b) To compare the effectiveness of VRET with traditional in vivo exposure therapy in terms of symptom reduction, treatment acceptability, and long-term outcomes.
- c) To examine the influence of technological advancements on VRET efficacy and patient engagement.

2.3 *Method*

This review synthesizes evidence from 50 peer-reviewed studies, primarily randomized controlled trials and controlled clinical investigations, to assess VRET's impact relative to conventional exposure methods.

2.4 *Research Design*

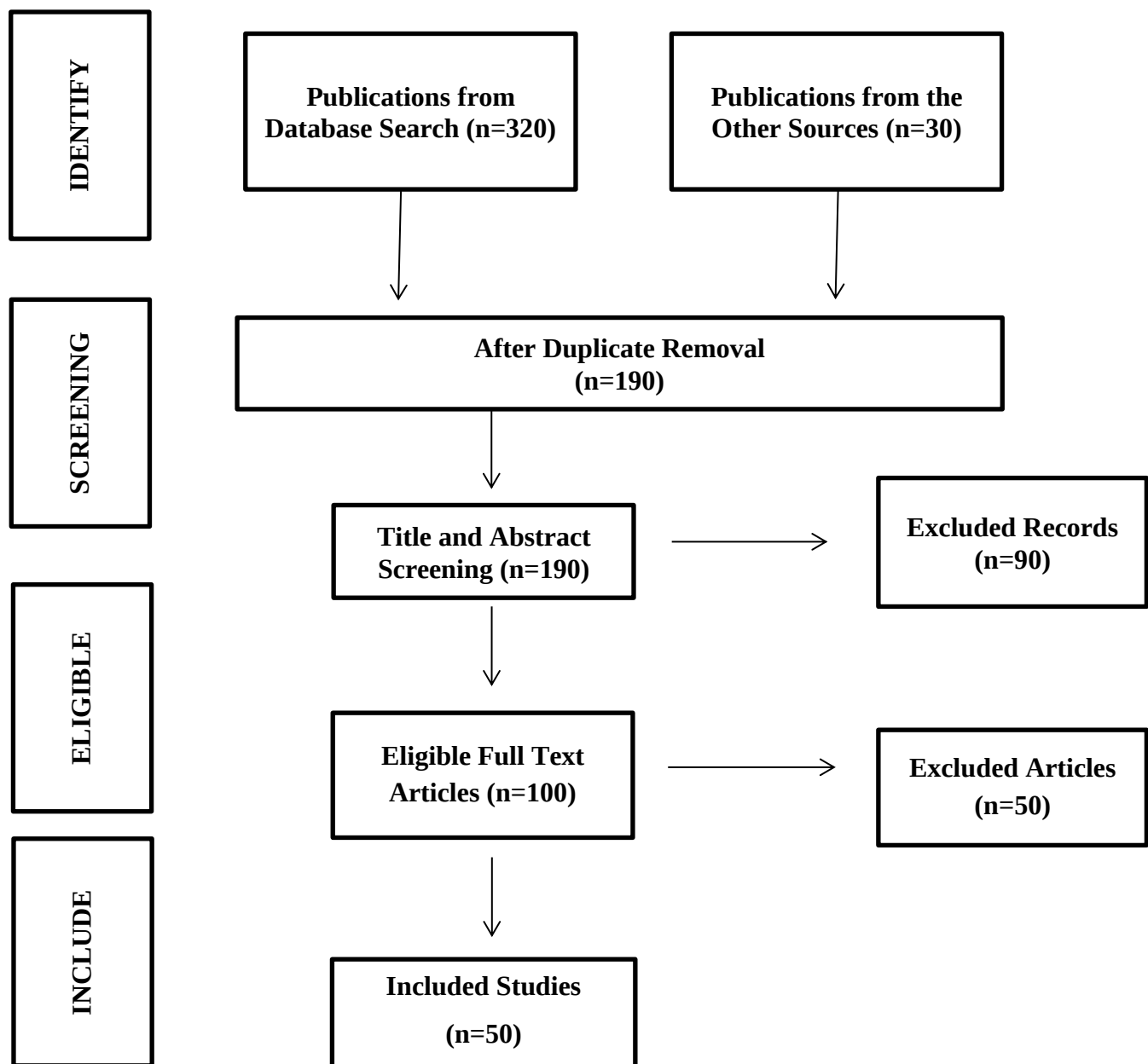


Figure 1: PRISMA Flow Diagram

2.5 Data Collection & Analysis

Relevant studies were sourced from databases such as PubMed, PsycINFO, Scopus, and Google Scholar using keywords like "Virtual Reality Exposure Therapy (VRET)," "phobia treatment," "cognitive-behavioral therapy (CBT) and VR," and "VR in mental health."

