American Journal of Psychiatric Rehabilitation

Expert Opinion Article

Virtual Reality's Efficacy In Assessing And Treating Phobias And PTSD: A Literature Review

Rozhan Ali Khdir[1*], Yağmur Çerkez[2]

[1-] Department of General Education, Cihan University-Erbil, Kurdistan Region, Iraq;
[2-] Ministry of education, Nicosia, North Cyprus.

***Corresponding Author:** Rozhan Ali Khdir
*E-mail: rozhan.ali93@gmail.com

Abstract
The study sought to determine the role of virtual reality in the assessment and treatment of phobias and post-traumatic stress disorder. The study employed the literature review method and reviewed 20 published articles for the study. These were studies that were based on primary research only. The study explored five specific types of phobia, which are small animal phobia, arachnophobia, acrophobia, fear of public speaking, and dental phobia. The study revealed that virtual reality provides an effective way of assessing and treating phobias and post-traumatic stress disorder (PTSD), especially where 360-degree videos and pictures are included. It provides an immersive method that allows the patients to face their fears rather than avoid them. It also offers a method that reduces avoidance behavior in patients compared to other treatment approaches. Advances in technology have resulted in the adoption of VR through the use of smartphones, and this could provide a great way for more widespread adoption of VR in treatments. There is still a need to improve the efficacy of VR by addressing its current limitations.

Keywords: *Phobia, virtual reality, PTSD, systematic review, treatment*

Introduction

Phobias and PTSD are common issues in today's society. In the United States of America alone, 5% of the population has PTSD every year (National Centre for PTSD). PTSD is as a result of exposure to a traumatic event for example, war, abuse, natural disasters. The prevalence of these issues has necessitated continued research into them in a bid to find better treatment. Several treatments like cognitive behaviour therapy, cognitive therapy and cognitive processing therapy have been used for the treatment of disorders. One of these developments has also been the emergence of virtual reality.

Virtual reality has grown in popularity over the past few years in the diagnosis, treatment and management of psychiatric and physiological disorders (Schroder et al, 2023). It was initially developed for phobia treatment and used in the treatment of acrophobia in 1995 and has since then developed immensely as a result of access to technology and it involves exposure to the patient's fears in a simulation method (Meyerbroker and Morina, 2021) and a customized approach to treatment of disorders. The immersion into this experience allows the patient to face their fears and to properly diagnose the disorder in a controlled and safe environment through data analysis (Kim and Kim, 2020). It allows the patient to process their emotions in a low-threat way, and decondition themselves (Kothgassner et al, 2019).

There are many types of virtual reality treatments but they all involve the use of computer technology to do simulations (Van Meggeln et al, 2022). According to Maples-Keller et al (2017), virtual reality provides a cost-effective manner of exposing the client to their fears and also a way in which they can do this repeatedly unlike in real life (Scheveneels et al, 2023). It provides an opportunity for full immersion (Dorner et al, 2019) in a way in which the patient's privacy is observed. The patient also has control over the events and feels comforted unlike in the real world. Most importantly, clinicians can identify problematic regions in the patient's brain and analyze it fully so that they can diagnose and assess the impact of potential drugs for treatment (Liu, 2021).

However, VR also has disadvantages. Kim and Kim (2020) pointed out that the recreation of traumatic events through VR is a challenging process. There have also been inconsistencies about the results of various studies even though in the short time, VR has been found to be effective. Birkhead et al (2019) explained that Virtual Reality sickness can manifest in the form of nausea, fatigue and headaches among other things as a result of the awareness of the disconnection between reality and the virtual environment (Canella et al, 2020).

Kamkuimo et al. (2021) also pointed out that some situations are not as easy to replicate in a virtual setting. There is also a need to address some problems that may stem from VR especially when

symptoms of mental disorder arise as a result of ambiguity in deciphering the difference between reality and the virtual world (Liu, 2021). Knaust et al (2020) pointed out that there is also a need to address the effectiveness of VR in patients that have problems with imagination as it is only assumed that VR can help with that but it has not been verified.

