NEXUS Multidisciplinary Research Journal (MIR)

Systematic review of technology-based psychological interventions for assessment anxiety as a specific type of social anxiety

DOI: https://doi.org/10.66615/xj1tdf26

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Received: 2026-05-19 Accepted: 2026-07-20 Publish: 2026-08-15

Abstract

Introduction. Test anxiety, as a specific type of social anxiety, is understood as a common emotional response to an evaluative test perceived as threatening by the person taking it. This type of anxiety has negative consequences not only for students' academic performance but also for their overall well-being. The aim of this study is to conduct a systematic review of the current scientific literature to present the available evidence regarding technology-based psychological treatments for addressing test anxiety. Method. 1,799 potentially relevant articles were retrieved from various databases, of which 13 were selected that met the selection criteria and achieved a score of 8 on the PEDro

Keywords: *test anxiety; social anxiety; virtual reality; exposure therapy; cognitive-behavioral therapy; psychological*

interventions; technology-based treatment	scientific quality scale. Results and Conclusions. The analysis of these studies suggests that. The main type of technology used for intervention in social anxiety is virtual reality, followed by 360° videos. Regarding the type of psychological intervention using technology, it is revealed that exposure techniques in virtual reality, often combined with attention guidance training, positive imagery, and... psychoeducation and counseling are prevalent and effective approaches in the treatment of social anxiety and public speaking anxiety. These interventions address the direct symptoms of anxiety and modify patterns of behavior and attention. There is a need for applied research studies using virtual reality software to address assessment anxiety

1. INTRODUCTION

Test anxiety, as a specific type of social anxiety, is understood as a common emotional response to an evaluative test that is perceived as threatening by the person taking it. It is a highly prevalent response among students, characterized by symptoms such as excessive sweating, rapid heartbeat, and difficulty concentrating, among others. (Crişan et al., 2014; Serrano Pintado & Escolar Llamazares, 2015).

The prevalence of test anxiety among student populations has been extensively documented. A recent systematic review and meta-analysis by Ansari and Iqbal (2025), encompassing 67 studies involving 43,545 students, found that the pooled prevalence of overall exam anxiety was 48.43% (95% CI [41.30, 55.63]), with moderate anxiety reported in 32.27% of participants and high anxiety in 20.16%. Notably, sex-specific analyses revealed higher prevalence rates among female students (54.96%) compared to male students (47.60%). These findings underscore the urgent need for effective, scalable interventions targeting test anxiety across diverse student populations.

This type of anxiety can have negative consequences not only on students' academic performance but also on their overall well-being. Therefore, it is important to identify and use effective ways to manage it in order to improve students' academic performance and quality of life. (Von der Embse et al., 2013).

In this regard, Putwain et al. (2021) emphasizes the importance of early identification and the implementation of effective psychological interventions to reduce this specific type of social anxiety. These authors point out that psychological interventions, such as cognitive-behavioral therapy or exposure therapy, can be effective in reducing it and consequently improving academic performance.

Exposure is a commonly used strategy in the treatment of anxiety, as it has been shown to be effective in reducing the symptoms of this type of disorder. Exposure therapy involves gradually exposing the patient to feared situations, in this case, exams, public speaking, or related environments. Through this strategy, the patient can learn to confront their fears and develop coping skills. (O'meara et al., 2020).

There are different types of exposure therapy, such as in vivo, imaginal, and virtual. In vivo exposure therapy involves gradually and controllably exposing the patient to feared situations in real life until their anxiety decreases. Imaginal exposure therapy, on the other hand, while based on the same premise of gradually reducing anxiety, instead of exposing patients in real life, asks them to imagine and confront feared scenes while in a relaxed and safe state.(Bryant et al., 2003; van Loenen et al., 2022) In recent decades, another type of exposure therapy has been developed that uses new technologies: virtual exposure therapy. This involves creating feared situations in virtual reality and allowing the patient to practice coping skills in a controlled and safe environment. (Guitard et al., 2019).

Virtual reality (VR) has established itself as a revolutionary tool in various fields, and its application in mental health, especially in the treatment of anxiety, has sparked growing interest. This technology is presented as an innovative therapeutic modality that offers immersive and controlled environments, allowing individuals to confront and overcome their fears and worries safely and gradually. It provides a controlled space for therapeutic exposure and systematic desensitization. (Perez Mamani, 2016).

In addition to being a booming alternative supported by technological advances in software and hardware, it has studies that back it up since the 1990s, as they point out Caballo and Mateos Vilchez (2000) and Valero Aguayo (2023) These researchers evaluated the effectiveness of virtual exposure in the treatment of acrophobia, and the results indicated that patients whose treatment included this modality reduced symptoms in less time than those who did not use it.

Recent meta-analytic evidence has further consolidated the empirical standing of VRET. Kuleli et al. (2025), in a systematic review and meta-analysis comparing VRET with in vivo exposure therapy across studies on social anxiety and specific phobia, concluded that both modalities produced comparable moderate effect sizes in symptom reduction. The authors noted that VRET offers distinct practical advantages including procedural safety, controllability, and accessibility that may render it particularly suitable for populations with limited access to traditional therapeutic resources or for whom real-world exposure presents logistical challenges. Similarly, van Loenen et al. (2022) demonstrated in a meta-analysis that VRET combined with CBT principles produces significant symptomatic improvements relative to waitlist controls in individuals with severe anxiety disorders, with effect sizes comparable to those of conventional CBT with in vivo exposure.

