International Journal of Innovative Technologies in Social Science

e-ISSN: 2544-9435

Operating Publisher
SciFormat Publishing Inc.
ISNI: 0000 0005 1449 8214

2734 17 Avenue SW,
Calgary, Alberta, T3E0A7,
Canada
+15878858911
editorial-office@sciformat.ca

ARTICLE TITLE	VIRTUAL REALITY (VR) IN THE TREATMENT OF POSTTRAUMATIC STRESS DISORDER (PTSD): EFFECTIVENESS, MECHANISMS OF ACTION, AND COMPARISON WITH TRADITIONAL EXPOSURE THERAPY
DOI	https://doi.org/10.31435/ijitss.2(50).2026.5437
RECEIVED	16 February 2026
ACCEPTED	05 May 2026
PUBLISHED	11 May 2026
LICENSE	The article is licensed under a **Creative Commons Attribution 4.0 International License.**

VIRTUAL REALITY (VR) IN THE TREATMENT OF POSTTRAUMATIC STRESS DISORDER (PTSD): EFFECTIVENESS, MECHANISMS OF ACTION, AND COMPARISON WITH TRADITIONAL EXPOSURE THERAPY

Julia Kacperczyk
Medical University of Lodz, Lodz, Poland
ORCID ID: 0009-0007-6354-301X

Julia Bezak
Medical University of Lodz, Lodz, Poland
ORCID ID: 0009-0005-8598-5594

Mateusz Winkler *(Corresponding Author, Email: Mateuszszopen@gmail.com)*
Nikolaus Copernicus University in Torun, Collegium Medicum, Bydgoszcz, Poland
ORCID ID: 0009-0004-4518-4728

Aleksandra Arczewska
Medical University of Lodz, Lodz, Poland
ORCID ID: 0009-0008-3092-7364

Michał Zaborowski
Poznan University of Medical Sciences, Poznan, Poland
ORCID ID: 0009-0002-7598-3737

Klaudia Purgał-Zaborowska
Poznan University of Medical Sciences, Poznan, Poland
ORCID ID: 0009-0007-2411-1601

Klaudia Michałowska
Nikolaus Copernicus University in Torun, Collegium Medicum, Bydgoszcz, Poland
ORCID ID: 0009-0003-7782-2264

Oliwier Kolanowski
Nikolaus Copernicus University in Torun, Collegium Medicum, Bydgoszcz, Poland
ORCID ID: 0009-0005-0278-1941

Olga Turzańska
Jagiellonian University in Krakow, Krakow, Poland
ORCID ID: 0009-0007-9495-5834

ABSTRACT

Post-traumatic stress disorder (PTSD) constitutes a significant clinical challenge due to its complex etiology and patients' difficulties in confronting traumatic experiences. The aim of this study is to analyze the effectiveness of virtual reality exposure therapy (VRET) as a modern alternative to classical therapeutic approaches and to evaluate its impact on patient engagement and the fear extinction process.

This paper presents a review of current scientific literature, including randomized controlled trials, meta-analyses, and clinical guidelines (including APA recommendations) concerning the use of emerging technologies in trauma treatment. Particular attention is given to the comparison between VRET and traditional exposure methods, such as imaginal and in vivo exposure.

The analysis indicates that VRET demonstrates effectiveness comparable to trauma-focused cognitive behavioral therapy (TF-CBT). A key advantage of VR is the high level of immersion and sense of presence, which facilitates emotional processing, particularly in patients who experience difficulties in visualizing traumatic events. Studies also suggest a tendency toward greater acceptance of this form of therapy among patients. Additionally, VRET shows strong potential for integration with adjunctive approaches, such as neuromodulation (tDCS) and physical activity (e.g., 3MDR).

Virtual reality does not replace traditional therapeutic methods but rather represents a significant technological extension of them. Its primary advantages include precise personalization of exposure and increased control over the therapeutic process. The main barriers to widespread implementation of VRET remain the cost of equipment and the lack of standardized clinical protocols.

