The impact of virtual reality exposure therapy in the treatment of PTSD and anxiety disorders

O impacto da terapia de exposição à realidade virtual no tratamento de TEPT e transtornos de ansiedade

El impacto de la terapia de exposición a la realidad virtual en el tratamiento del TEPT y los trastornos de ansiedad

1 Kirolos Eskandar   ORCID

ABSTRACT:

Virtual Reality Exposure Therapy (VRET) has emerged as an innovative and effective tool in the treatment of Post-Traumatic Stress Disorder (PTSD) and anxiety disorders. By providing a controlled and immersive environment, VRET facilitates the desensitization and extinction of fear

responses. The review process adhered strictly to the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines. This literature review systematically evaluates the mechanisms through which VRET enhances therapeutic outcomes, offering a comparison with traditional exposure therapies. The review focuses on the clinical applications of VRET in PTSD and various anxiety disorders, highlighting its advantages, such as increased patient engagement, flexibility in treatment customization, and sustained symptom relief. However, challenges such as technological limitations, accessibility issues, and ethical considerations are also critically examined. The review concludes by discussing future directions for VRET, underscoring its potential to transform mental health care through the integration of advanced technologies and personalized treatment approaches.

Keywords: virtual reality exposure therapy (VRET), post-traumatic stress disorder (PTSD), anxiety disorders, desensitization, immersive therapy, treatment customization, mental health innovation

RESUMO:
A Terapia de Exposição à Realidade Virtual (VRET) emergiu como uma ferramenta inovadora e eficaz no tratamento do Transtorno de Estresse Pós-Traumático (TEPT) e transtornos de ansiedade. Ao proporcionar um ambiente controlado e imersivo, o VRET facilita a dessensibilização e extinção das respostas ao medo. O processo de revisão seguiu rigorosamente as diretrizes PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses). Esta revisão da literatura avalia sistematicamente os mecanismos através dos quais o VRET melhora os resultados terapêuticos, oferecendo uma comparação com as terapias de exposição tradicionais. A revisão centra-se nas aplicações clínicas do VRET no TEPT e em vários transtornos de ansiedade, destacando suas vantagens, como maior envolvimento do paciente, flexibilidade na personalização do tratamento e alívio sustentado dos sintomas. No entanto, desafios como limitações tecnológicas, questões de acessibilidade e considerações éticas também são examinados criticamente. A revisão conclui discutindo as direções futuras para VRET, sublinhando o seu potencial para transformar os cuidados de saúde mental através da integração de tecnologias avançadas e abordagens de tratamento personalizadas.

RESUMEN:
La terapia de exposición a la realidad virtual (VRET) se ha convertido en una herramienta innovadora y eficaz en el tratamiento del trastorno de estrés postraumático (TEPT) y los trastornos de ansiedad. Al proporcionar un entorno controlado e inmersivo, VRET facilita la desensibilización y extinción de las respuestas de miedo. El proceso de revisión se adhirió estrictamente a las pautas PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses). Esta revisión de la literatura evalúa sistemáticamente los mecanismos a través de los cuales VRET mejora los resultados terapéuticos, ofreciendo una comparación con las terapias de exposición tradicionales. La revisión se centra en las aplicaciones clínicas de VRET en el trastorno de estrés postraumático y diversos trastornos de ansiedad, destacando sus ventajas, como una mayor participación del paciente, flexibilidad en la personalización del tratamiento y alivio sostenido de los síntomas. Sin embargo, también se examinan críticamente desafíos como las limitaciones tecnológicas, los problemas de accesibilidad y las consideraciones éticas. La revisión concluye analizando las direcciones futuras de VRET, subrayando su potencial para transformar la atención de salud mental mediante la integración de tecnologías avanzadas y enfoques de tratamiento personalizados.