2.6 Ethical Considerations

As a secondary research study, no direct human interaction was involved, ensuring compliance with ethical guidelines. Only publicly available, peer-reviewed data was used to maintain research integrity.

3. Results and Discussion

The use of Virtual Reality Exposure Therapy (VRET) for phobia treatment has gained significant attention in recent years, with multiple studies highlighting its effectiveness. This discussion explores the key findings from the reviewed literature, focusing on the efficacy of VRET, its comparison to in vivo exposure, technological advancements, and its applicability across different phobias.

The result table (**Table 1**) provides a list of these studies with their basic findings. The scope of data analysis in this review is limited to the identification of different themes based on the different methodologies employed.

Table 1: List of studies, corresponding authors, year, sample, method, and main finding.

S.No.	Authors (Year)	Sample	Method	Main Findings
1.	Andersson et al. (2023)	12 participants	Quasi-experimental pilot study using SPQ, FQ, BAT	VRET-AP significantly reduced spider fear with large effect sizes; all participants improved with no adverse effects.
2.	Bălan et al. (2023)	4 participants	Pilot study using AI-driven VR exposure for acrophobia	VR with AI and adaptive exposure scenarios shows promise for personalized phobia therapy.
3.	Baschab et al. (2026)	Studies on VR-based exposure for anxiety in children/adolescents (4–18 years)	Systematic review and meta-analysis	VR exposure therapies are effective and well-tolerated for social anxiety and related fears in youth; high adherence, positive user experience, and promising symptom reduction support its use in younger populations.
4.	Botella et al. (2017)	Multiple studies	Review of VRET effectiveness for phobias	VR improves phobia treatment but requires more research on factors like medication and sense of presence.
5.	Bouchard et al. (2017)	59 participants	RCT comparing VR and in vivo exposure for SAD	VR exposure was more effective than in vivo exposure, with sustained improvements and greater practicality for therapists.
6.	Cardoş et al. (2017)	11 studies	Meta-analysis of VRET for flight anxiety	VRET had a medium effect size at post-test and follow-up, supporting its efficacy despite barriers like cost and slow adoption.
7.	Carl et al. (2019)	30 RCTs, 1,057 participants	Meta-analysis of VRET for multiple anxiety disorders	VRET was as effective as in vivo exposure and significantly better than psychological placebo and waitlist controls.
8.	Cheng et al.	23 RCTs (n	Systematic review of	Immersive VR-based treatments (primarily

	(2025)	= 1,216 participants)	RCTs on immersive VR for anxiety disorders	VRET) show strong efficacy for specific phobias and social anxiety disorder, with symptom reductions comparable to traditional non-VR exposure; particularly effective when combined with cognitive-behavioral techniques.
9.	Cherestal et al. (2022)	17 participants	Comparison of remote vs. in-person VRET for aviophobia	Both formats were equally effective, supporting remote VRET as a viable teletherapy option.
10.	DemiR & Köskün (2023)	10 RCTs	Systematic review of VRET for specific phobias	VRET effectively reduced phobia symptoms with long-term benefits, supporting VR's integration into exposure therapy.
11.	Dhunnoo et al. (2024)	Multiple studies	Review of XR therapies for anxiety disorders	XR therapies provide immersive, drug-free alternatives, improving engagement and reducing stigma in treatment.
12.	Emmelkamp & Meyerbröker (2021)	Multiple studies	Review of VR for various mental disorders	VR is effective for anxiety and PTSD, with emerging evidence for addiction, eating disorders, psychosis, autism, and ADHD.
13.	Faizah et al. (2024)	27 participants	Pretest-posttest control group study on VRET-CR for acrophobia	Significant symptom reductions in acrophobia, with notable heart rate changes, supporting VRET-CR as an effective intervention.
14.	Farrell et al. (2021)	8 children (8–12 years old)	Preliminary study on VR one-session treatment (OST) for dog phobia	75% of participants recovered, 88% interacted with feared stimulus, suggesting VR OST is effective for childhood phobias.
15.	Fodor et al. (2018)	39 RCTs (52 comparisons)	Meta-analysis of VR for anxiety and depression	VR significantly improved anxiety ($g = 0.79$) and depression ($g = 0.73$), but concerns about high heterogeneity and bias remain.
16.	Freitas et al. (2021)	Multiple studies	Study comparing VRET vs. in vivo therapy for phobias	VRET was generally effective but lacked full immersion compared to in vivo exposure, requiring further high-dimensional studies.
17.	Gao et al. (2023)	2,224 participants (27 RCTs)	Systematic review & meta-analysis on VR for pediatric needle-related procedures	VR significantly reduced pain, anxiety, and fear in children, outperforming conventional distraction techniques.
18.	Gebara et al. (2015)	Adults (18–65) with social phobia	VRET using a 3D VR program	72.5% reduction in social anxiety, sustained at 6-month follow-up, with strong acceptability and minimal dropout.
19.	Gega (2017)	Multiple	Review of VR's role in	VR enhances exposure therapy but should

