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Effect of using virtual reality to manage needle phobia in adults undergoing medical procedures: A rapid review

Abstract

Background: Needle phobia, also known as blood–injection–injury (BII) phobia, is a severe form of needle fear that affects from 20 to 50 per cent of adolescents, 20 to 30 per cent of young adults and less than 5 per cent of the older adult population. When faced with venepuncture, approximately 75 per cent of patients with needle phobia will undergo an extreme physiological response which can lead to a vasovagal or fainting episode. An emerging therapy for medical phobias is the use of virtual reality, a three-dimensional environment generated by a computer that creates a sense of immersion.

Aim: To evaluate the effect of virtual reality on the severity of patient fear or anxiety induced by needle phobia during medical procedures.

Methods: We employed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines to identify studies that used virtual reality to treat or manage needle phobia in adult patients. Two reviewers assessed each article with a third reviewer to resolve disagreements. We searched Medline, Embase, PsycINFO, PubMed and Web of Science from inception to search date. Articles were included if they contained original research and used virtual reality to treat or manage needle phobia in adult patients.

Results: Five articles were included – two randomised controlled trials (RCTs) that used virtual reality exposure therapy for the treatment of needle phobia in adults, one cross-sectional study examining reduction of dental anxiety using virtual reality, and two case studies that used virtual reality as a distraction therapy in adults, one for an adult with needle phobia and another for an adult with needle induced dental phobia.

Conclusion: We found a paucity of research into virtual reality as either a treatment for needle phobia or as a distraction modality in adult patients. Further research is required to contribute to the evidence on the effectiveness of virtual reality as management or treatment for needle phobia.

Keywords: virtual reality, virtual reality exposure therapy, VR, VRET, needle phobia, BII, blood injection injury

Introduction

Needle phobia, also known as blood–injection–injury (BII) phobia, is a severe aversion to needles[1]. It is a heightened fear of injections and transfusions such that the patient actively avoids undergoing any procedure that involves exposure to needles or injections[2] and the sight of a needle can trigger adverse physiological responses[3]. Needle phobia has also been associated with avoidance of vaccinations, diagnostic tests and treatment of both acute and chronic conditions[4].

Approximately 75 per cent of patients with needle phobia will undergo an extreme physiological response when faced with venepuncture and will experience symptoms such as a physiologically significant increase in heart rate and blood pressure followed by a response reversal leading to a vasovagal or fainting episode[5]. In his seminal work on needle phobia, Hamilton[6] analysed patient case studies and reported 23 deaths attributed to needle phobia–related vasovagal episodes. Although these deaths were attributed to the patients having a previously compromised cardiovascular system, such as atherosclerosis or impaired sinoatrial or atrioventricular node that resulted in ventricular fibrillation or asystole, the deaths were catalysed by needle phobia[6].

The prevalence of needle phobia in the general population is dependent on age. It ranges from 20 to 50 per cent in adolescents, aged 10 to 19 years, and 20 to 30 per cent in adults aged 20 to 40 years[4]. The percentage of patients with needle phobia decreases with advancing age at a rate of 8.7 per cent per decade with an overall prevalence of less than five per cent in the ageing population[4]. Despite the lower rate of needle phobia in older patients, the impact is magnified because of age-related morbidity[7].

Management strategies for needle phobia include use of benzodiazepines, sedation, topical anaesthetic agents and hypnosis[8,9]. Each of these strategies has its benefits and limitations. For instance, topical anaesthetic agents reduce needle-related pain; however, they require time and have clinical implications[10]. Benzodiazepines and sedation are effective for reducing anxiety but require medical supervision and monitoring[8]. Other therapeutic options such as virtual reality need to be explored.

Virtual reality is an emerging innovative therapy for medical phobias and is typically defined as an artificial three-dimensional environment generated by a computer that creates a sense of immersion by transporting the user to an interactive environment[11]. The patient's presence in the environment is generated via visual stimuli in a head-mounted display that tracks head motion and displays images or video footage that move around in the virtual space which, combined with audio, gives the patient a sense of presence in this simulated environment[12]. Virtual reality works for phobias as either a method of distracting the patient or as a method of exposure[13]. Virtual reality exposure therapy (VRET) has been successfully used as treatment for specific phobias such as fear of falling, fear of flying and social anxiety[14–16].