Vincent et al (2021) stated that the main hindrances of VR integration into common practice are the financial costs, the uncertainty of the benefits, and the fear of negative effects among other things. This was also echoed by other studies (Riva and Serino, 2020). VR setups can cost as much as $30000 and are limited to a few fear domains (Minns et al 2019). Many articles have focused on the efficacy of VR treatments in the past. However, most recently, improved technology accessibility has led to more affordability of VR and the development of new technologies as well that did not exist before. This study aims to do an in-depth literature review of recent studies to determine the role of VR in the assessment and treatment of phobias.

Method

A literature review was implemented. A rigorous search for published articles was undertaken utilizing Science Direct, PubMed and APA PsycInfo. The main keywords were phobias, clinical trials, PTSD, virtual reality, and VRET.

Inclusion and exclusion criteria

Articles that were included in the study were those that predominantly employed the use of VR on either phobias or PTSD. Only studies that employed primary research were used. Randomized controlled trials were included. The studies were only included if they were from 2018-2023. There was no gender or age restriction on the participants. Identified articles were reviewed by two reviewers. Articles that explored various disorders were excluded from the study. Review studies, narrative studies were also not used. Studies in languages other than English were not used. Studies before 2018 were not included as there have been technological advances in the past few years.

Study characteristics

Table 1. The study charactersitics

Publication	Target Population	Type	Methodology	Conclusion
Penate et al, (2019)	32 male adults with various phobias related to cockroaches, lizards and spiders	Small animal phobia	Neuro-imagery, participants were subjected to VR and some to real phobic images.	VR is an effective tool in the treatment of phobias.
Vincent et al (2021)	22Service providers, MDs and PHDs	PTSD	Clinical experiences, Survey	There is a lack of integration of virtual reality in technology in common practice
Van Meggeln et al (2022)	44 War veterans, child sexual abuse survivors	PTSD	Narrative exposure therapy: 12 sessions of 3MR (Multi-Modal Memory Restructuring) system	3MR interventions led to a decrease in PTSD but there are discrepancies between treatments as usual was unclear.
Trahan et al (2021)	Student veteran	PTSD	Electroencephalogram (EEG) system. VR mobile phone grocery store application, thrice a week for 4 weeks, 12-15mins per session, a case study.	The VR exposure reduced social anxiety. VRET through mobile phones is very much feasible.
Minns et al (2019)	77 University of Texas undergraduates with arachnophobia	Arachno phobia	6, 5-minute 3D immersive video exposures, VR headsets. Pre and post-treatment questionnaires.	3D stereoscopic videos were significantly more effective in the treatment of arachnophobia.
Binder et al, (2022)	31 women with arachnophobia	Arachno phobia	Tracking of heart and body movements in VR. Phobic and non-phobic	VR triggers real behavior and emotion in participants. VR is

			groups with turtles were used as neutral controls. Fear of Spiders Questionnaire	adaptable.
Anderson et al, (2023)	12 women, 18-54yrs with arachnophobia	Arachno phobia	One session of VRET-AP, virtual reality assisted exposure, and Spider Phobia questionnaire. Follow-up interview after 7 days	VRET-AP decreased arachnophobia greatly and increased willingness to approach a live spider
Gujjar et al, (2019)	30 adult patients with dental phobia	Dental phobia	VRET for randomized patients and informational pamphlet condition. 1 week, 3 months and 6 months follow-up evaluations.	VRET was effective in dental phobia treatment
Majidi and Manshaee (2021)	30 clients for private clinics in Iran	Dental phobia	8 sessions of 15 minutes per week with a 45-day follow-up. Samsung Gear 360 and HTC VR headset.	VRET decreased dental phobia. Odontophobia patients are more willing to engage in virtual treatments.
Verger et al, (2020)	15 participants with PTSD	PTSD	VRE to war scenes, and, eye movement desensitization and reprocessing (EMDR) with brain18F-FDG-PET	The posterior cerebellum is crucial in the efficiency of eye movement desensitization and reprocessing in PTSD.
Van Gelderen et al, (2020)	22 war veterans	PTSD	Six VRE sessions, structured clinical interviews before and after the treatment, cortisol changes examined.	Cortisol levels are a great marker of response to VRE
Van Gelderen et al, (2020)	Treatment-resistant PTSD patients	PTSD	3MDR, mixed methods, thematic analysis and interviews. Randomized controlled trial with 6 sessions of 3MDR, 10 weeks of treatment as usual and a follow-up evaluation after 53 weeks.	3MDR facilitates memory retrieval and processing. 3MDR addresses transcend PTSD symptoms.
Difede et al, (2022)	122 Military personnel exposed to war zones in Iraqi and Afghanistan	PTSD	Nine, 90-minute weekly VRE or Prolonged Exposure therapy sessions, medication over 16 weeks and follow-up treatment 3 months after therapy. Genetic markers as moderators.	VRE was effective in treating the symptoms of PTSD.
Knaust et al, (2022)	36 soldiers 18 years and above	PTSD	360-degree nature videos with HMDR headsets, mixed feasibility study versus natural sounds and no	360-degree nature videos are effective in the treatment of PTSD as they improve relaxation in patients.