		studies	exposure therapy	integrate therapist interaction, discourage safety behaviors, and encourage real-life practice.
20.	Gujjar et al. (2019)	30 participants	RCT comparing VRET vs. informational pamphlets for dental phobia	Only VRET significantly reduced anxiety scores, supporting its effectiveness for dental phobia.
21.	Jones et al. (2024)	Multiple RCTs	Meta-analysis of VRET for anxiety disorders (phobias, SAD, PTSD, PD)	VRET had large effect sizes vs. waitlist and placebo, with effectiveness comparable to in vivo exposure. More research needed for PD and GAD.
22.	Kahlon et al. (2019)	27 adolescents (13–16 years)	Non-randomized feasibility trial of VR exposure for PSA	Significant reduction in PSA symptoms maintained at 3-month follow-up, supporting VR's feasibility for adolescent social anxiety.
23.	Kar et al. (2017)	1 case study	Single-case study on VRET for astraphobia	VRET effectively reduced anxiety and fear responses in an individual with astraphobia.
24.	Kılıç et al. (2021)	28 studies	Systematic review of VR for fear of medical procedures	VR was effective for most cases, but results were inconclusive for blood-injection-injury phobias and burn wound care.
25.	Kristína et al. (2024)	36 participants	Study on psychological & physiological responses to VRET for acrophobia	HRV analysis showed better anxiety management with psychological guidance, supporting VRET's role in exposure therapy.
26.	Kritikos et al. (2020)	20 participants	Study on hardware impact in VRET for acrophobia	Full-body motion recognition enhanced presence more than hand controllers, suggesting benefits for anxiety treatment.
27.	Krzystanek et al. (2021)	49 studies	Systematic review of VRET for anxiety disorders	VRET is effective for agoraphobia, social phobia, and specific phobias, with long-term benefits.
28.	Kuleli et al. (2025)	RCTs on social anxiety disorder and specific phobia	Systematic review & meta-analysis comparing VRET vs. in vivo exposure therapy (IVET)	VRET yields positive outcomes for specific phobias and social anxiety, with clinical efficacy statistically equivalent to in vivo exposure; no meaningful differences in post-treatment symptom severity or acceptability.
29.	Levy et al. (2016)	6 participants	Feasibility study on remote VRET (e-VRET) for acrophobia	Remote VRET was as effective as in-person sessions, with no dropouts or major technical issues.
30.	Lima et al.	36	Comparison of VRET vs.	VRET significantly reduced storm fear, with

	(2018)	participants	PMR for storm phobia	effects maintained at 30-day follow-up.
31.	Lindner et al. (2017)	20 RCTs	Review of VRET accessibility and advancements	Consumer VR systems enable wider VRET use, including self-help applications.
32.	Maples-Keller et al. (2017)	Multiple studies	Review of VR-based exposure therapy	VR enhances extinction learning, making it highly effective for anxiety disorder treatment.
33.	Miloff et al. (2016)	Participants with spider phobia	Comparison of gamified VR exposure vs. traditional OST	VR exposure therapy showed significant improvements, with no notable differences compared to in vivo exposure.
34.	Miloff et al. (2020)	Nearly 100 patients	Study on Samsung Gear VR for spider phobia using the Itsy app	VRET significantly reduced fear, similar to traditional exposure methods, highlighting VR's broader potential in therapy.
35.	Mitra & Pandey (2023)	Literature review	Theoretical exploration of VRET's potential	VRET offers a controlled and immersive therapy environment, with potential to transform phobia treatment.
36.	Oing et al. (2018)	49 studies	Systematic review of VR for anxiety-related disorders	VRET was effective for anxiety disorders, but limitations in VR technology highlight areas for improvement.
37.	Ong et al. (2022)	Literature review	Exploration of VRET combined with TeleMental Health (TMH)	VRET with TMH enhances accessibility and cost-effectiveness, requiring further optimization for diverse populations.
38.	Pereira et al. (2020)	Systematic review	Evaluation of VRET for phobia treatment and VR advancements	VRET is effective, with technological advancements enhancing realism and presence, offering a cost-effective alternative.
39.	Premkumar et al. (2021)	32 university students	Self-guided VRET for public-speaking anxiety (PSA)	Anxiety, arousal, and heart rate decreased with repeated exposure, with sustained PSA reduction.
40.	Ramos et al. (2018)	10 participants with arachnophobia	VR exposure therapy using 3D-modeled spiders	VR-based exposure increased anxiety initially but led to gradual desensitization.
41.	Reeves et al. (2021)	11 studies (508 participants)	Meta-analysis of VRET vs. in vivo exposure for PSA	Both methods reduced PSA, with IVET showing a slight advantage; VRET remains a promising alternative.
42.	Renner et al. (2024)	30 participants with	Comparison of VR and in vivo exposure therapy	In vivo exposure led to greater parasympathetic activation and lower stress levels than VR exposure.