KEYWORDS

Burn Injury, Psychological Disorders, PTSD, Depression, Anxiety, Psychotherapy, Social Support, Literature, Virtual Reality, VRET, Exposure Therapy, Trauma, Psychotherapy, Emerging Technologies

CITATION

Julia Kacperczyk, Julia Bezak, Mateusz Winkler, Aleksandra Arczewska, Michał Zaborowski, Klaudia Purgał-Zaborowska, Klaudia Michałowska, Oliwier Kolanowski, Olga Turzańska. (2026) Virtual Reality (VR) in the Treatment of Posttraumatic Stress Disorder (PTSD): Effectiveness, Mechanisms of Action, and Comparison with Traditional Exposure Therapy. *International Journal of Innovative Technologies in Social Science*. 2(50). doi: 10.31435/ijitss.2(50).2026.5437

1. Introduction

Post-traumatic stress disorder (PTSD) is a serious mental disorder that develops as a result of experiencing or witnessing a traumatic event. Its symptoms include recurrent intrusive memories, avoidance of trauma-related stimuli, negative alterations in mood and cognition, and heightened psychophysiological arousal.

Research indicates that PTSD frequently co-occurs with other mental disorders, such as depression, anxiety disorders, and self-harm behaviors. A particularly significant risk factor is childhood maltreatment, which has been shown to have a strong causal relationship with the development of PTSD and other mental health conditions [1].

From a biological perspective, PTSD is associated with dysfunctions in the nervous system as well as inflammatory processes. Increasing evidence highlights the important role of neuroinflammatory mechanisms in the pathogenesis of PTSD, opening new avenues for therapeutic interventions [2].

Additionally, PTSD negatively affects cognitive functioning, including memory, attention, and executive functions, as demonstrated in meta-analytical studies [5] and systematic reviews focusing on older populations [6].

The heterogeneity of symptoms and their biological underpinnings are reflected in the existence of different PTSD subtypes characterized by distinct neural biomarkers [7].

Despite the availability of effective treatments, such as trauma-focused cognitive behavioral therapy (TF-CBT), their efficacy may be limited by patients' difficulties in confronting traumatic memories and

relatively high dropout rates. Studies indicate that TF-CBT leads to a significant reduction in PTSD symptoms; however, the therapeutic process can be demanding for patients [3].

Current clinical guidelines emphasize psychotherapy as the primary treatment modality for PTSD, while also highlighting the need for further development and optimization of therapeutic approaches, particularly for patients with more complex clinical presentations [4].

In this context, there is growing interest in the use of emerging technologies, such as virtual reality (VR), which may enhance the effectiveness of exposure-based therapies by improving stimulus control and increasing patient engagement.

2. Methodology

To collect research material and assess the current state of knowledge regarding the application of virtual reality in PTSD therapy, a systematic review of the scientific literature was conducted. The selection process was based on the principles of evidence-based medicine (EBM) and current guidelines of the American Psychological Association (APA) concerning the effectiveness of therapeutic interventions.

2.1. Search Strategy and Databases

The primary bibliographic source was the PubMed (MEDLINE) database, supplemented by an analysis of reference lists from selected publications. The search was conducted using combinations of the following keywords and Boolean operators:

PTSD OR "post-traumatic stress disorder"
AND "virtual reality" OR "VRET"
AND "exposure therapy"
AND "evidence-based treatment"

2.2. Inclusion Criteria

The final analysis included studies that met all of the following criteria:

- **Time frame:** Publications from 2020–2026, allowing inclusion of the most recent technological advancements in VR and up-to-date clinical data.
- **Scope:** Studies directly addressing PTSD and the use of virtual reality as a primary or adjunctive therapeutic intervention.
- **Language:** Articles published exclusively in English, as the standard for international scientific communication.
- **Access type:** Only Open Access publications, ensuring full transparency and verifiability of reported data and findings.

2.3. Selection and Analysis of Materials

The selection process consisted of three stages:

1. **Screening:** Initial evaluation of titles and abstracts for relevance to the study topic.
2. **Full-text analysis:** Detailed assessment of selected articles, with particular attention to study design (randomized controlled trials – RCTs, meta-analyses, and systematic reviews).
3. **Guideline verification:** Evaluation of consistency with current APA recommendations, emphasizing trauma-focused therapeutic approaches.

Keywords: PTSD, virtual reality, VRET, exposure therapy, trauma, psychotherapy, emerging technologies.