Introduction

Virtual Reality Exposure Therapy (VRET) represents a significant innovation in psychological treatment, particularly for anxiety disorders and PTSD. It is a form of cognitive-behavioral therapy (CBT) that uses virtual reality (VR) to expose patients to simulations of their feared environments or situations. By immersing patients in a controlled, computer-generated environment, VRET facilitates gradual exposure to anxiety-provoking

stimuli in a safe and controlled setting, enabling the desensitization process critical to overcoming these fears [1].

The evolution of exposure therapy dates back to the mid-20th century, rooted in behavioral therapy principles. Traditional exposure therapy typically involves in vivo (real-life) or imaginal exposure, where patients confront their fears either directly or through vivid imagination. However, these methods have limitations. In vivo exposure, while effective, can be logistically challenging or even impossible for some phobias (e.g., fear of flying). Imaginal exposure relies heavily on the patient's ability to visualize, which not all patients can do effectively [2].

VRET emerged in the 1990s as a solution to these challenges, combining the immersive aspects of in vivo exposure with the flexibility of imaginal exposure. Unlike traditional methods, VRET allows for precise control over the intensity and nature of the stimuli presented, which can be gradually adjusted according to the patient's progress. This level of control reduces the risk of overwhelming the patient, a common concern in traditional exposure therapy, thus making the treatment more tolerable and potentially more effective [3].

Moreover, VRET offers distinct advantages by simulating environments that would be difficult, dangerous, or impossible to replicate in real life. For instance, veterans with PTSD can be immersed in a virtual combat environment that closely mimics their traumatic experiences, allowing for systematic desensitization without the associated real-world risks [4]. The immersive nature of VR also engages multiple senses, making the experience more vivid and potentially more effective than traditional imaginal exposure.

However, the effectiveness of VRET varies depending on several factors, including the number of sessions required, the longevity of the therapeutic effects, and the specific clinical context. For example, the number of sessions needed to observe significant improvement can vary, and it is crucial to understand how long these effects last post-treatment. Additionally, VRET might not be suitable for all patients, and contraindications or instances of unsuccessful treatments should be discussed. PTSD itself can result from diverse causes, such as combat or sexual abuse, which may lead to varying treatment outcomes across different populations. This raises the question of how generalizable the results are across different approaches and contexts within VRET.

In summary, while VRET is a modern extension of traditional exposure therapy that leverages advancements in VR technology to offer more flexible, controlled, and immersive therapeutic experiences, further critical examination of its clinical benefits, contraindications, and applicability across various contexts is necessary. This review aims to critically assess the effectiveness of VRET in treating PTSD and anxiety disorders, focusing on the clinical outcomes, potential limitations, and future implications for practice [1, 5].

Methodology
Study design

This literature review was conducted using a systematic approach to assess the impact of Virtual Reality Exposure Therapy (VRET) in the treatment of Post-Traumatic Stress Disorder (PTSD) and anxiety disorders. The review process adhered strictly to the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines, ensuring a comprehensive and transparent evaluation of the existing literature.

Search strategy

A thorough and systematic search was conducted across multiple reputable electronic databases: PubMed, Google Scholar, Scopus, and Web of Science. The search aimed to identify all relevant studies published up until [insert cutoff date here]. The search terms were carefully selected to encompass the key aspects of VRET and its application in PTSD and anxiety disorders. The primary keywords used were: "Virtual Reality Exposure Therapy (VRET)," "Post-Traumatic Stress Disorder," "PTSD," "Anxiety Disorders," "Desensitization," "Immersive Therapy," and related terms. Boolean operators (AND, OR) were employed to combine these terms effectively and expand the search scope.

Inclusion and exclusion criteria

To ensure the relevance and quality of the studies included in this review, the following inclusion criteria were applied:

• Language: Only studies published in English were considered.

• Focus: Studies must focus explicitly on Virtual Reality Exposure Therapy.

• Population: The studies must involve participants diagnosed with PTSD or any form of anxiety disorder.

• Outcome Measures: Studies must report measurable outcomes related to the effectiveness of VRET in treating PTSD or anxiety disorders, including symptom reduction, patient engagement, and long-term effects.