		agoraphobia		
43.	Rimer et al. (2021)	74 clinicians, 54 non-clinicians	Study on modern wireless VR with hand tracking for height phobia	VR effectively induced and reduced fear responses; clinicians' attitudes toward VR therapy improved after exposure.
44.	Salehi et al. (2020)	25 studies	Review of VR for social phobia	VRET was the most effective approach, leading to reduced anxiety and real-world improvements.
45.	Spytska (2024)	Literature review	Role of VR in phobia treatment, exposure therapy, and CBT	VR offers controlled exposure and individualized treatment, though challenges include cost and ethical concerns.
46.	Suso-Ribera et al. (2019)	Patients with small animal phobia	Comparison of in vivo (iVET), VR (VRET), and AR (ARET) exposure therapy	All methods were equally effective; iVET slightly better for high-avoidance patients.
47.	Tan et al. (2025)	RCTs evaluating VRET for social anxiety disorders	Meta-analysis and meta-regression of randomized controlled trials	VRET significantly outperforms waitlist controls in reducing social anxiety symptoms at post-treatment and follow-up; serves as a valuable, evidence-supported addition to exposure-based therapy with durable effects.
48.	Tsai et al. (2018)	Patients with claustrophobia	Comparison of VR and AR exposure therapy	AR triggered stronger physiological responses, while VR was more practical for therapy.
49.	Wechsler et al. (2019)	Systematic review	Comparison of VR and in vivo exposure for phobic anxiety disorders	Both methods were effective; IVET slightly better for social phobia, while VRET offers accessibility and cognitive intervention potential.
50.	Zeng et al. (2025)	RCTs on VR therapy for anxiety disorders in adolescents and adults	Systematic review and meta-analysis of RCTs	VR interventions (including VRET) demonstrate a consistent positive effect on anxiety symptom improvement across phobia and anxiety disorder populations; overall beneficial and clinically meaningful impact confirmed.

Virtual Reality Exposure Therapy (VRET) has demonstrated substantial efficacy across a broad range of phobias and anxiety-related conditions, with particularly strong outcomes observed in animal, natural environment, situational, and social anxiety contexts. Research targeting fears such as arachnophobia and cynophobia consistently reports

significant symptom reductions, with quasi-experimental studies showing large effect sizes, universal participant improvement, and absence of adverse reactions (Andersson et al., 2023). In pediatric populations, one-session interventions have achieved recovery rates of approximately 75%, accompanied by strong behavioral engagement with feared stimuli (Farrell et al., 2021). Consumer-based virtual reality platforms have similarly demonstrated reductions in fear comparable to in vivo exposure methods across larger samples (Miloff et al., 2016, 2020). Comparable outcomes have also been reported for natural environment phobias, including astraphobia and storm-related fears, where symptom improvements have been maintained for up to 30 days following treatment (Kar et al., 2017; Lima et al., 2018).

Situational phobias such as acrophobia, aviophobia, and claustrophobia have shown consistent responsiveness to VRET interventions. Studies integrating virtual exposure with cognitive restructuring report significant symptom declines and measurable physiological changes, including altered heart rate responses (Faizah et al., 2024). Heart rate variability findings further indicate improved emotional regulation when therapist guidance accompanies exposure (Kristína et al., 2024). Meta-analyses of flight anxiety treatments demonstrate medium and sustained treatment effects (Cardoş et al., 2017), while comparisons with augmented reality approaches suggest that although augmented environments may provoke stronger initial responses, VRET remains more practical and manageable in clinical settings (Tsai et al., 2018). Technological enhancements such as full-body tracking have also been shown to improve users' sense of presence and therapeutic gains, particularly in height-related phobias (Kritikos et al., 2020).