3. Exposure Therapy

Exposure therapy is one of the primary methods for treating PTSD and is based on the principles of learning theory, particularly the processes of fear extinction (extinction learning). Its aim is the gradual confrontation of the patient with trauma-related stimuli in controlled therapeutic conditions.

The effectiveness of trauma-focused cognitive behavioral therapy (TF-CBT), which incorporates elements of exposure, has been confirmed in experimental studies demonstrating a significant reduction in PTSD symptom severity during therapy [3].

Despite its proven effectiveness, traditional exposure therapy is associated with significant limitations. Patients often experience difficulties in imagining traumatic events or actively avoid confrontation with them,

which may reduce treatment effectiveness and lead to premature dropout. This issue is particularly evident in more complex forms of PTSD [4].

In response to these limitations, approaches combining classical exposure therapy with additional supportive methods are being developed. One example is the use of vagus nerve stimulation (VNS) in conjunction with exposure therapy. Research indicates that the simultaneous application of exposure and vagus nerve stimulation may enhance neuroplasticity processes and strengthen fear extinction learning. Clinical studies have demonstrated significant and sustained improvement in PTSD symptoms in treatment-resistant patients, with no serious adverse effects reported [8].

An important aspect of PTSD treatment is also the management of comorbid conditions, such as insomnia, which can hinder the therapeutic process and worsen prognosis. A randomized study involving veterans with PTSD showed that cognitive behavioral therapy targeting insomnia (BBTI), both as a standalone intervention and in combination with pharmacotherapy (eszopiclone), led to significant improvements in sleep quality, with comparable long-term outcomes between approaches [9].

This suggests that adjunctive interventions may improve patient functioning, although they do not always enhance the long-term effectiveness of the primary therapy.

Additionally, growing interest has been observed in integrating cognitive behavioral therapy with other forms of intervention, such as music therapy. These approaches may increase therapeutic flexibility and improve patient engagement while maintaining the core principles of CBT [10].

In the context of treating patients with comorbid PTSD and depression, research also highlights the importance of combining different therapeutic components, such as cognitive processing therapy (CPT) and behavioral activation. The observed phenomenon of “sudden gains” suggests that appropriately tailored interventions may lead to rapid and clinically significant improvements in symptoms [11].

In summary, although classical exposure therapy remains the gold standard for PTSD treatment, it is increasingly being expanded with additional biological, pharmacological, and psychosocial interventions. These approaches aim to enhance therapeutic effectiveness, improve patient engagement, and reduce the limitations associated with traditional exposure methods.

4. Virtual Reality in PTSD Therapy

Virtual reality (VR) is a modern therapeutic tool that enables the creation of immersive, controlled environments simulating trauma-related situations. In the context of PTSD, the most commonly used approach is Virtual Reality Exposure Therapy (VRET), which represents an extension of classical exposure therapy.

VR allows for precise reproduction of trauma-related stimuli while maintaining full control over their intensity and the course of exposure. This enables gradual and safe confrontation with traumatic memories, representing a significant advantage over traditional imaginal exposure.

The literature emphasizes that VR not only replicates reality but also allows for its modification in a way tailored to the individual needs of the patient, thereby increasing its therapeutic potential [13]. At the same time, the implementation of VR in clinical practice is associated with challenges such as high costs, the need for standardization of therapeutic procedures, and limited availability of specialized equipment [13].

An important direction in the development of VRET is the integration of therapy with additional elements aimed at enhancing its effectiveness. One example is the incorporation of physical activity during therapeutic sessions. In the 3MDR (Multi-modal Motion-assisted Memory Desensitization and Reconsolidation) model, the patient walks on a treadmill while being exposed to trauma-related stimuli in a virtual environment. It is hypothesized that physically “approaching” the stimulus may reduce avoidance behaviors and strengthen the therapeutic effect [12]. Ongoing randomized studies aim to determine whether the addition of movement enhances therapeutic outcomes by intensifying fear extinction processes and reducing avoidance.

VR is also used in research on emotional mechanisms associated with PTSD. Due to its ability to elicit controlled emotional responses, virtual environments provide a valuable tool for analyzing processes such as emotion prediction and individual differences in responses to trauma-related stimuli. Studies indicate that individuals with PTSD may exhibit distinct patterns of emotional processing in VR settings, which may be relevant for therapy personalization [14].