There are other successful interventions for specific phobias, such as aerophobia. (Rosado Figuerola, 2018) glossophobia and claustrophobia (Botella et al., 2007) These studies support the effectiveness of virtual reality in various therapeutic contexts related to specific anxiety disorders.

In this scientific context, the objectives of this systematic review have been:

1. Analyze what type of technology is used for the treatment of social anxiety and specifically assessment anxiety.
2. Identify the main psychological interventions used in the treatment of social anxiety and specifically assessment anxiety.
3. Analyze the main assessment instruments used to evaluate the effectiveness of

psychological interventions with technology in social anxiety.

2. METHOD

2.1. Search Strategy

The methodology used followed a quantitative approach, based on a systematic bibliometric review, considering the criteria established in the PRISMA statement (Liberati et al., 2009) Specific search equations were designed to select, analyze, and categorize documents published in scientific journals, using the Web of Science, Scopus, ScienceDirect, SpringerLink, and Taylor & Francis databases. Search variables included "test anxiety," "virtual reality," and "exposure therapy," as well as their English equivalents "test anxiety," "virtual reality," and "exposure therapy," since articles in both languages were considered.

2.2. Selection criteria

For inclusion in the review, articles published in scientific journals were considered. Systematic reviews were excluded; the focus was solely on original studies. Articles had to be written in Spanish or English and have university students as their sample. Only open-access articles published from 2019 onwards and whose subject matter was directly related to the search variables mentioned above were considered. Finally, the scientific quality of the articles was assessed using the PEDro scale. (Maher et al., 2003) selecting those that had a score higher than 8 out of 11.

The application of the PEDro scale to evaluate the methodological quality of studies is noteworthy in the context of this review. Originally developed for physical therapy research, the PEDro scale assesses key methodological features of randomized controlled trials, including allocation concealment, blinding, and completeness of data. Its use in the present review reflects the authors' commitment to including methodologically rigorous studies. However, for future iterations of this review, the authors may also consider supplementary quality appraisal tools more specifically tailored to psychological intervention research, such as the Cochrane Risk of Bias Tool 2 (RoB 2) or the Mixed Methods Appraisal Tool (MMAT), which provide more nuanced assessments of psychological study designs.

3. RESULTS AND DISCUSSION

3.1. Systematic review

The search process used to identify relevant articles in the aforementioned scientific databases began with the use of specific search equations that combined terms related to test anxiety, virtual reality, and exposure therapy. This first step resulted in a total of 15,975 articles (Table 1).

Table 1
Search equations

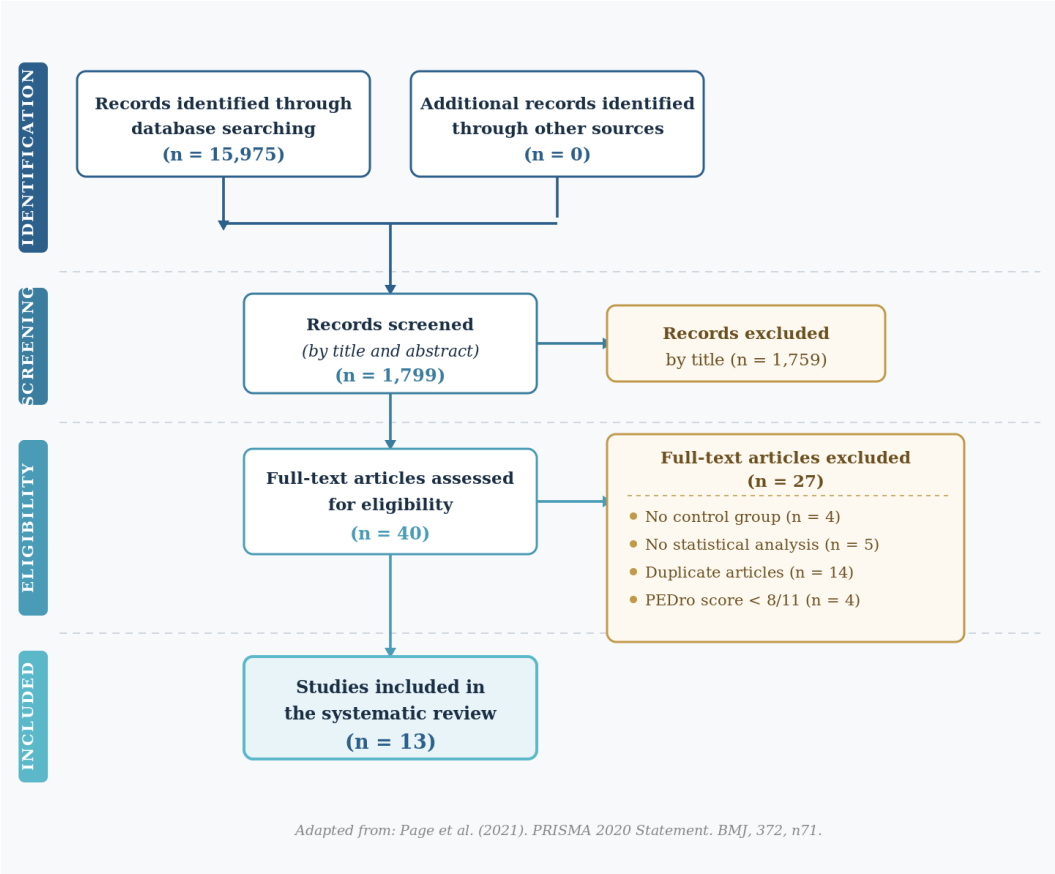
Databases	Search equations in databases	Results