Strong evidence also supports VRET's effectiveness in social anxiety disorder (SAD) and public speaking anxiety (PSA). Controlled trials among adults report symptom reductions exceeding 70%, with improvements sustained for up to six months and accompanied by high treatment acceptability (Gebara et al., 2015). Adolescent feasibility studies and student-based self-administered protocols similarly report significant reductions in anxiety symptoms and physiological arousal (Kahlon et al., 2019; Premkumar et al., 2021). Meta-regression and systematic reviews further confirm VRET's superiority over waitlist controls and highlight its effectiveness as an adjunct exposure strategy that facilitates real-world behavioral transfer (Tan et al., 2025; Salehi et al., 2020).

Evidence regarding medical and procedural fears remains promising but somewhat variable. Systematic reviews demonstrate notable reductions in pain and anxiety among children undergoing needle-related procedures (Gao et al., 2023), although findings related to blood-injection-injury phobias and burn treatment settings remain inconclusive, suggesting a

need for refined protocols (Kılıç et al., 2021). In contrast, dental phobia research consistently reports VRET's superiority over informational interventions in reducing anxiety (Gujjar et al., 2019). Beyond specific phobias, VRET has demonstrated effectiveness across broader anxiety and trauma-related disorders, including agoraphobia, posttraumatic stress disorder (PTSD), and generalized anxiety. Systematic reviews report sustained long-term improvements in agoraphobia-related symptoms (Krzystanek et al., 2021), while meta-analyses indicate large effect sizes relative to control groups and outcomes comparable to established treatments (Jones et al., 2024; Fodor et al., 2018).

Comparative findings suggest that VRET is frequently equivalent to traditional in vivo exposure therapy across anxiety disorders, with meta-analytic evidence confirming superior outcomes compared to placebo and waitlist conditions (Carl et al., 2019; Kuleli et al., 2025; Cheng et al., 2025; Zeng et al., 2025). In the treatment of social anxiety, VRET has demonstrated advantages in practicality and, in some cases, sustained superiority (Bouchard et al., 2017). However, some studies indicate modest advantages for in vivo exposure in physiological recovery or highly avoidant cases, as well as slight benefits in public speaking contexts (Renner et al., 2024; Suso-Ribera et al., 2019; Reeves et al., 2021).

In addition to therapeutic effectiveness, VRET offers practical advantages such as controlled stimulus presentation, repeatability, and enhanced safety, which address logistical and ethical challenges associated with traditional exposure methods. Remote delivery models have demonstrated outcomes comparable to in-person therapy (Cherestal et al., 2022; Levy et al., 2016), while increasing access to consumer-grade virtual reality hardware supports self-guided and home-based treatment models (Lindner et al., 2017). Emerging technological advancements, including artificial intelligence-driven adaptive environments, biofeedback systems, and full-body motion tracking, further enhance immersion and therapeutic outcomes (Bălan et al., 2023; Kritikos et al., 2020; Rimer et al., 2021). Extended reality systems have also been associated with improved engagement and reduced stigma related to treatment seeking (Dhunnoo et al., 2024). Moreover, VRET demonstrates strong applicability across diverse populations, particularly among children and adolescents, where meta-analytic findings indicate high adherence and meaningful symptom reduction (Baschab et al., 2026). Pediatric and adult-focused studies further support its effectiveness across varied anxiety presentations (Farrell et al., 2021; Gao et al., 2023; Emmelkamp & Meyerbröker, 2021).

6. Conclusion

From a clinical perspective, VRET represents a cost-effective and accessible alternative to traditional exposure methods, with strong potential for integration into cognitive-behavioral therapy frameworks and telehealth services. Advancements in technology continue to improve realism, accessibility, and scalability, supporting wider implementation in both clinical and community settings (Botella et al., 2017). Future research should prioritize large-scale longitudinal trials, development of subtype-specific protocols, and exploration of multimodal interventions that combine VRET with complementary therapeutic techniques. Addressing ethical concerns, cost barriers, and accessibility limitations will be essential to ensure equitable adoption and to maximize the long-term clinical utility of VRET across diverse populations.