In summary, virtual reality represents a promising extension of traditional exposure therapy, offering greater control over the therapeutic process, increased patient engagement, and the potential for individualized treatment. However, further research is required to better understand its mechanisms of action, effectiveness, and optimal clinical applications.

5. Effectiveness of VRET

Virtual Reality Exposure Therapy (VRET) represents one of the most promising innovations in the treatment of PTSD. In recent years, numerous studies have been conducted to evaluate its effectiveness both as a standalone intervention and in combination with other therapeutic approaches.

Systematic reviews indicate that VRET leads to a significant reduction in PTSD symptoms, particularly when compared to control groups (e.g., waitlist conditions). Therapeutic effects include a decrease in intrusive symptoms, avoidance behaviors, and hyperarousal [15].

Additionally, meta-analyses demonstrate a moderate effect size and sustained improvements in follow-up observations, suggesting the durability of VRET outcomes.

An important direction in research involves combining VRET with neuromodulation techniques. A randomized clinical trial showed that the use of transcranial direct current stimulation (tDCS) in combination with VR therapy may lead to greater reductions in PTSD symptoms compared to exposure therapy alone. This suggests that modulation of neural activity may enhance the therapeutic effects of VRET [16].

The effectiveness of VR-based interventions has also been demonstrated in contexts indirectly related to trauma. In a multicenter randomized controlled trial involving relatives of intensive care unit patients, VR interventions were shown to reduce stress-related and mental health symptoms [17]. Although this study does not directly address PTSD, its findings support the hypothesis that VR may positively influence emotional regulation and stress reduction.

In direct comparisons of exposure modalities, randomized studies indicate that VRET may be at least as effective as traditional imaginal exposure. One study demonstrated that VR exposure combined with a cognitive enhancer resulted in a significant reduction in PTSD symptoms while also improving the efficiency of fear extinction learning [18].

At the same time, it should be emphasized that despite promising results, the effectiveness of VRET may vary depending on the studied population, type of trauma, and applied therapeutic protocol. Literature reviews highlight the need for further research on standardization of interventions and determination of optimal treatment parameters [19].

In summary, current scientific evidence suggests that VRET is an effective method for reducing PTSD symptoms, particularly compared to no treatment, and that its effects may be enhanced through integration with other therapeutic techniques. However, further research is necessary to clearly establish its superiority over traditional forms of exposure therapy.

6. Comparison of VRET with Traditional Exposure Therapy

The comparison of Virtual Reality Exposure Therapy (VRET) with classical forms of exposure therapy, such as imaginal and in vivo exposure, represents a key area of research in optimizing PTSD treatment. Available evidence suggests that both approaches demonstrate similar effectiveness; however, they differ in terms of mechanisms of action, patient engagement, and the therapeutic process.

6.1 Therapeutic Effectiveness

Randomized studies indicate that VRET may be at least as effective as traditional exposure therapy. In a study comparing virtual reality exposure with imaginal exposure, significant reductions in PTSD symptoms were observed in both groups, with VR combined with a cognitive enhancer potentially further increasing therapeutic effectiveness [21].

These findings are consistent with earlier systematic reviews indicating that the effectiveness of VRET is comparable to traditional exposure therapy, particularly in reducing intrusive symptoms and avoidance [22, 24].

At the same time, some studies report no clear superiority of VRET over classical methods, suggesting that its primary value lies not necessarily in greater efficacy but in providing an alternative mode of delivering exposure therapy [25, 27].

6.2 Patient Engagement and Immersion

One of the most important factors differentiating VRET from traditional exposure therapy is the level of patient engagement. VR enables the creation of immersive therapeutic environments, increasing the sense of presence and realism.

Unlike imaginal exposure, which relies on the patient's ability to generate and maintain mental images of traumatic events, VRET provides ready-made sensory stimuli. This may be particularly beneficial for

individuals who have difficulty visualizing trauma. Reviews suggest that higher levels of immersion may lead to greater emotional engagement and more effective processing of traumatic experiences [25, 27].