Web of Science	"Test anxiety" AND "virtual reality" AND "exposure therapy"	386
SCOPUS	"test" AND "anxiety" AND "virtual" AND "reality" AND "exposure" AND "therapy"	162
Science Direct	"test anxiety" AND "virtual reality" AND "exposure therapy"	2701
Springer Link	test anxiety AND virtual reality AND exposure therapy	9042
Taylor and Francis	test AND anxiety AND virtual AND reality AND exposure AND therapy	3684

Subsequently, the initial sample of articles found was refined using the selection criteria, reducing it to a total of 1,799 articles. These articles were then reviewed again by the researchers, eliminating duplicate studies or those that did not meet the established criteria. In addition, only publications available in full text were considered, excluding abstracts and research notes, reducing the sample to 40 articles. Finally, these articles were evaluated using the PEDro scale, and only those that exceeded a score of 8/11 were selected. See Flowchart-Figure 1-according to Liberati et al., 2009).

Figure 1

Flowchart according to Liberati et al. (2009).



A total of k=13 articles on the treatment of social anxiety using VR technology were selected. The articles were published between 2019 and 2024 in both Spanish and English. The total sample size was n=611 subjects, of whom 390 (63.83%) were women, 191 (31.26%) were men, and 30 (4.91%) were not specified by the researchers. The studies were conducted in the following countries: the United States, Finland, the Netherlands, Belgium, Germany, France, Italy, Iran, and Israel.

3.2. General Results

Table 2 below shows a summary of the main characteristics of the 13 studies included in the review, taking into account: title and authors, assessment instruments used, assignment to experimental conditions, sample size, technology implemented, type of intervention used, main results, proposals for improvement, number of sessions, and score on the PEDRO Scientific Quality Scale.

The results and discussion are presented below, organized according to the objectives of this review. Specifically, the results obtained from the analysis of the articles allow us to identify relevant aspects regarding the type of technology implemented, the type of psychological interventions, and the type of assessment instruments used.

Table 2

Summary of Characteristics of the 13 Studies Included in the Systematic Review

Type of technology used

In several studies, virtual reality is used as the primary tool for therapeutic exposure. For example, in the study of Rubin et al. (2022) 360° videos and eye tracking are used for virtual reality exposure therapy (VRET) combined with attention guidance training (AGT). This combination showed significant effects in modifying visual attention and reducing social anxiety. Similarly, in the work of (Landkroon, Meyerbröker, et al., 2022)360° VR videos are used for exposure and imagination of positive situations, achieving a decrease in anticipatory anxiety and improving the perception of speech performance. Other studies used exclusively 360º videos for exposure therapy to reduce social anxiety, with promising results (Sarpourian et al., 2022; Van Dis et al., 2021; Wechsler et al., 2021).

Another investigation, carried out by (Serafini & Chittaro, 2024) This study examines the effectiveness of a non-immersive VR application for test anxiety. Participants rated the tool positively for both studying for and practicing oral exams, as well as for managing the emotional aspects associated with these exams, highlighting the potential of VR applications in educational and emotional settings.

Furthermore, in the study of (Gorinelli et al., 2023) A virtual reality application was used in an Acceptance and Commitment Therapy (ACT) intervention for social and communication anxiety. The results indicated a significant decrease in anxiety and an improvement in psychological flexibility, highlighting the effectiveness of VR as a

complement to traditional psychological therapies.

The use of specific technologies such as eye tracking is also highlighted in the study of (Fehlmann et al., 2023) where repeated exposure to VR eye-tracking significantly reduced anxiety when speaking in public. These findings suggest that eye-tracking technology may be particularly useful for addressing eye-tracking avoidance, a common symptom of social anxiety. In summary, VR, and specifically 360° videos, are the most widely used technology for treating social anxiety and fear of public speaking. Combined with other technologies such as eye-tracking, VR has proven effective in helping to place individuals in anxiety-provoking situations and significantly reducing the anxiety they experience.