References

- American Psychiatric Association. (2022). Diagnostic and statistical manual of mental disorders (5th ed., text rev.). <https://doi.org/10.1176/appi.books.9780890425787>
- Andersson, J., Hallin, J., Tingström, A., & Knutsson, J. (2023). Virtual reality exposure therapy for fear of spiders: an open trial and feasibility study of a new treatment for arachnophobia. *Nordic Journal of Psychiatry*, 78(2), 128–136.
- Bălan, O., Moldoveanu, A., & Leordeanu, M. (2021). A machine learning approach to automatic phobia therapy with virtual reality. *Modern Approaches to Augmentation of Brain Function*, 607-636.
- Benito, K. G., et al. (2024). Mechanisms of change in exposure therapy for anxiety and related disorders: A research agenda. *Clinical Psychology Review*, Article 102399.
- Botella, C., Fernández-Álvarez, J., Guillén, V., García-Palacios, A., & Baños, R. (2017). Recent progress in virtual reality exposure therapy for phobias: a systematic review. *Current psychiatry reports*, 19, 1-13.
- Bouchard, S., Dumoulin, S., Robillard, G., Guitard, T., Klinger, E., Forget, H., ... & Roucaut, F. X. (2017). Virtual reality compared with in vivo exposure in the treatment of social anxiety disorder: a three-arm randomised controlled trial. *The British Journal of Psychiatry*, 210(4), 276-283.
- Cardoş, R. A., David, O. A., & David, D. O. (2017). Virtual reality exposure therapy in flight anxiety: a quantitative meta-analysis. *Computers in Human Behavior*, 72, 371-380.
- Carl, E., Stein, A. T., Levihn-Coon, A., Pogue, J. R., Rothbaum, B., Emmelkamp, P., ... & Powers, M. B. (2019). Virtual reality exposure therapy for anxiety and related

- disorders: A meta-analysis of randomized controlled trials. *Journal of anxiety disorders*, 61, 27-36.
- Cheng, M. H. C., et al. (2025). A systematic review of randomized controlled trials on immersive virtual reality for treating anxiety disorders. *Clinical Simulation in Nursing*. <https://doi.org/10.1016/j.ecns.2025.101653>
- Cherestal, S., Schare, M. L., Grimaldi, S., Costello, K., & DeJesus, C. (2021). Remotely conducted versus office-based virtual reality treatment for aviophobia: Questions of feasibility and accessibility. *Translational Issues in Psychological Science*, 7(3), 218.
- Dhunoo, P., Wetzlmair, L., & O'Carroll, V. (2024). Extended Reality Therapies for Anxiety Disorders: A Systematic review of Patients' and healthcare Professionals' perspectives. *Sci*, 6(2), 19.
- Emmelkamp, P. M., & Meyerbröker, K. (2021). Virtual reality therapy in mental health. *Annual review of clinical psychology*, 17(1), 495-519.
- Faizah, M., Ramdhani, N., & Utami, M. S. (2024). Conquer fear of heights using virtual reality exposure therapy with cognitive restructuring. *Gadjah Mada Journal of Professional Psychology (GamaJPP)*, 10(1), 14.
- Farrell, L. J., Miyamoto, T., Donovan, C. L., Waters, A. M., Krisch, K. A., & Ollendick, T. H. (2021). Virtual reality one-session treatment of child-specific phobia of dogs: a controlled, multiple baseline case series. *Behavior Therapy*, 52(2), 478-491.
- Foa, E. B., & McLean, C. P. (2016). Psychological treatments for anxiety disorders. *Annual Review of Clinical Psychology*, 12, 1-28.
- Fodor, L. A., Coteș, C. D., Cuijpers, P., Szamoskozi, Ș., David, D., & Cristea, I. A. (2018). The effectiveness of virtual reality based interventions for symptoms of anxiety and depression: A meta-analysis. *Scientific Reports*, 8(1).
- Freeman, D., Reeve, S., Robinson, A., Ehlers, A., Clark, D., Spanlang, B., & Slater, M. (2017). Virtual reality in the assessment, understanding, and treatment of mental health disorders. *Psychological Medicine*, 47(14), 2393-2400. <https://doi.org/10.1017/S003329171700040X>
- Freitas, J. R. S., Velosa, V. H. S., Abreu, L. T. N., Jardim, R. L., Santos, J. A. V., Peres, B., & Campos, P. F. (2021). Virtual reality exposure treatment in phobias: a systematic review. *Psychiatric Quarterly*, 92(4), 1685-1710.
- Gao, Y., Xu, Y., Liu, N., & Fan, L. (2023). Effectiveness of virtual reality intervention on reducing the pain, anxiety and fear of needle-related procedures in paediatric patients: A systematic review and meta-analysis. *Journal of Advanced Nursing*, 79(1), 15-30.