Moreover, advancements in VR technology allow integration with other therapeutic modalities, such as mindfulness, neuromodulation, and artificial intelligence, potentially further enhancing its therapeutic potential [28, 29].

6.3 Dropout Rates and Treatment Acceptance

A significant limitation of traditional exposure therapy is the relatively high dropout rate, often resulting from the emotional difficulty associated with confronting traumatic memories. In this context, VRET may offer advantages through more controlled and gradual exposure to stress-inducing stimuli.

Although existing studies do not always demonstrate statistically significant differences in dropout rates between VRET and traditional therapy, they indicate a tendency toward better acceptance of VR-based treatment and greater willingness to continue therapy [22, 27].

This may be due to an increased sense of control over the therapeutic process and the ability to adjust stimulus intensity to individual patient needs.

6.4 Limitations and Methodological Differences

Interpretation of comparative study results is complicated by significant methodological differences across studies. These include variability in study populations (e.g., military veterans vs. civilian populations), differences in therapeutic protocols, and lack of standardization in VR interventions.

Additionally, some studies are pilot in nature or represent research protocols only, which limits the ability to draw definitive conclusions regarding comparative effectiveness [20].

At the same time, literature reviews emphasize the need for further large-scale randomized controlled trials and long-term follow-up studies [26].

Summary of Comparison

Current evidence suggests that:

- VRET is at least as effective as traditional exposure therapy
- no clear superiority has been established in terms of PTSD symptom reduction
- VR offers greater immersion and patient engagement, which may improve the therapeutic process
- there is potential for reducing dropout rates, although findings are not conclusive
- the greatest advantage of VRET lies in its flexibility and capacity for personalization

Therefore, VRET should be considered not as a replacement for traditional exposure therapy, but as its modern extension, which may be particularly beneficial for selected patient groups.

Table 1. The comparison indicates that VRET offers several technological and engagement-related advantages while maintaining clinical effectiveness comparable to traditional exposure therapy. The main limitations of VRET include accessibility, cost, and the lack of standardized therapeutic protocols.

Category	VRET (Virtual Reality Exposure Therapy)	Traditional Exposure Therapy (imaginal / in vivo)	Sources
Effectiveness in reducing PTSD symptoms	Comparable effectiveness; significant symptom reduction	Comparable effectiveness; gold standard of treatment	[21, 22, 24, 27]
Therapeutic mechanism	Exposure in an immersive environment; high control over stimuli	Imaginal or real-life exposure	[21, 25]
Patient engagement	High – due to immersion and realism of the experience	Variable – dependent on patient's imaginative ability	[25, 27]
Immersion ("presence")	Very high – 3D environment, multisensory stimuli	Low to moderate – dependent on patient imagination	[25, 27]
Control over stimuli	Very high – precise modulation of stressors	Limited – especially in in vivo exposure	[13, 25]

Personalization of therapy	High – customizable VR scenarios	Limited – dependent on therapist and patient	[13, 27]
Dropout rates	Potentially lower; better treatment acceptance	Often higher – due to avoidance of exposure	[22, 27]
Accessibility	Limited – requires VR equipment and trained personnel	High – widely available method	[13, 25]
Costs	Higher (equipment, software)	Lower	[13]
Integration with other methods	Very high (AI, neuromodulation, movement, mindfulness)	Limited but possible (e.g., CBT + pharmacotherapy)	[16, 28, 29]
Standardization of protocols	Low – lack of unified standards	High – well-established CBT protocols	[20, 26]

7. Future Directions of Research

The dynamic development of research on PTSD and exposure-based therapies, including VRET, highlights the need for further refinement of therapeutic approaches and their better alignment with the complex nature of this disorder. Contemporary research directions increasingly focus on moving beyond the classical, purely fear-based model of PTSD toward more complex, multidimensional frameworks.

Traditional therapeutic approaches, primarily based on fear extinction mechanisms, appear insufficient for a subset of patients, particularly those with more complex forms of PTSD. It is estimated that up to half of patients do not achieve full remission, and a substantial proportion discontinue therapy prematurely [30].

Therefore, future research should focus on integrating new therapeutic models that incorporate identity-related processes, emotions such as shame and guilt, and mechanisms related to emotion regulation.