Exclusion criteria were also rigorously applied to refine the selection process:

•   Duplicate Studies: Any duplicates identified across the databases were removed.

•   Non-Peer-Reviewed Articles: Grey literature, such as dissertations, conference papers, and non-peer-reviewed articles, were excluded.

•   Studies Without Full Text: Studies for which the full text was not available were excluded.

•   Non-Clinical Studies: Research that did not involve clinical outcomes (e.g., theoretical papers, technical papers on VR development) was excluded.

Study Selection Process

The initial database search yielded 131 studies. After removing duplicates, the remaining articles were screened based on their titles and abstracts. Articles that clearly did not meet the inclusion criteria were excluded during this phase. Subsequently, the full texts of the remaining studies were retrieved and thoroughly reviewed for eligibility.

Each study was independently reviewed by two authors to ensure consistency and minimize bias in the selection process. Discrepancies between reviewers were resolved through discussion or consultation with a third author when necessary.

Data Extraction

A structured data extraction form was developed to systematically collect relevant information from each selected study. The key data extracted included:

•   Study Characteristics: Author(s), year of publication, study design (e.g., randomized controlled trial, cohort study), and setting.

•   Participant Details: Sample size, demographic information (e.g., age, gender), and diagnosis (e.g., PTSD, social anxiety disorder).

•   Intervention Details: Description of the VRET intervention, including the duration and number of sessions, type of VR environment used, and any adjunctive therapies involved.

•   Outcomes: Primary and secondary outcomes reported, such as symptom reduction, patient adherence, and follow-up results.

•   Quality Assessment: Methodological quality of the studies, including randomization, blinding, and attrition rates, was assessed using standardized tools, such as the Cochrane Risk of Bias Tool for randomized trials or the Newcastle-Ottawa Scale for observational studies.

Quality Assessment

The quality of the included studies was rigorously evaluated to assess the risk of bias and the overall strength of the evidence. Randomized controlled trials were assessed using the Cochrane Risk of Bias Tool, focusing on aspects such as sequence generation, allocation concealment, blinding of participants and personnel, and incomplete outcome data. Observational studies were assessed using the Newcastle-Ottawa Scale, which considers selection bias, comparability of study groups, and the assessment of outcomes.

Data Synthesis

A qualitative synthesis of the data was performed, focusing on the effectiveness of VRET in reducing symptoms of PTSD and anxiety disorders. Studies were grouped based on their primary outcomes, and a narrative synthesis was developed to summarize the findings. Where appropriate, meta-analytic techniques were considered to quantify the effects across studies, although this was contingent on the homogeneity of the study designs and outcome measures.

PRISMA Flow Diagram

To provide a transparent overview of the study selection process, a PRISMA flow diagram was generated using a PRISMA flow diagram generator tool. The diagram illustrates the number of records identified, screened, and included in the review, along with detailed reasons for exclusion at each stage [Figure 1].

Results

Study selection and characteristics

Out of the 131 articles initially identified through the systematic search, 25 studies met the inclusion criteria after removing duplicates and applying exclusion criteria. These studies encompassed various applications of Virtual Reality Exposure Therapy (VRET) in the treatment of PTSD and anxiety disorders, providing a broad perspective on its effectiveness and clinical utility.

• Study Design: The selected studies included randomized controlled trials (RCTs), pilot studies, and systematic reviews. Most studies were conducted in the past decade, reflecting the growing interest in VRET as a therapeutic modality.

• Population: The studies involved diverse populations, including military veterans, adolescents, and adults with PTSD or various anxiety

disorders (e.g., social anxiety disorder, generalized anxiety disorder). The sample sizes varied, with some studies involving small cohorts (e.g., pilot studies) and others large-scale clinical trials.

• Interventions: VRET interventions varied significantly in terms of the virtual environments used, session duration, and the total number of sessions. Most studies reported using graded exposure techniques, with the flexibility to adjust the intensity of exposure based on patient progress.