- Gebara, C. M., De Barros-Neto, T. P., Gertsenchtein, L., & Lotufo-Neto, F. (2015). Virtual reality exposure using three-dimensional images for the treatment of social phobia. *Brazilian Journal of Psychiatry*, 38(1), 24–29.
- Gega, L. (2017). The virtues of virtual reality in exposure therapy. *The British Journal of Psychiatry*, 210(4), 245-246.
- Gujjar, K. R., van Wijk, A., Kumar, R., & de Jongh, A. (2019). Efficacy of virtual reality exposure therapy for the treatment of dental phobia in adults: A randomized controlled trial. *Journal of anxiety disorders*, 62, 100-108.
- Kahlon, S., Lindner, P., & Nordgreen, T. (2019). Virtual reality exposure therapy for adolescents with fear of public speaking: a non-randomized feasibility and pilot study. *Child and Adolescent Psychiatry and Mental Health*, 13(1).
- Kar, N. B., Pattnaik, N. D. P., & Mahapatra, N. D. J. (2017). Application of Virtual Reality exposure therapy on Management of astraphobia: a single case study. *International Journal of Indian Psychology*, 4(4).
- Kılıç, A., Brown, A., Aras, I., Hui, R., Hare, J., Hughes, L. D., & McCracken, L. M. (2021). Using virtual technology for fear of medical procedures: a systematic review of the effectiveness of virtual reality-based interventions. *Annals of Behavioral Medicine*, 55(11), 1062-1079.
- Kristína, V., Dagmar, S., Oto, J., Lenka, J., Kateřina, B., & Vojtěch, J. (2024). Virtual reality exposure effect in acrophobia: psychological and physiological evidence from a single experimental session. *Virtual Reality*, 28(3).
- Kritikos, J., Zoitaki, C., Tzannetos, G., Mehmeti, A., Douloudi, M., Nikolaou, G., ... & Koutsouris, D. (2020). Comparison between full body motion recognition camera interaction and hand controllers interaction used in virtual reality exposure therapy for acrophobia. *Sensors*, 20(5), 1244.
- Krzystanek, M., Surma, S., Stokrocka, M., Romańczyk, M., Przybyło, J., Krzystanek, N., & Borkowski, M. (2021). Tips for effective implementation of virtual reality exposure therapy in phobias—A systematic review. *Frontiers in psychiatry*, 12, 737351.
- Kuleli, D., et al. (2025). Examining the comparative effectiveness of virtual reality and in-vivo exposure therapy on social anxiety and specific phobia: A systematic review & meta-analysis. *Journal of Behavioral and Cognitive Therapy*, 35(2), Article 100524. <https://doi.org/10.1016/j.jbct.2025.100524>

- Levy, F., Leboucher, P., Rautureau, G., & Jouvent, R. (2016). E-virtual reality exposure therapy in acrophobia: A pilot study. *Journal of telemedicine and telecare*, 22(4), 215-220.
- Lima, J., McCabe-Bennett, H., & Antony, M. M. (2018). Treatment of storm fears using virtual reality and progressive muscle relaxation. *Behavioural and cognitive psychotherapy*, 46(2), 251-256.
- Lindner, P., Miloff, A., Hamilton, W., Reuterskiöld, L., Andersson, G., Powers, M. B., & Carlbring, P. (2017). Creating state of the art, next-generation Virtual Reality exposure therapies for anxiety disorders using consumer hardware platforms: design considerations and future directions. *Cognitive behaviour therapy*, 46(5), 404-420.
- Maples-Keller, J. L., Yasinski, C., Manjin, N., & Rothbaum, B. O. (2017). Virtual reality-enhanced extinction of phobias and post-traumatic stress. *Neurotherapeutics*, 14(3), 554-563.
- Miloff, A., Lindner, P., & Carlbring, P. (2020). The future of virtual reality therapy for phobias: Beyond simple exposures. *Clinical Psychology in Europe*, 2(2).
- Miloff, A., Lindner, P., Hamilton, W., Reuterskiöld, L., Andersson, G., & Carlbring, P. (2016). Single-session gamified virtual reality exposure therapy for spider phobia vs. traditional exposure therapy: study protocol for a randomized controlled non-inferiority trial. *Trials*, 17, 1-8.
- Mitra, V., & Pandey, Y. K. (2023). EXPLORING THE THERAPEUTIC REALM: VIRTUAL REALITY EXPOSURE THERAPY FOR PHOBIAS. *Biochemical & Cellular Archives*, 23.
- National Institute of Mental Health. (n.d.). Specific phobia. <https://www.nimh.nih.gov/health/statistics/specific-phobia>
- Oing, Theodore, and Julie Prescott. "Implementations of virtual reality for anxiety-related disorders: systematic review." *JMIR serious games* 6.4 (2018): e10965.
- Ong, T., Wilczewski, H., Soni, H., Nisbet, Q., Paige, S. R., Barrera, J. F., Welch, B. M., & Bunnell, B. E. (2022). The Symbiosis of Virtual Reality Exposure Therapy and Telemental Health: A review. *Frontiers in Virtual Reality*, 3.
- Pedram, S., et al. (2025). Exploring the potential of virtual reality (VR) in mental healthcare: A systematic literature review. *Virtual Reality*. <https://doi.org/10.1007/s10055-025-01181-6>