One of the key directions for development is the creation of more personalized therapeutic interventions. Emerging approaches emphasize tailoring therapy to the type and severity of trauma as well as individual patient characteristics, which may increase treatment effectiveness and reduce dropout rates [30].

In this context, technologies such as virtual reality may play a significant role by enabling the development of individualized therapeutic scenarios.

Another important direction is the integration of psychological therapies with biological and somatic approaches. Research points to the potential of combining exposure-based therapy with neuromodulation techniques and body-oriented interventions, which may support emotional regulation and trauma processing [30].

According to current guidelines from the American Psychological Association (APA), evidence-based therapies—particularly trauma-focused approaches such as exposure therapy, cognitive processing therapy (CPT), and EMDR—demonstrate the highest effectiveness [31].

At the same time, there is a clear need for further research aimed at optimizing these methods and developing new forms of therapy that could improve accessibility and overall treatment outcomes.

In the future, the development of digital technologies such as virtual reality and artificial intelligence may play a crucial role in creating more interactive and accessible therapeutic modalities. The integration of these tools with traditional psychotherapeutic methods may contribute to enhanced treatment effectiveness and better alignment with individual patient needs.

In summary, future research on PTSD therapy should focus on:

- personalization of therapeutic interventions,
- integration of psychological, biological, and technological approaches,
- increasing accessibility of treatment,
- and improving understanding of the complex mechanisms underlying PTSD.

Such an approach may contribute to further improvements in treatment effectiveness and overall quality of life for patients.

8. Discussion

When interpreting findings on the effectiveness of PTSD therapies, it is essential to consider the complexity of the mechanisms underlying this disorder. PTSD is not a homogeneous condition but comprises different subtypes with distinct neurobiological profiles [7].

Neuroinflammatory processes also play a significant role, potentially influencing both symptom severity and treatment response [2].

Additionally, cognitive impairments observed in patients with PTSD may affect their ability to engage in therapy and process traumatic experiences [5, 6].

In light of these factors, the effectiveness of both traditional exposure therapy and VRET should be interpreted cautiously. Both approaches demonstrate comparable efficacy in reducing PTSD symptoms; however, the lack of a clear superiority of one over the other suggests that treatment effectiveness depends more on individual patient characteristics than on the therapeutic modality itself [21, 22, 24].

One of the most important factors differentiating these approaches is the level of immersion and the concept of "presence," defined as the subjective feeling of being in a given environment. In VRET, high immersion may lead to stronger emotional engagement, potentially facilitating more effective processing of traumatic memories. In contrast, traditional imaginal exposure relies heavily on the patient's ability to generate and maintain mental imagery, which may constitute a significant limitation [25, 27].

At the same time, greater immersion does not always directly translate into superior clinical outcomes. However, it may influence the therapeutic process by increasing patient engagement and reducing avoidance behaviors. In this context, VRET may be particularly beneficial for patients who struggle with traditional exposure methods, which is reflected in the observed trend toward lower dropout rates [22, 27]**.**

Another important aspect is the potential for integrating VRET with additional therapeutic interventions. Studies indicate that combining VR-based therapy with neuromodulation techniques, such as transcranial direct current stimulation, may enhance treatment effectiveness by modulating neural activity [16]. Similarly, incorporating physical activity into VR exposure may reduce avoidance behaviors and strengthen therapeutic outcomes [12].

On the other hand, the development and implementation of VRET face significant methodological and practical limitations. Many studies are characterized by small sample sizes, lack of standardized therapeutic protocols, and heterogeneity of study populations, which limits the generalizability of findings [19, 26]**.**

Moreover, some available studies are pilot studies or research protocols, which restricts the ability to draw definitive conclusions [20].

Practical considerations also remain relevant, including the cost of technology, availability of equipment, and the need for specialized therapist training, all of which may limit the widespread implementation of VRET in clinical practice [13].

In conclusion, current evidence suggests that both traditional exposure therapy and VRET are effective treatments for PTSD. The differences between them primarily relate to aspects of the therapeutic experience, such as immersion, patient engagement, and the potential for personalization. Therefore, the future of PTSD treatment may lie not in replacing one method with another, but in their integration and adaptation to individual patient needs.