Review question

This is a rapid review of virtual reality as an intervention method for needle phobia in adults undergoing medical procedures requiring the use of a needle, such as injections or venous access. The primary question is 'What is the effect of virtual reality on the severity of patient experienced–fear or anxiety induced by needle phobia during medical procedures?'

Secondary review questions are:

- What types of virtual reality technology are being used and how are they being used, i.e. as exposure or distraction therapy?
- What are the characteristics of the patients who use virtual reality, i.e. age, gender?
- What, if any, are the characteristics of the patients who benefit the most from virtual reality?
- What, if any, are the side effects of using virtual reality and what, if any, are the characteristics of the patients who react negatively to virtual reality?

Methods

This review complied with the Preferred Reporting Items for Systematic reviews and Meta-Analysis (PRISMA) framework. This study is registered with PROSPERO registration number CRD42021285261.

Unlike systematic literature reviews and meta-analyses, there is no universally recommended methodological framework for rapid reviews. Haby et al.[17] recommend that authors of rapid reviews outline their methods to enable readers to make a quality assessment. Rapid reviews draw from components of other forms of review[18]. This rapid review was performed following the framework for literature reviews outlined by Peters et al.[19] and Arksey and O'Malley[20], that has four steps:

1. identifying the research question
2. identifying relevant studies
3. selecting studies to include
4. extracting and charting the results.

Additional steps were also undertaken to reduce bias and increase the outcome of the rapid review, as per Pluddeman et al.[21], including publishing the protocol in

a peer-reviewed journal[22], verifying all studies, having a second reviewer appraise risk of bias and quality, and using detailed appraisal tools.

1. Identifying the research question

This rapid review investigated the application of virtual reality for the treatment and/or management of needle phobia in patients undergoing medical procedures involving a needle. The question was framed around the PICOS (participants/population, intervention, comparators, outcomes, study type) format[23] as follows:

- Participants – adults, aged over 18 years.
- Intervention – virtual reality.
- Comparators – no virtual reality, placebo, another intervention, standard care.
- Outcomes – severity of fear or anxiety experienced by the participants.
- Study type – all types of study design.

2. Identifying relevant studies

A concept map incorporating medical subject heading (MeSH) terms and keywords was created by CG and TR, in consultation with a research librarian, to assist with defining the search terms (see Table 1). Five databases, Medline, Embase, PsycINFO, PubMed and Web of Science were searched from inception to the 18 July 2023. In addition, a hand search of bibliographic references of included publications was undertaken to identify potential additional articles that met the inclusion criteria.

Table 1: Concept map

Concept 1: Population	**Concept 2:** Intervention (virtual reality)	**Concept 3:** Condition (needle phobia)
adult (MeSH term)	virtual reality (MeSH term) virtual reality exposure therapy (MeSH term)	belonephobia (MeSH term) aichmophobia (keyword) blood injection injury (keyword) needle fear (keyword) phobia, needle (keyword) phobia, injection (keyword) trypanophobia (keyword)

The search was conducted independently by CG under the guidance and supervision of TR and IB. The resulting list of titles and abstracts was imported into Endnote X9™ and duplicates were automatically removed by Endnote before manual deduplication was carried out. All articles were then imported into Covidence[24], an online tool, for screening.

3. Study selection

Study screening and selection were performed by two reviewers (CG and TR) who independently performed title and abstract screening for relevance. In the first instance, disagreements between the two independent reviewers were resolved by consensus, while IB acted as an adjudicator of disagreements if consensus could not be reached. If relevance could not be determined from the

Table 2: Search criteria

Inclusion criteria	Exclusion criteria
Original research articles about using virtual reality for the treatment or management of needle fear or related phobias	Articles exclusively about needle phobia in children or paediatric participants (participants under 18 years of age)
Articles about research involving adult participants	
Articles either written in or translated into English	

title and/or abstract, screening progressed to the full article. Next, the full texts of articles deemed to have relevant titles or abstracts were retrieved and assessed for inclusion against a priori criteria for inclusion and exclusion (see Table 2).