The rapid evolution of VR hardware and software has substantially expanded the therapeutic possibilities of VRET in recent years. Advances in head-mounted display (HMD) technology including higher resolution screens, wider fields of view, and improved tracking systems have been shown to enhance the sense of presence and embodied immersion in virtual environments, which are theoretical mediators of therapeutic outcomes in VRET (Premkumar et al., 2024). In their randomized controlled trial, Premkumar et al. (2024) demonstrated that augmenting self-guided VRET for social anxiety with real-time biofeedback (measuring heart rate and frontal alpha asymmetry) produced significant reductions in social anxiety symptoms and physiological arousal, suggesting that the integration of biofeedback with VR may represent a meaningful advancement in personalized exposure-based interventions. These findings point toward a promising trajectory in which VRET is not merely a passive exposure tool but an adaptive, responsive therapeutic platform

Type of psychological intervention

Throughout the different articles, a predominant use of Virtual Reality Exposure Therapy (VRET) is observed, combined with various additional techniques to maximize the effectiveness of the interventions. (Meyerbröker, et al., 2022; Rubin et al., 2022; Van Dis et al., 2021). Several studies, such as that by Rubin et al. (2022), employ VRET in conjunction with Attention Guidance Training (AGT), which has demonstrated a significant impact on modifying visual attention toward audience members, thereby reducing social anxiety. This combination suggests that real-time intervention can alter visual avoidance patterns and, consequently, reduce social anxiety.

Another interesting approach is that of Landkroon, Meyerbröker, et al. (2022) This method combines virtual reality exposure with the visualization of positive situations. It not only addresses direct exposure to feared situations but also utilizes future-oriented imaginative reinterpretation as a preliminary exposure technique, particularly useful for individuals who are initially too afraid to confront their fears. On the other hand, the study of Sarpourian et al. (2022) The study highlights the use of VRET in conjunction with counseling sessions. This approach demonstrates that, while both methods are effective in reducing public speaking anxiety, combining them can offer additional benefits, such as increased participation in treatment services and a greater sense of reduced anxiety following the intervention.

The investigation of Fehlmann et al. (2023) This study highlights a VRET intervention

focused on gaze exposure, where eye tracking is used to address anxiety related to public speaking. It shows that repeated gaze exposure in a VR environment can significantly reduce state anxiety, suggesting that this technique could be particularly effective in treating the social component of anxiety. Besides, Scheveneels et al. (2019) They investigate the role of VRET, observing a reduction in public speaking anxiety, but highlighting the need to explore more alternatives that can meet participants' expectations.

An interesting approach was that provided by Rubin et al. (2022) where, in addition to comparing VRET with the combination of VRET and AGT, he introduced psychoeducation on social anxiety as the central focus of treatment. Finally, the study of Sülter et al. (2022) It uses a VR app called SpeakApp-Kids! to reduce public speaking anxiety in children, showing a significant decrease in anxiety both during practice sessions and in real presentations. In conclusion regarding the type of intervention, it is revealed that virtual reality exposure techniques, often combined with other methodologies such as attention guidance training, positive imagery, psychoeducation, and counseling, are prevalent and effective approaches in the treatment of social anxiety and public speaking anxiety. These interventions not only address the direct symptoms of anxiety but also modify patterns of behavior and attention, providing a solid foundation for future research and clinical applications. (Sarpourian et al., 2022).

From a theoretical standpoint, the effectiveness of VRET can be understood through multiple mechanisms. Inhibitory learning theory (Craske et al., 2014, as cited in included studies) posits that exposure reduces anxiety not by extinguishing the original fear memory but by creating new, competing inhibitory memories that suppress the fear response. VR provides a particularly advantageous context for this process, enabling repeated, varied, and escalating exposures across multiple anxiety-provoking scenarios, a design difficult to achieve with traditional in vivo methods. Furthermore, the safety and controllability of VR environments may reduce anticipatory anxiety about the exposure itself, thereby improving treatment adherence and engagement, which are recognized predictors of therapeutic outcome in exposure-based interventions.

Types of assessment instruments

The studies analyzed employed a variety of assessment instruments, including self-report questionnaires, immersion scales, and physiological measurements. Several studies also used the Structured Clinical Interview for DSM-5 Disorders (SCID-5-CV). (Rubin et al., 2022; Serafini & Chittaro, 2024; Van Dis et al., 2021).

Among the most prominent self-reports are those used by Landkroon, Meyerbröker, et al. (2022) The researchers used the Public Report of Confidence as a Speaker (PRCS), the Big 5 Inventory, the Immersive Tendencies Questionnaire (ITQ), and the Immersive Experience Questionnaire. These instruments are designed to assess confidence in public speaking, personality traits, and immersive experience, offering a comprehensive view of how virtual reality can influence these areas.

Besides, Rubin et al. (2022) The Personal Report of Public Speaking Anxiety (PRPSA), the Liebowitz Social Anxiety Scale Self Report Version (LSAS-SR), and the Speech Anxiety Thoughts Inventory (SATI) were used. These instruments are specifically

designed to measure anxiety in public speaking and social situations, as well as the thoughts associated with this anxiety. In addition, scales such as the Subjective Units of Distress (SUDs) and the Structured Clinical Interview for DSM-5 (SCID-5) were included, allowing for a more in-depth assessment of subjective distress and clinical diagnostic criteria.

Landkroon, Meyerbröker, et al. (2022a)They also point to instruments such as the VR Experience Scale and the Beck Depression Inventory. This approach allows researchers not only to evaluate immersive experiences in virtual reality but also to measure depressive symptoms that can influence anxiety when speaking in public. The inclusion of the SUDS scale and the Behaviors Checklist (BCL) adds another layer of assessment by analyzing the level of distress and specific behaviors during the interventions.