Global analysis of selected studies

The selected studies were representative of a broad geographical distribution, though a significant portion originated from Western countries, particularly the United States. This geographic bias may influence the generalizability of the results to non-Western populations, which is an important consideration for future research.

• Publication Sources: The studies were published in reputable, peer-reviewed journals, including those specializing in psychiatry, psychology, and digital health. This indicates that the research is recognized within the academic community and contributes to the growing body of evidence supporting VRET.

• Quality Assessment: The scientific quality of the included studies was evaluated using standardized tools. Most studies demonstrated low to moderate risk of bias, with well-reported methodologies. However, some studies, particularly older ones, lacked sufficient detail regarding randomization and blinding procedures, which could affect the validity of their findings.

Descriptive summary of study findings

• Effectiveness of VRET: The majority of the studies reported positive outcomes for VRET in reducing symptoms of PTSD and anxiety disorders. For instance, [6] found that VRET led to significant reductions in PTSD symptoms, with effects comparable to traditional exposure therapies. Similarly, [7] noted that VRET was particularly effective in treating social anxiety disorder, with patients showing faster improvement compared to in vivo exposure.

• Duration of Effects: Several studies highlighted the lasting impact of VRET, with follow-up assessments indicating sustained symptom reduction up to six months post-treatment. However, long-term efficacy beyond one year was less frequently reported, suggesting a need for further research in this area.

• Patient Engagement: Studies consistently reported high levels of patient engagement with VRET, attributing this to the immersive and interactive nature of VR environments. This increased engagement was linked to better therapeutic outcomes, as noted by Boeldt et al. [5].

• Limitations and Challenges: Despite the promising results, some studies identified challenges, such as technological limitations, cybersickness, and the need for specialized equipment. Moreover, a few studies reported cases where VRET was less effective, particularly in patients with severe psychiatric conditions or those who did not achieve adequate immersion in the virtual environment.

Critical analysis and representativeness

While the findings support the use of VRET as an effective treatment for PTSD and anxiety disorders, the representativeness of the studies is limited by geographic and demographic factors. Most studies were conducted in Western settings, with predominantly adult participants, which may limit the applicability of the results to other populations, such as non-Western countries or pediatric patients.

• Scientific Soundness: The overall scientific rigor of the selected studies was satisfactory, but there were notable variations in methodological quality. Studies with larger sample sizes and robust study designs (e.g., RCTs) provided more reliable evidence, while pilot studies and those with smaller samples offered preliminary insights but with greater uncertainty.

• Tool for Quality Assessment: The Cochrane Risk of Bias Tool and Newcastle-Ottawa Scale were used to evaluate the quality of the studies. The findings suggest that while VRET is a promising therapy, the evidence base could be strengthened by more high-quality, large-scale RCTs and studies with diverse populations.

Summary table

A summary table [Table 1] is provided below, detailing the characteristics and key findings of each study included in the review. This table includes information on study design, population, intervention specifics, outcome measures, and quality assessment scores.

Mechanisms of action in virtual reality exposure therapy

Virtual Reality Exposure Therapy (VRET) operates through intricate psychological and physiological mechanisms that enhance its effectiveness in treating anxiety disorders and PTSD. A critical element of VRET's success is its ability to create a highly immersive and controlled environment, often referred to as "presence," where patients can safely confront their fears. This sense of presence is essential for replicating real-world scenarios in a virtual space, allowing patients to engage with and process their anxieties without the risks associated with actual exposure.

The psychological foundation of VRET lies in principles of classical conditioning and cognitive-behavioral therapy (CBT). In VRET, patients are repeatedly exposed to anxiety-triggering stimuli within a virtual environment, leading to a gradual reduction in their fear response—a process known as desensitization. Over time, this repeated exposure facilitates fear extinction, where the anxiety linked to the stimuli significantly diminishes [8]. However, it is important to note that the degree of effectiveness can vary based on the realism and adaptability of the virtual environments used, as well as individual differences in patients' ability to immerse themselves in the virtual scenarios.