4. Extracting and charting the data

The primary author, CG, was responsible for data extraction under the supervision of TR. Data extraction included:

- Study characteristics – the year and country of publication, study design and setting, main study findings.
- Intervention – the identified treatment or management with virtual reality and types of virtual reality equipment used.
- Population – adults with symptoms or clinical diagnosis of needle phobia.
- Participant characteristics – age, gender, medical procedure.
- Outcomes – including anxiety levels, blood pressure (BP), heart rate (HR), vasovagal response, qualitative experience and feedback.
- Side effects – any unintended consequences of using virtual reality, including symptoms of motion sickness.

5. Study quality appraisal and risk of bias

Risk of bias of included studies was assessed with the Cochrane risk of bias tool, for randomised controlled trials (RCTs)[25], and Joanna Briggs Institute Critical Appraisal Checklists and transferability to different contexts[26,27], for all non-RCT studies. Primary assessment was performed by CG with TR providing supervision and secondary independent appraisal to ensure reliability.

6. Data analysis and synthesis

Data from the included studies were first summarised using a descriptive narrative framework to capture the context and content of the research landscape. This narrative synthesis allows for a nuanced interpretation of included study outcomes, contextualising them within the broader scope of the existing literature. In doing so, we elucidated key trends, identified gaps and presented an organised summary that offers a cohesive understanding of the use of virtual reality in the management of needle phobia in adult patients undergoing medical procedures involving needles.

In addition to the descriptive narrative, we also conducted a pooled data analysis on data obtained from RCTs included in this review. This quantitative synthesis serves to aggregate findings to generate more robust conclusions than could be provided by an individual RCT. The analysis aids in clarifying the effectiveness of virtual reality interventions or treatments and offers insights that individual studies may lack due to limited sample sizes or varied methodologies.

Results

An electronic search of five databases returned 1477 titles and abstracts and one from snowball search. After automatic and manual duplicate removal, 978 records were screened for relevance and the full texts of 30 records were assessed for eligibility. Five unique studies met the inclusion criterion for this review (see Table 3).[28–32] This is represented in Figure 1 as the PRISMA flow diagram.[33]

Risk of bias and quality appraisal assessments

Risk of bias assessments, transferability assessments and quality appraisals were undertaken for all the identified studies. The RCTs were assessed using the revised Cochrane risk of bias tool for randomised control trials, version two (RoB 2)[25]. Table 4 shows the results of the assessments for each domain. Both RCTs scored some concerns during the risk of bias assessment, this is due to the study design and the participants being aware of which intervention they were allocated to.

The non-RCTs were all assessed using the Joanna Briggs Institute (JBI) checklists and the results are presented in Table 5. All the studies recorded high transferability, meaning that the findings are generalisable to other settings, populations and contexts. The studies scored a yes in each domain of their respective checklists with the exception of confounding factors and adverse events as outlined in Table 5. The completed checklists are included as supplementary materials.

Included studies were few and widely varied in their design. Also, potential data errors were identified in one of the RCTs[28]. Consequently, results are presented as a critical appraisal and narrative of each individual study and a combined synthesis.

Jiang et al.[28] conducted a pilot study that assessed the effectiveness of a single session of virtual reality exposure therapy for BII phobias. The study randomly allocated forty-three participants to either an intervention or a waitlist control group. Participants were aged between 18 and 48 years and diagnosed with either sub-clinical or clinical BII phobia.