Gorinelli et al. (2023) used instruments such as the Social Interaction Anxiety Scale (SIAS) and the Personal Report of Communication Apprehension (PRCA-24). These questionnaires focus on anxiety in social interactions and communication apprehension, respectively, providing detailed data on how virtual reality-based therapies may affect these areas. Furthermore, the inclusion of the Mental Health Continuum (MHC-SF) and the Perceived Stress Scale (PSS) allows for a more holistic assessment of mental well-being and perceived stress.

The most evaluated variables were anxiety about public speaking through the Personal Public Speaking Anxiety Assessment (PRPSA), the virtual reality experience using the VR Experience Scale, and the Immersive Experience Questionnaire (Landkroon, Meyerbröker, et al., 2022; Landkroon, Van Dis, et al., 2022; Rubin et al., 2022; Sarpourian et al., 2022; Scheveneels et al., 2019; Sülter et al., 2022; Van Dis et al., 2021; van Veen et al., 2024; Wechsler et al., 2021), the ability to put oneself in the situation through analog visual scales, the presence that the user feels in the virtual reality environment through the IPQ (Igroup Presence Questionnaire)(Sarpourian et al., 2022; Wechsler et al., 2021),the discomfort experienced during exposure through Subjective Anxiety Units (SUAs)(Landkroon, Van Dis, et al., 2022; Rubin et al., 2022; Van Dis et al., 2021; Wechsler et al., 2021), and fear of negative evaluations measured through the Brief Fear of Negative Evaluation Scale (BFNE)(Landkroon, Meyerbröker, et al., 2022; Van Dis et al., 2021; Wechsler et al., 2021).

As for the physiological measurements, they were collected through biofeedback devices, the most evaluated being eye movements and blinking of the orbicularis oculi muscle (through eye tracking) (Fehlmann et al., 2023; Rubin et al., 2022; van Veen et al., 2024), the galvanic response or skin conductance (measured by electrodes) (van Veen et al., 2024) and heart rate via a chest strap ECG monitor (Fehlmann et al., 2023; Van Dis et al., 2021).

The multimodal assessment approaches observed in the included studies reflect a growing consensus in the field that anxiety is a multidimensional construct requiring evaluation at the cognitive-verbal, behavioral-motoric, and physiological levels (Lang's tripartite model of fear). The integration of self-report measures with objective

physiological indices represents a methodological strength of the reviewed literature, as it mitigates the limitations inherent to self-report alone including response biases and demand characteristics. Future research should continue to prioritize multi-modal assessment batteries while ensuring that the selected instruments are validated for the specific populations and cultural contexts under study.

4. RECOMMENDATIONS AND CONCLUSIONS

4.1. Main recommendations

First, most of the studies in this systematic review highlight the need to replicate the experiments with a larger sample size to validate the findings and improve the robustness of the conclusions.(Ghasempeyvandi & Torkan, 2023; Landkroon, Meyerbröker, et al., 2022; Rubin et al., 2022d; Sarpourian et al., 2022)This is relevant because a larger sample size can provide more representative data and strengthen the external validity of the results, as well as allow for their potential generalizability to the general population. It would be necessary to replicate these studies with larger and more representative samples from diverse cultural and demographic contexts to solidify the conclusions.

Another relevant point common to the various articles is the need to include physiological assessments both before and after the interventions, as well as during them. Measuring variables such as heart rate and skin temperature could provide a deeper understanding of participants' physiological responses to VR therapies and help establish a clearer relationship between changes in anxiety subjectively perceived by subjects through questionnaires and each subject's physiological anxiety response. (Van Dis et al., 2021).

Furthermore, the implementation of control groups is suggested, as it is difficult to compare the specific effects of VR with other forms of intervention because many studies did not use active control groups. Including a control group could help to more accurately determine the specific effects of VR interventions compared to a group receiving no intervention. (Landkroon, Meyerbröker, et al., 2022).

Furthermore, a key recommendation is to extend the duration of interventions. Some studies suggest that increasing the number of therapy sessions could lead to more lasting results, opening an important avenue for future research. (Sarpourian et al., 2022) For example, it has been suggested that a longer treatment period with more sessions could enhance the therapeutic effects and provide more lasting relief from social anxiety symptoms. (Sarpourian et al., 2022).

Furthermore, the recommendations include the need for further research into the effectiveness of VR interventions in different contexts and with diverse populations. This implies exploring the application of these technologies not only in clinical psychology but also in other fields such as education and professional training. (Chollet et al., 2022; Landkroon, Van Dis, et al., 2022; Sarpourian et al., 2022; Wechsler et al.,

2021).

Given that VR technology is constantly evolving, the use of more advanced and comprehensive software could improve the effectiveness of interventions and allow for greater personalization of treatments according to the individual needs of people with anxiety problems. (Sarpourian et al., 2022).

Finally, the importance of addressing the financial and logistical barriers that can hinder the implementation of VR in clinical practice is mentioned. The acquisition of VR equipment and the associated costs of training and maintenance can be very high. Therefore, finding solutions to reduce these costs and increase accessibility is fundamental for the widespread adoption of these technologies. (Sarpourian et al., 2022).