			video. Randomized controlled trial, relaxation measures and semi-structured interview.	
Bisson et al, (2020)	42 Male veterans with treatment-resistant PTSD	PTSD	Single-blind randomized controlled trial, follow up at 12 and 26weeks	3MDR is an effective tool in the treatment of PTSD
Bentz et al, (2021)	70 participants with a fear of heights	Fear of heights	Single-blind, randomized controlled trial with 3-5 weeks follow up. Use of the app six times in 14 days, 30 minutes per session.	Smartphone-based VR greatly reduces fear of heights.
Freeman et al, (2018)	100 participants with a fear of heights in the UK, 49 immersed in VR	Fear of heights	Single-blind, randomized trial, control group of usual care. Six VR sessions, over two weeks, half an hour per session. VR trackers and virtual coaches used	Automated VR treatment greatly decreased fear of heights. Results were maintained at follow-up.
Kahlon et al, (2019)	27 adolescents from Norwegian high school	Public speaking phobia	Non-randomized trial. VR exposure therapy, head-mounted VR display. One and three months follow-ups.	VR consumer hardware can be effective for Public speaking phobia.
Takac et al, (2019)	19 students from RMIT University	Public speaking phobia	VR computer and public speaking software. Three VR sessions, non-clinical sample.	Repetitive VR sessions are essential to avoid increased anxiety without habituation.
Van Dis et al (2021)	32 participants from Utrecht University	Public speaking phobia	VRE, questionnaires, heart rates for distress, 360-degree virtual environments. 2-day VR experience with a follow-up a week later. Follow up after 2 and 4 weeks.	VR was successful in evoking recovery, and arousal levels.

Discussion

The studies revealed that VR is an effective tool when it comes to the assessment and treatment of PTSD and phobias. Twenty articles were employed with eight being based on PTSD and the other 12 for phobias.

PTSD

PTSD is triggered by exposure to trauma which ultimately leads to psychological, mental and social functioning (Besher et al 2019). VR helps to prevent the manifestation of PTSD as well as the treatment of it (Volovik et al, 2023). PTSD can also lead to death, as found from several studies and that at least 65000 deaths from 2010 are military suicides as a result of PTSD (Fox et al, 2021).

In the treatment and assessment of PTSD, the use of 3MDR as a treatment for PTSD using VR tools were found to be effective (Van Meggeln et al, 2022; Van Gelderen et al, 2020). Van Gelderen et al, (2020) utilized cortisol levels in 3MDR to predict the success of PTSD symptoms through VRE. Six sessions of 3MR were conducted involving saliva collection to determine cortisol levels. The study was conducted to try and bridge the gap in the inconsistent available literature review. A post-treatment was also done 16 weeks later as well as another interview. The Clinical Administered

Questionnaire scale was also used. The study revealed that cortisol was crucial in treatment-resistant PTSD. The 3MDR was done at different times for individuals and this has to be standardized for future studies.