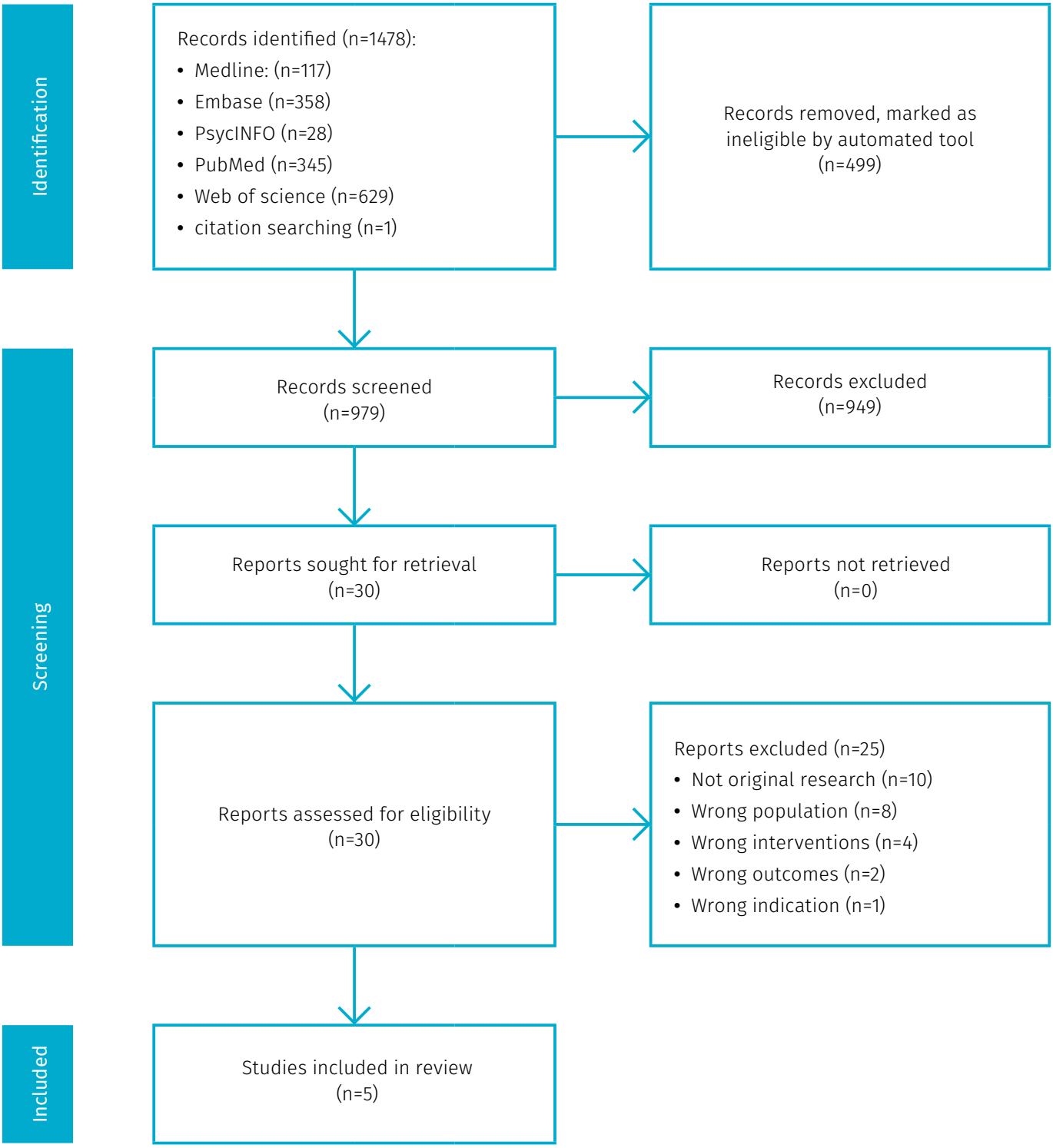

Figure 1: PRISMA flow diagram of paper selection process

Table 3: Data extraction of included studies

Author (year) Country Setting	Study design Measure/s	Population and participant characteristics	Equipment used	Study outcome/s and side effects of using virtual reality	Study limitations
Cheruvatoor et al.[30] (2021) Malaysia Penang International Dental College	cross-sectional study HAM-A,	176 participants (50% female) requiring endodontic therapy or tooth extraction, aged 18–50 years.	Smart phone (underwater environment and music). Exact type of virtual reality headset not reported.	Change in anxiety levels Patients experience with the intervention Physiological observations were not reported. Virtual reality sickness was not reported.	Lack of control group. Only one simulation used.
Jiang et al.[28] (2020) Australia Single session of VRET at University of New South Wales, Sydney	RCT MFS, MBPI, MDAS, ADIS-5, credibility and expectancy questionnaire	43 participants (81.4% female) with diagnosed clinical or sub-clinical BII phobia, aged 18–48 years (M = 23.44, SD = 6.42).	Samsung Gear VR™ headset Samsung Galaxy™ S7 mobile smart phone Dental Gear VR™ package	Change in participants' medical fears (primary) Participant expectations of treatment and rating of treatment rationale credibility (secondary) Physiological observations were not reported. Virtual reality sickness was not reported.	A pilot study has a lower generalisability of findings. The majority of participants were female (n=35, 81.4%), students (n=31, 72.1%) and of Asian descent (stated not specified).
Kunusoth et al.[31] (2022) India Department of Oral and Maxillofacial Surgery, MNR Dental College and Hospital, Sangareddy	Case study Patient-reported experience of extraction	1 female participant with phobia of local anaesthesia injection and history of traumatic tooth extraction experience during childhood, aged 20 years.	Smart phone playing soothing video of patient's choice through Irusu mini virtual reality headset.	Demonstrated the efficacy of virtual reality as a distraction for a patient with a dental phobia triggered by exposure to needles. Blood pressure and heart rate were monitored but not reported. Virtual reality sickness waws not reported.	None reported
Lacey et al.[29] (2023) New Zealand Participants independently used a mobile health application combining self-guided virtual reality exposure and cognitive behaviour therapy	RCT Severity Measures for Specific Phobia – Adults, PHQ9, FMS scale, Brief Fear of Negative Evaluation Scale	126 participants (80% female) with a fear of flying, heights, spiders, dogs or needles, aged 18–64 years (M = 42.2 years, SD = 13.2).	oVRcome™ app, a mobile health application used on smart phone. Exact type of virtual reality headset not reported.	Change in phobia severity Depressive symptoms Symptoms of social phobia Participant experience with the intervention Physiological observations were not reported. Virtual reality sickness measured (M = 3.3)	No diagnostic interview to confirm phobia. COVID-19 lockdowns limited participant exposure to phobia. Small number of participants in two phobias.