From an applied perspective, the clinical implementation of VRET for test and social anxiety requires careful consideration of practitioner training requirements, patient acceptability, and integration within existing service delivery frameworks. Clinicians intending to adopt VR tools should be trained not only in the technical operation of equipment but also in the theoretical and procedural components of exposure-based interventions. Institutional support including dedicated technological infrastructure and ongoing supervision is a prerequisite for sustainable VRET deployment in both clinical and educational settings.

4.2. CONCLUSIONS

In relation to the objectives set out in this systematic review, it can be concluded thatThe main type of technology used to treat social anxiety is the use of 360° videos, followed by virtual reality. Regarding the type of psychological intervention used in the treatment of social phobias with technology, it is revealed that virtual reality exposure techniques, often combined with other methodologies such as attention guidance training, positive imagery, and... psychoeducation Counseling and therapy are prevalent and effective approaches in the treatment of social anxiety and public speaking anxiety. These interventions not only address the direct symptoms of anxiety but also modify patterns of behavior and attention, providing a solid foundation for future research and clinical applications.
Regarding the main assessment instruments used to evaluate the effectiveness of the interventions, it is concluded that the most prominent self-reports were the Public Report of Confidence as a Speaker (PRCS), the Big 5 Inventory, the Immersive Tendencies Questionnaire (ITQ), and the Immersive Experience Questionnaire.

Further limitations merit consideration. First, the included studies were conducted across nine different countries with distinct educational systems, cultural norms regarding evaluative performance, and healthcare infrastructures, limiting the cross-cultural generalizability of conclusions. Second, the exclusive focus on university student populations restricts the applicability of findings to other educational levels and clinical populations. Third, the heterogeneity of outcome measures spanning self-report questionnaires, physiological indices, and behavioral assessments across the included

studies precluded a formal meta-analytic synthesis of effect sizes. Future reviews with sufficient homogeneous data should consider quantitative pooling of results to provide more precise estimates of VRET efficacy for test and social anxiety. Finally, the PEDro scale, while a validated quality appraisal tool, was originally developed for physical therapy research and may not fully capture methodological rigor in psychological intervention studies; future reviews may benefit from complementary quality assessment tools such as the Cochrane RoB 2 tool.

Finally, the main limitations of this systematic review lie in the difficulty of accessing some publications due to their restricted availability and the limited search terms beyond assessment anxiety. Nevertheless, this review has yielded evidence on important issues concerning psychological interventions using technology to address assessment anxiety as a specific type of social anxiety. Based on the findings of this review, future studies are currently underway to develop virtual reality software with environments related to assessment anxiety (exams and oral presentations) for implementation in applied research.

* The 13 references marked with an asterisk are those that have been included in this systematic review

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Table 2

Characteristics of the studies included in the review

Qualification	Author and Year	Instrument	Assignment	Sample	Technology	Intervention	Results	Improvement	Session	PEDr0
1. Attention guidance augmentation of virtual reality exposure therapy for social anxiety disorder: a pilot randomized controlled trial	(Rubin et al., 2022a)	PRPSA LSAS-SR SAT LDS SCID-5 C-SSRS	Random	N=21 (n=11 VRET + AGT) (n=10 VRET)	360° videos and eye tracking (VRET)	360° videos and eye tracking (VRET) Virtual Reality Exposure Therapy + Attention Guidance Training (VRET + AGT)	The study shows an overall positive impact of the intervention on reducing social anxiety symptoms and changing visual attention toward the audience. Although little evidence was found of a significant effect on fear of public speaking and mediation, these results were constrained by the model's assumptions. In summary, the findings suggest that visual attention can be modified during Virtual Reality Exposure Therapy (VRET) and that the decrease in eye contact avoidance may be related to the reduction in social anxiety.	The study needs to be replicated with a larger sample size.	2	10
2. Future-Oriented Positive Mental Imagery Reduces Anxiety for Exposure to Public Speaking	(Landkroon et al., nd-b)	PRCS VR Experience Scale BDI SUDS BCL		N= 43 (n=22 positive imagery + 360º) (n=21 360° videos)	360º videos	Exposure to positive situations through imagination + exposure to 360 videos 360 video exposure only	The study showed that positive, future-oriented mental imagery can reduce anticipatory anxiety and distress during exposure to a feared situation. This technique appeared to lessen the emotional impact of negative imagery by encouraging a reappraisal of the feared event. However, it did not increase willingness to undergo exposure, possibly due to the use of a standardized script. Although positive imagery did not immediately improve mood, it did result in a less negative mood after virtual reality (VR) exposure and a more positive perception of speech performance.	The study had limitations, such as a small sample size and a lack of generalizability to clinical populations. Although the results are promising for people with social anxiety, further research is needed to optimize the intervention's effectiveness and assess its long-term impact.	1	10
3. Future-oriented imagery rescripting facilitates conducting behavioral experiments in social anxiety	(Landkroon, Meyerbröker, et al., 2022a)	SIAS BFNE YOU GO	Random	N= 60 (n= 30 imagination to refocus the situation) (n=30 control group)	Exhibition in imagination	Exhibition in imagination Negative anticipation + live exposure	The effects of the behavioral experiment were not reduced by adding imaginal reinterpretation; rather, they were potentially enhanced, as the anticipated probability of the negative outcome, levels of helplessness, and the validity of the general conditional statement were further reduced compared to a behavioral experiment alone. This suggests that future-oriented imaginal reinterpretation could be used as a lower-level exposure exercise when individuals are too anxious to confront feared situations immediately during treatment.	The study had limitations, such as the absence of an active control to isolate the effects of reinterpretation on imagination, the use of a non-clinical sample that limits generalizability, and the lack of assessment of imagination capacity, which could affect the effectiveness of the intervention.	2	10
4. The effect of virtual reality therapy and counseling on students' public speaking anxiety	(Sarpourian et al., 2022a)	LSAS PRPSA IPQ/ IGP	Random	N=30 (n= 15 intervention group) (n=15 control group)	360 videos (VR scenarios)	Exhibition in RV Counseling session	This study showed that virtual reality (VR) and counseling did not affect the reduction of social anxiety (SA). However, it also demonstrated that counseling and VR effectively reduced public speaking anxiety (PSA) in students. In addition to counseling, VR, as an emerging method, could effectively treat PSA in students. VR has the potential to increase participation in services and enhance the effects of treatment before, during, and after intervention. VR allows individuals with high PSA to voluntarily expose themselves	Further empirical research is proposed, using larger samples and longer periods to improve the consistency of the findings. Limitations include the lack of a control group, the absence of physiological assessments during speech (such as heart rate), and financial and logistical difficulties. The study recommends incorporating	1	11