On a physiological level, VRET engages the brain's fear circuitry, particularly the amygdala, which plays a crucial role in threat processing. By repeatedly exposing the brain to feared stimuli in a controlled virtual setting, VRET recalibrates the brain's response, reducing amygdala hyperactivity and enhancing regulation through the prefrontal cortex. This not only diminishes the fear response but also promotes cognitive restructuring, enabling patients to develop healthier responses to anxiety-provoking situations [9]. It is important to critically assess these mechanisms, considering that some studies suggest variability in outcomes depending on the intensity and duration of exposure, as well as the individual patient's baseline neurophysiological state.

The role of presence and realism is critical in VRET, as these factors enhance the therapy's effectiveness. Advances in VR technology have enabled the creation of highly detailed and responsive environments that closely mimic real-world experiences, thereby improving therapeutic outcomes. However, the success of VRET also depends on the patient's level of immersion, which can vary significantly and impact the therapy's effectiveness [10]. Future research should focus on optimizing these variables to maximize therapeutic benefits across diverse patient populations.

Clinical applications of VRET in PTSD

In the treatment of PTSD, Virtual Reality Exposure Therapy (VRET) provides a novel approach by immersing patients in controlled virtual environments that facilitate the desensitization and extinction of traumatic memories. PTSD, which can be triggered by various traumatic events such as combat or severe accidents, manifests through symptoms like intrusive thoughts, avoidance behaviors, negative mood, and heightened arousal. Traditional treatments for PTSD, including cognitive-behavioral therapy (CBT), exposure therapy, and pharmacotherapy, often face limitations in engaging patients, particularly when it comes to revisiting traumatic memories.

VRET addresses these challenges by offering a highly immersive experience that allows patients to confront trauma-related cues in a safe, controlled manner. This controlled exposure helps reduce emotional reactivity to these triggers over time, making it particularly beneficial for individuals who struggle with recalling or visualizing traumatic events. The ability to tailor virtual environments to specific trauma scenarios, such as combat zones for veterans, enhances the relevance and effectiveness of the therapy, leading to more significant improvements in PTSD symptoms compared to traditional methods.

Clinical trials and case studies consistently support the efficacy of VRET in reducing PTSD symptoms. For instance, a meta-analysis demonstrated that VRET, particularly in its graded exposure form, produces substantial improvements in PTSD symptoms, often surpassing the results of traditional exposure therapies [6, 11]. However, these results must be interpreted with caution, as the success of VRET can be influenced by factors such as the patient's engagement level, the severity of symptoms, and the presence of comorbid conditions.

The advantages of VRET extend beyond its therapeutic efficacy. As technology advances, VRET can be delivered through more cost-effective and portable devices, broadening its accessibility to various patient populations. The immersive nature of VRET is crucial for engaging patients with the therapeutic content, leading to more robust treatment outcomes [12]. However, it is essential to address the potential limitations related to accessibility and patient adaptability to VR environments, which may affect the generalizability of these findings.

Clinical applications of VRET in anxiety disorders

Virtual Reality Exposure Therapy (VRET) has gained prominence as an effective treatment for various anxiety disorders, offering a compelling alternative to traditional therapeutic approaches. Anxiety disorders, including social anxiety disorder (SAD), generalized anxiety disorder (GAD), panic disorder, and agoraphobia, are characterized by excessive fear and avoidance behaviors, which significantly impair daily functioning. While conventional treatments like cognitive-behavioral therapy (CBT) with exposure elements have shown efficacy, VRET enhances these treatments by providing a highly immersive environment that simulates anxiety-provoking situations in a controlled, virtual setting.