Studies have also shown that even though there are many treatments for PTSD, some individuals simply fail to respond to treatment (Fonzo et al, 2020). Van Gelderen et al (2020) utilized 3MDR in another study to treatment-resistant PTSD patients. The study sought to bridge the gap in previous studies which only employed quantitative methods and thus used a mixed approach. Ten male treatment-resistant PTSD war veterans who had previously undergone at least one 3MDR session were used for the study. The war veterans went through six sessions of 3MDR and all but one, had psychotropic treatment. The study revealed that 3MDR forced patients to engage with traumatic memory unlike in EMDR where they could use avoidance. They also experienced a heightened sense of awareness during 3MDR and it was immersive that they felt as if they were stepping into their actual memories of prior events. The immersive aspect of 3MDR contributes to its effectiveness (Hamilton et al, 2021). P

The patients highlighted that they felt much better 2-3 weeks post 3MDR. There was a reduction in PTSD symptoms and no recurring negative effects. One component of 3MDR that was found to be highly effective was walking towards the trauma picture. This enhances cognitive and motor interactions in a virtual environment (Nijdam and Vermetten, 2018). The limitation of the study was the awareness of the patients of the program that they were undertaking. This is something that could have had them biased toward giving befitting responses (Lundin et al, 2023). The time between treatment and latter interviews varied which could also have affected memory recall of the 3MDR sessions.

Bisson et al (2020) also employed 3MDR for the assessment of treatment-resistant PTSD over 9 weeks. Thirty-two male veterans were used for the study in a randomized controlled trial. Most of the participants registered maintenance of positive outcomes even at 26 weeks, with only a few having different results. A few did not tolerate 3MDR as a treatment though it was well received by most. VR can have the downside of instilling a sense of losing oneself and not many are keen on accepting technological solutions (Weech et al, 2018). The study was limited in terms of a small sample size and also that it focused only on military veterans. It was also only on a three-month follow up and a longer timeline and period of treatment would have been beneficial.

Van Meggeln et al, (2022) employed computer-based virtual reality through 3MR for 44 veterans and low therapist involvement for child sexual abuse survivors and in comparison, to the usual treatments like imaginal and narrative exposure therapy. A high drop-out rate was noted compared to those who took part in the study and reflected that this tends to happen when there is low therapist involvement as was in the study. It also happens a lot in studies where participants have to face their traumas (Lewis et al, 2020). Expectations of the efficacy of the study can also affect the potential results of the study especially where the participants are not blind to the treatment condition. The study also revealed a reluctance in patient participation in e-mental health applications which is in line with other studies (Weech et al, 2018; Lundin et al, 2023).

On the other hand, Verger et al (2020), employed EMDR as a treatment for PTSD through the F-FDG PET, which is a functional imaging technique that is sensitized by VRE to determine metabolic changes. The study employed 15 war veterans who served in Mali and Afghanistan. The Post Traumatic Checklist Scale was also used. The study involved injection and VRE immersion for 7 minutes, then a quiet environment for 15 minutes. They also underwent a second functional imaging technique a month after the EMDR therapy. The study revealed that all the participants were PTSD-free after the EMDR therapy and none exhibited any PTSD symptoms. This study's findings are limited by the small sample and should be replicated on a large scale to determine the efficiency.

Difede et al (2022) focused on the role of VRET on participants that had been exposed to the war zones of Iraq and Afghanistan and these comprised of military personnel, journalists and others unlike most studies that only focus on the military personnel. The study used a randomized controlled trial. It involved two double-blind treatment studies. A pill was also administered before the treatment. Head-mounted displays were utilized as VR tools. VRE was found to have a greater impact than prolonged exposure therapy in the treatment of PTSD in depressed patients and vice versa on non-depressed patients. VRE improved completion rates and thus decreased drop-out rates.

Knaust et al (2022) used 360-degree nature videos for the treatment of PTSD in a randomized controlled trial in comparison to natural sounds. The study revealed that the 360-degree nature videos provided relaxation to the patients and combined with imaginal trauma exposure therapy they resulted in a great decrease in PTSD-related symptoms. The 360-degree panorama VR provides an affordable way with increased mobility that also

does not sacrifice photorealism (Ritter and Chambers, 2022).