9. Conclusions

Based on the conducted literature analysis and review of studies on the application of virtual reality in the treatment of post-traumatic stress disorder (PTSD), the following conclusions were drawn:

Therapeutic equivalence:

Virtual Reality Exposure Therapy (VRET) demonstrates effectiveness comparable to traditional exposure therapy (both imaginal and in vivo). VRET represents a fully valid, evidence-based alternative to the "gold standard" of PTSD treatment, particularly in reducing intrusive symptoms and avoidance.

Superiority of immersion over imagination:

A key advantage of VR technology is its ability to provide a high level of immersion and sense of presence. This enables effective fear extinction processes in patients who experience difficulties with trauma visualization or exhibit strong cognitive avoidance mechanisms. As a result, this may lead to better therapy acceptance and potentially lower dropout rates.

High potential for personalization and control:

VRET offers a unique ability to precisely regulate the intensity of stress-inducing stimuli and modify the therapeutic environment in real time. This allows therapy to be closely tailored to the individual clinical profile of the patient, which is difficult to achieve in classical forms of exposure.

Multimodal synergy:

Virtual reality provides an optimal platform for integrating psychological approaches with biological interventions. Combining VRET with neuromodulation techniques (e.g., tDCS, VNS) or physical activity (e.g., the 3MDR model) opens new pathways for enhancing neuroplasticity and treatment effectiveness, particularly in patients resistant to conventional therapies.

Implementation barriers:

Despite its demonstrated effectiveness, the widespread implementation of VRET in clinical practice is currently limited by high technological costs, restricted access to specialized equipment, and insufficient standardization of therapeutic protocols. Future efforts should focus on developing unified clinical guidelines.

REFERENCES

1. Zhang, Z., & Jiang, C. (2025). Childhood maltreatment and mental health: Causal links to depression, anxiety, non-fatal self-harm, suicide attempts, and PTSD. *European Journal of Psychotraumatology, 16*(1), 2480884.
2. Sah, A., & Singewald, N. (2025). The (neuro)inflammatory system in anxiety disorders and PTSD: Potential treatment targets. *Pharmacology & Therapeutics, 269*, 108825.
3. Kooij, L. H., & Hein, I. M. (2025). PTSD symptom changes during trauma-focused cognitive behavioural therapy (TF-CBT) in children and adolescents: A single-case experimental design study. *European Journal of Psychotraumatology, 16*(1), 2538355.
4. Schaug, J. P., & Møller, L. (2025). Psychotherapies for adults with complex presentations of PTSD: A clinical guideline and five systematic reviews with meta-analyses. *BMJ Mental Health, 28*(1), e301158.
5. Aspelund, S. G., & Lorange, H. L. (2025). Assessing neurocognitive outcomes in PTSD: A multilevel meta-analytical approach. *European Journal of Psychotraumatology, 16*(1), 2469978.
6. van Rossum, J. E., & Op den Camp, S. (2025). PTSD and cognition in older adults: A systematic literature review. *Journal of Anxiety Disorders, 114*, 103047.
7. Zhang, C., & Haim-Nachum, S. (2025). PTSD subtypes and their underlying neural biomarkers: A systematic review. *Psychological Medicine, 55*, e153.
8. Powers, M. B., & Hays, S. A. (2025). Vagus nerve stimulation therapy for treatment-resistant PTSD. *Brain Stimulation, 18*(3), 665–675.
9. El-Solh, A. A., & Lawson, Y. (2025). Cognitive behavioral therapy alone or in combination with eszopiclone in comorbid insomnia and obstructive sleep apnea in veterans with posttraumatic stress disorder: A randomized trial. *Psychiatric Quarterly, 96*(4), 787–802.
10. Head, J. H., & Vasquez, N. N. (2025). Integrating cognitive behavioral therapy into music therapy methods using a flexibility within fidelity framework. *Frontiers in Psychiatry, 16*, 1734508.
11. Head, J. H., & Vasquez, N. N. (2025). Integrating cognitive behavioral therapy into music therapy methods using a flexibility within fidelity framework. *Frontiers in Psychiatry, 16*, 1734508.
12. de Haart, R., & Daniels, J. K. (2026). Augmenting virtual reality exposure for PTSD with physical activity: Study protocol of a randomised controlled trial. *European Journal of Psychotraumatology, 17*(1), 2605803.
13. Machado, S., & Paes, F. (2025). Virtual reality: Challenges and perspectives in mental health. *Alpha Psychiatry, 26*(5), 47536.
14. Loisel-Fleuriot, L., & Fovet, T. (2025). An exploratory study of emotional forecasting and experience disparities in PTSD: Insights from a virtual reality paradigm. *European Journal of Psychotraumatology, 16*(1), 2524289.
15. Wiebe, A., & Kannen, K. (2022). Virtual reality in the diagnostic and therapy for mental disorders: A systematic review. *Clinical Psychology Review, 98*, 102213.
16. van 't Wout-Frank, M., & Arulpragasam, A. R. (2024). Virtual reality and transcranial direct current stimulation for posttraumatic stress disorder: A randomized clinical trial. *JAMA Psychiatry, 81*(5), 437–446.
17. Drop, D. L. Q., & Vlake, J. H. (2025). Effect of an intensive care unit virtual reality intervention on relatives' mental health distress: A multicenter, randomized controlled trial. *Critical Care, 29*(1), 62.
18. Difede, J., & Rothbaum, B. O. (2022). Enhancing exposure therapy for posttraumatic stress disorder (PTSD): A randomized clinical trial of virtual reality and imaginal exposure with a cognitive enhancer. *Translational Psychiatry, 12*(1), 299.
19. Machado, S., & Paes, F. (2025). Virtual reality: Challenges and perspectives in mental health. *Alpha Psychiatry, 26*(5), 47536.