VRET is particularly beneficial for treating social anxiety disorder and panic disorder, with or without agoraphobia. In these contexts, VRET allows patients to confront feared stimuli—such as public speaking scenarios or enclosed spaces—gradually and repeatedly, leading to desensitization and reduced anxiety responses. The adaptability of VRET is a significant advantage, as it can be customized to mirror individual patients' triggers, making the therapy more relevant and effective.

Comparative studies have shown that VRET is as effective, if not more so, than traditional exposure therapy. For example, studies have demonstrated that patients undergoing VRET report significant improvements in anxiety symptoms, often achieving these results more quickly than those using in vivo exposure [13, 14]. This suggests that VRET not only matches but can exceed traditional methods in terms of efficacy, particularly when the therapy is tailored to the patient's specific needs.

The growing evidence from clinical trials and meta-analyses supports the efficacy of VRET in treating anxiety disorders. These studies highlight not only the effectiveness of VRET in reducing anxiety symptoms but also its potential to enhance the overall therapeutic experience by providing a safe and controlled environment for exposure. This enhanced environment leads to improved patient outcomes [7, 15]. However, future research should continue to explore the long-term effectiveness of VRET and address potential limitations such as technological accessibility and individual differences in response to virtual environments.

Advantages of VRET over traditional exposure therapy

Virtual Reality Exposure Therapy (VRET) presents several advantages over traditional exposure therapy, making it a more flexible and engaging option

for patients. One of the primary benefits is its ability to customize and control the therapeutic environment. Unlike traditional exposure therapy, which relies on real-world settings that may be difficult to control, VRET allows therapists to create tailored virtual scenarios that precisely match the patient's fears or anxieties. This customization ensures that patients are exposed to stimuli most relevant to their condition, thereby enhancing the therapeutic process and potentially leading to more effective outcomes [16].

Another significant advantage of VRET is its potential for increased accessibility, particularly through remote therapy options. With advancements in technology, VRET can be delivered via various platforms, including VR headsets compatible with smartphones. This capability allows patients to undergo therapy from the comfort of their homes, which is particularly beneficial for those with mobility issues or those living in remote areas. Additionally, the option for remote therapy reduces the need for in-person sessions, thereby making mental health care more widely available and reducing barriers to treatment [17]. However, it is essential to recognize that while VRET's accessibility is a notable strength, it may also depend on patients' technological literacy and access to the required equipment.

Patient acceptance and engagement are also higher with VRET compared to traditional methods. Traditional exposure therapy can be daunting, as it involves direct exposure to real-life situations that trigger anxiety. VRET mitigates this issue by providing a safe, controlled virtual environment where patients can gradually confront their fears. The immersive nature of VR often makes the scenarios feel less intimidating than real-life exposure, thereby increasing patient engagement and making it easier for patients to fully participate in their treatment [18]. However, the level of engagement and the therapy's effectiveness may still vary depending on the patient's ability to experience presence within the virtual environment.

Challenges and limitations of VRET

Despite its significant advantages, Virtual Reality Exposure Therapy (VRET) is not without its challenges and limitations. A major issue is the technological barriers that can limit accessibility. The cost of the necessary hardware, such as high-end VR headsets and powerful computers, can be prohibitive, particularly for smaller clinics and individual practitioners. Additionally, the rapid pace of technological advancement necessitates ongoing maintenance and upgrades, further driving up costs and

potentially limiting the widespread adoption of VRET [19]. These financial constraints could pose a significant barrier to integrating VRET into standard clinical practice, especially in low-resource settings.

Accessibility is another critical concern. Although VR technology is becoming more widespread, there are still significant disparities in access, particularly in low-income or rural regions. This digital divide may exacerbate existing disparities in mental health care, limiting the reach of VRET to those who could benefit most from it [20]. Furthermore, the requirement for specialized knowledge to operate and troubleshoot VR systems can challenge healthcare providers, who may not possess the necessary technical expertise [21]. These factors highlight the importance of considering both the technological and logistical aspects of VRET implementation.