The study revealed that VR was found to be a costly solution to treatments. However, with growing advances in technology, the costs are becoming more and more reasonable. Smartphones were also found to be a convenient and affordable manner in which VR can be utilized. They are something that is affordable, mobile and can provide a convenient alternative to treatment. Trahan et al (2021) explored the possibility of using VRET through the mobile telephone. Simulations of a grocery store were implemented through a mobile phone application. The study revealed that it was very much possible and the participant who was a student veteran had reduced PTSD symptoms and better sleeping patterns. The study also showed that it led to a reduction in fear symptoms. However, this study only had one participant and there is a need for a broader audience so that this technique can be analyzed in-depth.

Mobile-based VRET allows for deeper engagement given the frequency of use of mobile phones which means a lot of trials and more repeated exposure (Park et al, 2019). The use of mobile phones is prevalent these days and this could well offer a low-cost alternative to VR treatments (Arias and McNeill, 2020). Portable Virtual Reality technology offers a viable way of reducing these unnecessary deaths through the assessment and treatment of PTSD (Walters and Beidel, 2022).

Acrophobia (Fear of heights)

Acrophobia is the most common phobia with a third of the population having a strong fear of heights and can be found in 28% of adults, more so in women than men and 34% in children that have not reached puberty (Huppert et al, 2020). Fear of heights can account for 20-30% in the population (Eaton et al, 2018). Bentz et al (2021) also employed the use of smartphone-based Virtual Reality to assess and treat fear of heights through an application. It was based on 70 German participants. The study revealed that the VR application reduced avoidance behavior. Results were observed within a few hours of using the application which shows the effectiveness of the application. There was a follow-up 3-5 weeks afterward. The exposure app included 360-degree panoramic views which allowed deep immersion. The study also showed that smartphones can provide a low-cost method of employing virtual reality.

In another bid to lower costs in the use of VR, Freeman et al, (2019) used immersive VR to assess and treat fear of heights. The study employed a virtual therapist, a virtual environment as well as a software made by Oxford VR. A VR headset and tracker were also used. A VR sickness simulator was also employed to check for the adverse effects of VR treatment. VR may sometimes result in cybersickness in the form of fatigue and dizziness (Weech et al, 2019). The treatment was well received. The results revealed that gender did not moderate the effects of the treatment. It also revealed that the automated VR sessions were very effective in the treatment of fear of heights which is in line with Rimer et al, (2021) in a similar study. Levels of discomfort using VR were also very low which is great as VR can cause cybersickness (Kourtesis et al, 2019). The study was limited in that the VR was brief and it did not reveal the particular aspects of it that led to the phobia reduction.

Public speaking phobia

Kahlon et al, (2019) used VRET on 27 Norwegian high school students to determine the effects of virtual reality on public speaking phobia. Follow-ups were done one and three months later. An animated virtual audience allows the students to immerse themselves and face their fears head-on. The study revealed that VR offered an affordable way of exposure therapy and access to controlling stimuli. The study however had a major limitation of lacking a control group and a longer follow-up timeline would also be useful.

Takac et al. (2019) also used VR exposure to try and curb fear of public speaking. The students were subjected to three VR sessions in a non-clinical trial. Participants were exposed to different room scenarios as part of the exposure to enhance distress habituation. The study revealed that speech distress can be incorporated into the design of the VR and that it was a great attribute when measured during performance rather than afterward. The study also showed that a single session is not ideal as it increases anxiety levels, therefore VR exposure should be done as multiple sessions. The study, however, used a small sample and did not have a long follow-up period which is necessary to determine the sustainability of the effects.

Van Dis et al (2021) employed VR for participants to determine the return of fear and fear renewal. This was a novel study as most just focused on treatment for the first time, but some participants may relapse and provided greater insight into the sustainability of treatment. The study revealed fear renewal was present in the participants, but the VR exposure reduced anxiety, arousal and distress. However, avoidance responses were not measured in the study and they have the potential of affecting relapse.

Animal phobia

Penate et al (2019) assessed the efficacy of VR in phobias used as an exposure therapy compared to real images. The study showed that even though

there were differences and real-life images produced more intense reactions, VR images still managed to invoke enough distress sufficient for brain analysis and treatment of phobias. Minns et al (2019) employed 3D immersive stereoscopic video exposure in the treatment of arachnophobia. A clinical trial was employed and subjects also filled in questionnaires before and after the study. The study sought to overcome the challenge that VR simulations based on computer-generated images often have content that looks unreal. The study revealed that the 3D immersive stereoscopic video produced more real images and is useful in the treatment of arachnophobia in a more tolerable manner. A large effect size was recognized between those that were exposed to the 3D method and those that were not. The sample used was also a much bigger sample which helped in the generalization of results compared to most studies.