						to virtual social threats, decrease short-term anxiety and physiological arousal, and improve their perception of PSA after the intervention.	physiological assessments, improving equipment, and promoting the use of VR within the healthcare system.		
5. Look at the Audience? A Randomized Controlled Study of Shifting Attention from Self-Focus to Nonsocial vs. Social External Stimuli During Virtual Reality Exposure to Public Speaking in Social Anxiety	(Wechsler et al., 2021a)	SPIN SOUTH STAI Brief PANAS BSQ BFNER PRCS IPQ	Random	N=41 (focused on faces of the audience (n = 21) focused on objects in the room (n = 20).	RV	Dealing with the VR situation by looking at audience faces Dealing with the situation in VR by looking at objects in the room	Anxiety about public speaking and fear of negative evaluation decreased significantly in all groups. There were no significant changes in focus time, but there were changes in the proportion of time spent looking at the audience: the group with social focus increased, while the group without social focus decreased. Both versions of VR training showed positive short-term effects in people with high social anxiety, with external social focus improving eye contact and positive affect.	Further research is suggested on the long-term benefits of the social approach and the reinterpretation of dysfunctional beliefs by not avoiding social cues.	1	11
6. Old Fears Die Hard: Return of Public Speaking Fear in a Virtual Reality Procedure.	(Van Dis et al., 2021a)	SCID-5-CV BDI-II PRPSA BFNEII BCL EPQ-N SO SUDS VR Valence and Arousal scale Speech Topic Difficulty scale. Heart rate Skin conductance response Eye blink startle reflex (SR).	Random	N=32 (n=16= AA) (n=16=AB)	360 Videos	5 VR speeches in the same context (A) 4 VR speeches in context A + 1 VR speech in context B	Randomization and manipulation checks indicated no significant differences between groups in baseline characteristics, suggesting successful randomization. Rebound intensity (RI) and subjective discomfort decreased during Day 1 speeches, with no differences between groups. In spontaneous recovery, RI increased from Day 1 to Day 8, particularly in the AA group, but subjective discomfort and arousal remained unchanged. In fear renewal, although there was no effect on RI, subjective discomfort, negative valence, and arousal increased in the AB group, but not in the AA group. This study validates a variable response (VR) paradigm for studying spontaneous recovery and renewal of fear of public speaking.	The study has several limitations, including insufficient statistical power to analyze individual differences and the lack of measurement of avoidance responses. It is recommended that future studies include measures of skin conductance, fear-enhanced startle, and eye tracking to assess avoidance. Despite these limitations, the use of virtual reality (VR) allowed for a controlled environment and the assessment of spontaneous recovery. VR was effective in inducing heart rate recovery and renewing subjective distress, suggesting that it could be useful for testing strategies to reduce the return of fear in individuals with social anxiety.	2	9
7. Positive mood induction does not reduce return of fear: A virtual reality exposure study for public speaking anxiety.	(van Veen et al., 2024b)	PRPSA SAMs PANAS-X MNTQ Post-experimental question	Random	N=62 (positive group, n=23) (negative group, n=19) (control group, n=20)	RV	Inducing a positive mood before the speech Induction of negative mood after speech Without mood induction	The study found no evidence that inducing a positive mood before exposure enhances the lasting effects of exposure therapy for public speaking anxiety. Instead, inducing a negative mood before exposure may reduce spontaneous recovery and reinstatement, highlighting the importance of translational research in fear and anxiety studies.	The study has several limitations: musical preferences may affect the effectiveness of standardized music, gender differences could not be analyzed due to the small sample size, and the lack of positive mood measurements may have weakened emotional induction. Furthermore, anticipatory anxiety may have influenced galvanic skin response (SSR) scores before speech, although decreases were observed during exposure. Finally, the social media ostracism task may not have been intense enough to generate a reinstatement effect. Further studies with ecologically valid stimuli in	3	9