Ethical considerations also play a crucial role in the deployment of VRET. Ensuring patient safety is paramount, particularly concerning cybersickness—a form of motion sickness triggered by VR environments. Symptoms such as nausea, dizziness, and disorientation may disrupt the therapeutic process and be distressing for patients. Moreover, the immersive nature of VR could lead to adverse reactions, especially in individuals with severe psychiatric conditions, necessitating careful patient selection and ongoing monitoring throughout the treatment [22]. These ethical concerns must be carefully managed to avoid potential harm to patients.

Individual differences in response to VRET also present a challenge. Factors such as age, cognitive abilities, and prior exposure to technology can influence how patients experience and respond to VR environments. For instance, older adults or those with limited experience with digital technology may find the VR environment less intuitive or more challenging to navigate, potentially reducing the therapy's effectiveness. Additionally, some patients may not experience the necessary level of presence or immersion in the virtual environment, which is critical for the success of exposure therapy [21, 23]. These individual differences underscore the need for personalized approaches within VRET to maximize its therapeutic benefits.

Future directions in VRET
The future of Virtual Reality Exposure Therapy (VRET) is poised to be significantly shaped by advancements in technology, particularly through

the integration of artificial intelligence (AI), augmented reality (AR), and biofeedback. AI can enhance VRET by providing real-time data analysis and enabling personalized adjustments to the therapy based on individual patient responses. For instance, machine learning algorithms can analyze physiological signals such as heart rate or EEG data to detect emotional states and optimize the therapy accordingly. This allows for a more tailored approach, ensuring that the therapeutic stimuli are adjusted to the patient's current emotional and physiological state, thereby increasing the efficacy of the treatment [24].

The use of AR in VRET represents another promising development, where real-world elements are augmented with virtual components to create a more immersive and contextually relevant therapeutic environment. This approach can be particularly useful in treating conditions like PTSD or phobias, where real-world triggers are replicated and gradually introduced in a controlled manner, allowing for effective desensitization without exposing patients to actual danger [25]. However, the integration of AR into VRET also introduces new challenges, such as ensuring the seamless integration of real and virtual elements and managing the potential for sensory overload.

Moreover, VRET's expansion into other psychiatric conditions beyond anxiety and PTSD is an emerging trend. Disorders such as Obsessive-Compulsive Disorder (OCD) and addiction are beginning to see applications of VRET, where the controlled, immersive environments help patients confront and manage their compulsions or cravings. This expansion highlights the versatility of VRET and its potential to become a cornerstone in personalized and precision psychiatry, where treatments are specifically designed to match the unique characteristics of each patient [25]. As VRET continues to evolve, ongoing research will be essential to explore its effectiveness across a broader range of conditions and to refine the technology to enhance its therapeutic potential.

Conclusion

In conclusion, Virtual Reality Exposure Therapy (VRET) represents a significant advancement in psychiatry, offering innovative and effective treatment options for PTSD, anxiety disorders, and potentially other psychiatric conditions. By leveraging the immersive capabilities of VR, VRET enhances traditional exposure therapy by providing customizable, controlled environments that improve patient engagement and therapeutic outcomes. Despite its many advantages, VRET faces challenges related to

technological accessibility, ethical considerations, and individual variability in treatment response. As technology continues to evolve, integrating AI, augmented reality, and biofeedback into VRET will likely expand its applications, paving the way for more personalized and precision-based psychiatric care.