Binder et (2022), also employed immersive VR to assess and treat arachnophobia. The study employed 31 females as females are more prone to arachnophobia compared to males. The study revealed that VR offered a way of providing a customized treatment without the need for much maintenance. As it does not require the use of many therapists it reduces costs and also has the capability of being done on a large scale. VR also revealed avoidance behaviour which could be used to determine levels of phobia and in treatment. The study was limited in the fact that it used a small sample for the study, a larger sample is ideal for the generalization of results.

Anderson et al (2023) sought to also determine the role of VR in arachnophobia and to overcome previous studies limitations by using the latest VR hardware. The study on 12 women with arachnophobia included one session of VRET-AP and then the Spider Phobia questionnaire. Behavioral Approach Test was implemented to determine the ability to approach a live spider. A follow-up was done through a phone interview seven days after the study. The study revealed a great decrease in arachnophobia with two participants having no fear whatsoever. The participants were also now more willing to face a real live spider as compared to before the study. However, the study did not include men and therefore there was a limitation.

Dental phobia

Odontophobia, dental phobia in adults is as high as 4-6% (Brahm et al, 2019) and 20-30% have a fear of dental treatments (Majidi and Manshaee, 2019). It can stem from a lot of things like fear of injections, pain, other forms of abuse and prior negative experiences among other things (Arias and McNeill, 2020).

Gujjar et al (2019) assessed adult patients in a single blind trial on dental phobia. The study employed follow ups at time intervals up to 6 months to determine changes and better analyse the effect of VRET. The control group utilized VRET and the information pamphlet condition on 30 patients. The study sought to overcome limitations from earlier studies of a small sample and also addressing issues like cybersickness during treatment.

Likewise, Majidi and Manshaee (2019) employed a sample of 30 dental clients and employed high technology VR tools as well as the Modified Dental Anxiety Scale in assessing the efficacy of VR in dental phobia. The study showed that VRET greatly decreased odontophobia in the experimental group. However, the study did not include things like heart or pressure rate which can be essential. Patients engage easily in the virtual environment which greatly reduces their anxiety levels and ultimately their phobia. The study also revealed that there was need to also align VR to the Iranian culture which raises an interesting aspect to the implementation of VR in treatments.

Despite the advances in technology and effectiveness of the treatment, it is still not yet as widespread in its adoption (Rimer et al, 2021). There is need to determine the effects of VR in depth to counter issues like VR addiction, dizziness, motion sickness, dry eyes and so forth. (Park et al, 2019). There needs to be an optimal use of VR (Kim and Kim 2020)

Conclusion

The study sought to determine the role of VR in assessment and treatment of PTSD and phobias through a review of existing literature. The studies revealed that there have been great advances in technology over the past few years which has increased the adoption of VR as a useful tool in treatment and assessment of PTSD and phobias. The use of smartphones and virtual coaches has shown that there is a huge potential in adoption of VR in a more affordable way and this can be a great development to policy workers and clinicians. It can pave way to a more widespread use of VR especially as most of the population these days use smartphones which would go a long way in overcoming reluctance of adoption of technologies. VR is effective because of its immersive nature and can definitely allow patients to feel more like they are in the moment. However, most of the studies were based on small sample sizes and for replication and generalization of results, future studies should adopt higher samples. In addition, a high drop-out rate was noted in some of the studies which indicates that some people are still not ready to relive the traumatic events. This is also one of the reasons for many not seeking treatment. VR should

be modified in such a way that it improves and develops a way that encourage participants to accept treatment and reduce drop-out rates. This study was based on the qualitative aspect of the literature review. Future studies can also incorporate the quantitative aspect so that results will be more balanced and be backed up by figures.

Funding: This work not received any funding.

Acknowledgement: Authors are appreciate the reviewers helpful remarks and suggestions for improving our manuscript.

Conflict of interest: We have no conflicts of interest to disclose.

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