Meindl et al.[32] (2019) USA Baseline and generalisation session in doctor's office. VRET sessions completed in participant's home.	Case study Changing criterions design with generalisation probes	1 male participant with autism spectrum disorder (ASD) and a history of extreme needle phobia, aged 26 years.	Tzumi Dream Vision™ headset iPhone 6s™ smart phone Customised software simulating a doctor's office	Demonstrated the efficacy of a low-cost VRET DRO in increasing compliance with blood-draw procedure for an adult with ASD who had a severe needle phobia. Physiological observations were not reported. Virtual reality sickness was not reported.	The changing criterion design could have been strengthened.

HAM-A = Hamilton anxiety rating scale, MFS = Medical Fear Survey, MBPI = Multidimensional Blood Phobia Inventory, MDAS = Modified Dental Anxiety Scale, ADIS-5 = Anxiety and Related Disorders Interview Schedule for Diagnostic and Statistical Manual of Mental Disorders 5th edition, BII phobia = blood–injection–injury phobia, M = mean, SD = standard deviation, VR = virtual reality, PHQ9 = Patient Health Questionnaire 9 – quick depression assessment, FMS scale = Fast Motion Sickness scale, VRET = virtual reality exposure therapy, DRO =

Table 4: Risk-of-bias assessment results for RCTs

Study	D1: Bias due to randomisation	D2: Bias due to deviations from the intended interventions	D3: Bias due to missing data	D4: Bias due to outcome measurement	D5: Bias due to selection of the reported results	Overall
Jiang et al.[28]	Low	High	Low	Low	Low	Low
Lacey et al.[29]	Low	High	Low	Low	Low	Low

The outcomes of the Jiang et al. study[28] suggest that single-session VRET may offer benefits in terms of reducing catastrophic cognitions and specific fears associated with BII phobia. However, it should be considered as a potential adjunct or preliminary step before traditional in vivo exposure therapy rather than a stand-alone treatment. Furthermore, some potential data errors were identified in the publication. In Table 3 of the study which showed observed means, standard deviations and effect sizes for the clinician-administered outcome measures, the mean and standard deviations columns presented the same figures. Without further data and considering these potential issues, the interpretation and generalisation of the study's findings may be affected.

The study by Jiang et al.[28] also found that between the baseline and one-week post-treatment the intervention group had improvements in BII phobia severity and the cognitions assessment coping score, as rated by clinicians, as well as a demonstrated decrease in their perceived likelihood of the negative experience during the needle exposure and the severity of any negative experience that could occur. These results are suggestive that single-session VRET was effective in reducing the participants' needle fears.