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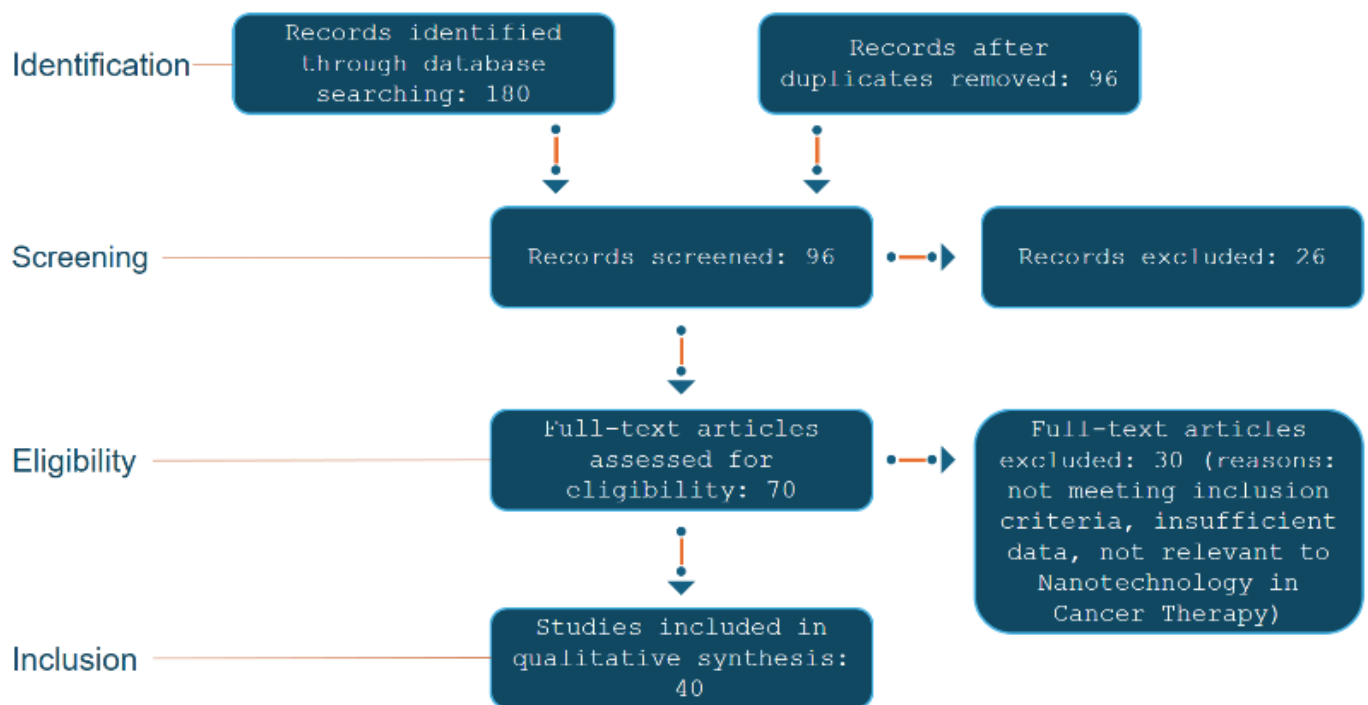
Figure 1. Illustrates the PRISMA flow diagram

Table 1. Provides a concise overview of the key findings from the selected studies, illustrating the diversity of study designs, populations, and outcomes related to VRET

Study	Design	Population	Intervention	Outcome Measures	Key Findings	Quality Score
Geraets et al. (2019) [2]	Pilot Study	Adults with SAD	VRET (social scenarios)	Symptom reduction, patient adherence	Significant reduction in social anxiety symptoms	Moderate
Kothgassner et al. (2019) [6]	Meta-Analysis	PTSD patients (various causes)	VRET (combat, trauma-related scenarios)	PTSD symptom reduction	Significant reduction in PTSD symptoms across studies	High
Boeldt et al. (2019) [5]	Review	Anxiety disorder patients	VRET (varied)	Patient engagement, therapeutic outcomes	High engagement, better outcomes than traditional therapy	High
Rothbaum & Rothbaum (2024) [10]	RCT	PTSD and anxiety disorder patients	VRET (customized VR environments)	Symptom reduction, side effects (e.g., cybersickness)	VRET effective, but effectiveness varies based on patient characteristics	High
Heo & Park (2022) [11]	Systematic Review	PTSD patients	VRET (graded exposure)	Long-term symptom reduction	Sustained effects up to 6 months post-treatment	High