- Premkumar, P., Heym, N., Brown, D. J., Battersby, S., Sumich, A., Huntington, B., ... & Zysk, E. (2021). The effectiveness of self-guided virtual-reality exposure therapy for public-speaking anxiety. *Frontiers in psychiatry*, 12, 694610.
- Ramos, O., Ríos, D., Serrano, J., & Research India Publications. (2018). Treatment of Specific Phobia by using Exposure Therapy through Virtual Reality. In *International Journal of Applied Engineering Research* (Vol. 13, Issue 15, pp. 12018–12022) [Journal-article]. Research India Publications.
- Reeves, R., Curran, D., Gleeson, A., & Hanna, D. (2021). A Meta-Analysis of the efficacy of virtual reality and in vivo exposure therapy as psychological interventions for public speaking anxiety. *Behavior Modification*, 46(4), 937–965.
- Renner, V., Witthöft, M., Hardt, J., Conrad, R., & Petrowski, K. (2024). Potential fearful situations in virtual reality—A pilot study assessing the effects of exposure in virtual reality and in vivo on anxious healthy participants in narrow rooms. *Journal of Behavioral and Cognitive Therapy*, 34(3), 100500.
- Rimer, E., Husby, L. V., & Solem, S. (2021). Virtual reality exposure therapy for fear of heights: clinicians' attitudes become more positive after trying VRET. *Frontiers in psychology*, 12, 671871.
- Salehi, E., Mehrabi, M., Fatehi, F., & Salehi, A. (2020). Virtual reality therapy for social phobia: a scoping review. *Digital personalized health and medicine*, 713-717.
- Slater, M., & Sanchez-Vives, M. V. (2016). Enhancing our lives with immersive virtual reality. *Frontiers in Robotics and AI*, 3, 74. <https://doi.org/10.3389/frobt.2016.00074>
- Spytska, L. (2024). The use of virtual reality in the treatment of mental disorders such as phobias and post-traumatic stress disorder. *SSM-Mental Health*, 6, 100351.
- Suso-Ribera, C., Fernández-Álvarez, J., García-Palacios, A., Hoffman, H. G., Bretón-López, J., Banos, R. M. , ... & Botella, C. (2019). Virtual reality, augmented reality, and in vivo exposure therapy: a preliminary comparison of treatment efficacy in small animal phobia. *Cyberpsychology, Behavior, and Social Networking*, 22(1), 31-38.
- Tryon, W. W. (2005). Possible mechanisms for why desensitization and exposure therapy work. *Clinical Psychology Review*, 25(6), 655–673. <https://doi.org/10.1016/j.cpr.2004.08.005>
- Tsai, C. F., Yeh, S. C., Huang, Y., Wu, Z., Cui, J., & Zheng, L. (2018). The effect of augmented reality and virtual reality on inducing anxiety for exposure therapy: a comparison using heart rate variability. *Journal of Healthcare Engineering*, 2018(1), 6357351.

- Wardenaar, K. J., Lim, C. C. W., Al-Hamzawi, A. O., Alonso, J., Bromet, E. J., et al. (2017). The cross-national epidemiology of specific phobia in the World Mental Health Surveys. *Psychological Medicine*, 47(10), 1744–1760. <https://doi.org/10.1017/S0033291717000174>
- Wechsler, T. F., Kümpers, F., & Mühlberger, A. (2019). Inferiority or even superiority of virtual reality exposure therapy in phobias?—A systematic review and quantitative meta-analysis on randomized controlled trials specifically comparing the efficacy of virtual reality exposure to gold standard in vivo exposure in agoraphobia, specific phobia, and social phobia. *Frontiers in Psychology*, 10, Article 1758. <https://doi.org/10.3389/fpsyg.2019.01758>
- Zeng, W., et al. (2025). Effectiveness of virtual reality therapy in the treatment of anxiety disorders in adolescents and adults: A systematic review and meta-analysis of randomized controlled trials. *Frontiers in Psychiatry*, 16, Article 1553290. <https://doi.org/10.3389/fpsyt.2025.1553290>