20. Buselli, R., & Corsi, M. (2023). Comparison between standard expository cognitive behavioral therapy (CBT-E) and immersive virtual reality CBT (CBT-VR) for rehabilitation of patients affected by occupational stress disorders: Study protocol. *International Journal of Environmental Research and Public Health, 20*(9), 5735.
21. Difede, J., & Rothbaum, B. O. (2022). Enhancing exposure therapy for posttraumatic stress disorder (PTSD): A randomized clinical trial of virtual reality and imaginal exposure with a cognitive enhancer. *Translational Psychiatry, 12*(1), 299.
22. Gonçalves, R., & Pedrozo, A. L. (2012). Efficacy of virtual reality exposure therapy in the treatment of PTSD: A systematic review. *PLoS One, 7*(12), e48469.
23. Li, M., & Patel, J. (2025). The impact of extended reality cognitive behavioral therapy on mental disorders among children and youth: A systematic review and meta-analysis protocol. *PLoS One, 20*(3), e0315313.
24. Canadian Agency for Drugs and Technologies in Health. (2014). Virtual reality exposure therapy for adults with post-traumatic stress disorder: A review of the clinical effectiveness. CADTH Rapid Response Reports.
25. Kim, S., & Kim, E. (2020). The use of virtual reality in psychiatry: A review. *Journal of the Korean Academy of Child and Adolescent Psychiatry, 31*(1), 26–32.
26. Mansour, M., & Joseph, G. R. (2023). Post-traumatic stress disorder: A narrative review of pharmacological and psychotherapeutic interventions. *Cureus, 15*(9), e44905.
27. Rowland, D. P., & Casey, L. M. (2022). A decade in review: A systematic review of virtual reality interventions for emotional disorders. *Psychosocial Intervention, 31*(1), 1–20.
28. Senda, M. C., & Johnson, K. A. (2023). A pilot trial of stepwise implementation of virtual reality mindfulness and accelerated transcranial magnetic stimulation treatments for dysphoria in neuropsychiatric disorders. *Depression and Anxiety, 2023*, 9025984.
29. Savio, A., & Srivastava, M. (2026). A review of artificial intelligence enhanced cognitive behavioural therapy using the BECK AI BOT for mental health interventions. *Discover Mental Health, 6*(1), 43.
30. Burback, L., & Winkler, O. (2025). Evolving psychotherapeutic approaches for PTSD: Beyond the fear-based model. *Psychiatry and Clinical Psychopharmacology, 35*(Suppl. 1), S152–S167.
31. Pappas, S. (2025). PTSD and trauma: New APA guidelines highlight evidence-based treatments. *Monitor on Psychology, 56*(5), 44.