		naire						subclinical samples are needed.		
8. The effect of virtual reality exposure therapy on focus of attention, self-criticism, and interpretation bias in university students with social anxiety	(Ghasempeyvandi & Torkan, 2023b)	Structured Clinical Interview SPIN FAQ LOSC revised interpretation bias inventory	Random	N=30 n=15 VRET Group n=15 control group	Reality environment	VRET	The results showed that virtual reality exposure therapy significantly reduced symptoms of attention focusing, self-criticism, and interpretation bias in the experimental group compared to the control group ($p < 0.01$).	The research had a limitation in participants; they recommend that future research expand the number of participants and also broaden the range of participating ages.	8	10
9. Training public speaking with virtual social interactions: effectiveness of real-time feedback and delayed feedback	(Chollet et al., 2022b)	PRCS ITQ Immersive experience questionnaire	Random assignment	N= 57	Reality environment	VRET	The results showed that the training system with virtual social interactions led to positive training outcomes and could complement traditional teaching methods.	The proposed improvement is that social skills training systems could benefit from being adapted to the particular individual circumstances of the participants.	1	10
10. Trial of a desktop virtual reality application as a method of exposure for test anxiety: a qualitative study	(Serafini & Chittaro, 2024b)	Interview	Quasi-experimental	N=21	Non-immersive virtual reality application.	Virtual exam, VRET	The results indicate that participants perceived the VR application as valuable not only for studying and practicing oral exams, but also for managing the emotional aspects associated with the exam. Furthermore, the application helped increase confidence and awareness of their preparedness level among some participants.	One limitation of the study is the lack of quantitative data on the duration of app use by each participant, as it relied solely on self-reported data from the final interviews. Future studies will incorporate automated recording methods to accurately quantify app usage and other user behaviors, thereby improving the assessment of the app's influence on participants' perceptions and feedback.	3	9
11.Virtual reality acceptance and commitment therapy intervention for social and public speaking anxiety: A randomized controlled trial	(Gorinelli et al., 2023b)	SIAS PRCA-24 MHC-SF PSS YOU GO	Random	N = 76	Virtual reality application	VR ACT training	The results showed a significant decrease in social and communication anxiety ($d = 0.55$-0.61) and a significant improvement in psychological flexibility ($d = 0.61$) in the VRACT group compared to the waitlist group.	To explore the long-term effectiveness of the VRACT intervention through longer follow-up and integration of the VRACT intervention into university mental health services to improve access to and effectiveness of treatment for students.	3	10
12.Virtual reality gaze exposure treatment reduces state anxiety during public speaking in individuals with public speaking anxiety: A randomized	(Fehlmann et al., 2023b)	PST state anxiety and physiological measures.	Random	N= 89 Treatment Group: n= 43, Control Group: n= 46,	360° videos in virtual reality application Eye tracking	VRET	The results showed that repeated exposure to VR gaze significantly reduced state anxiety during public speaking compared to the control group.	The study indicates that the design does not allow for conclusions regarding the effective component of the intervention (i.e., exposure to the gaze versus the social context). It suggests the need for further research in clinical populations.	10	10

controlled trial to, **13**.Virtually Unexpected: No Role for Expectancy Violation in Virtual Reality Exposure for Public Speaking Anxiety	(Schevenee ls et al., 2019b)	PRCS SSPS BAT	Random	N= 43	Virtual reality environment	VRET	A reduction in anxiety about public speaking was observed from pre- to post-VRET. However, the treatment effects were not predicted by the proportion of expectations that could be tested.	While VRET implementation has been shown to reduce anxiety related to public speaking, this outcome does not meet the participants' expectations. Therefore, further research into other alternatives that may fulfill these expectations is recommended.	4	10

* PRPSA. Personal Report of Public Speaking Anxiety; LSAS-SR. Liebowitz Social Anxiety Scale Self Report Version; SATI. Speech Anxiety Thoughts Inventory; SUDs.Subjective Units of Distress Scale; SCID-5. Structured Clinical Interview for DSM-5; C-SSRS. Columbia Suicidality Severity Rating Scale; PRCS. Personal Report of Confidence as a Speaker; BDI. Beck Depression Inventory; BCL. Behaviors Checklist; SIAS. Social Interaction Anxiety Scale; BFNE. Brief Fear of Negative Evaluation Scale; VAS. Visual Analogue Scales; IPQ. Igroup Presence Questionnaire; SPIN. Social Phobia Inventory; STAI. scale of the State-Trait Anxiety Inventory; PANAS. Brief Measure of Positive and Negative Affect; BSQ. The Body Sensations Questionnaire; SCID-5-CV. Structured Clinical Interview for DSM-5 Disorders; ASI.Anxiety Sensitivity Index; SAMs. Self-Assessment Manikins MNTQ. Mood and Need for Threat Questionnaire; FAQ. Focus of Attention Questionnaire; LOSC. Levels of Self-Criticism Scale; ITQ. The Immersive Tendencies Questionnaire; PRCA-24. Personal Report of Communication Apprehension; MHC-SF. Mental Health Continuum; PSS. The Perceived Stress Scale; PST. Public Speaking Test; BAT. Behavioral Avoidance Test.