Lacey et al.[29] conducted a study that assessed the effectiveness of the mobile health application 'oVRcome™' in treating specific phobias, including needle phobia among other common fears. The study was part of a two-arm, six-week RCT. In the context of needle phobia, the study found that self-guided use of the oVRcome™ app was effective in reducing the severity of symptoms. The active group, which used the app, showed a greater reduction in needle phobia severity compared to the waitlist control group.

Table 5: Joanna Briggs Institute checklist results for non-RCTs

Study	JBI checklist	Transferability	Confounding factors	Adverse event
Cheruvatoor et al.[30]	JBI Checklist for Analytical Cross-Sectional Studies[26]	High	No	N/A
Kunusoth et al.[31]	JBI Critical Appraisal Checklist for Case Reports[27]	High	N/A	No
Meindl et al.[32]	JBI Critical Appraisal Checklist for Case Reports[27]	High	N/A	No

JBI = Joanna Briggs Institute, N/A = not applicable for the checklist

The effect size for the needle phobia subgroup was small to moderate (Cohen's d=0.266). This effect size underscores the practical significance of the intervention, suggesting that the oVRcome™ app had a noticeable impact on alleviating needle phobia symptoms. While the effect size is relatively modest, it is important to consider that even small to moderate reductions in phobia severity can have meaningful clinical implications for individuals struggling with needle phobia. Participants were assessed for virtual reality sickness using the Fast Motion Sickness tool (0: no motion sickness – 20: frank sickness) with a mean score of 3.3 and no participants withdrawing due to sickness.

Collectively, these two RCTs underscore the potential of technology-based interventions in the treatment or mitigation of needle phobia symptoms. These findings offer promising avenues for enhancing the accessibility and effectiveness of treatments for individuals grappling with specific phobias. Despite this, the two studies have notable limitations, as outlined in Table 4.

Cheruvatoor et al.[30] conducted a cross-sectional study looking at the use of virtual reality as an audio-visual distraction tool in the reduction of dental anxiety during local anaesthesia. The study recruited 176 patients undergoing endodontic therapy or tooth extraction. This study was included as needle exposure is an important reason patients experience dental fear.[34–36] The authors evaluated participant perception of the use of virtual reality to reduce the level of dental anxiety during local anaesthetic injections.

The participants were introduced to the virtual reality headset and then completed the Hamilton anxiety rating (HAM-A) scale[37]. This scale consists of 14 questions, with each question scored from zero to five, for a score range between 0 and 56. The participants then viewed a three-minute video on the headset while the local anaesthetic was administered, then the dental procedure was performed. Immediately after the dental procedure, the HAM-A was readministered, and a feedback questionnaire provided to the participant.

The primary outcome being measured was the change in anxiety levels as measured by the HAM-A scale before and after the virtual reality exposure. The mean anxiety score on arrival to the dental clinic was 3.73 (SD=3.226) and post-intervention it had reduced to 1.80 (SD=2.54, p <0.001). The authors articulated that these findings highlight the effectiveness of the intervention in reducing the levels of anxiety in patients with dental phobia.

The secondary outcomes of the study found that 62.1 per cent of participants felt that the virtual reality intervention was beneficial in reducing their levels of dental phobia and 59.7 per cent of participants would use virtual reality in future appointments.

Kunusoth et al.[31] conducted a single-patient case study where virtual reality was used to manage dental anxiety during a tooth extraction. The patient was a 20-year-old female with an impacted molar who required dental surgery. Upon examination, the patient reported a traumatic tooth extraction during childhood and a phobia of local anaesthetic injection.

The patient was counselled by the staff that the procedure would be pain free and asked to undertake meditation and deep breathing techniques. Once the patient relaxed, the procedure was attempted using musical and audio–visual distraction methods. This technique was unsuccessful, and the patient was required to be calmed again using peaceful conversation and meditation techniques.

Since seeing the syringe triggered anxiety in the patient, the virtual reality headset was used to alter their vision and distract them using a soothing video of their choice. The dental work was then undertaken with the patient being surprised after the procedure that the procedure was completed without pain. The patient's heart rate and blood pressure were recorded before and immediately after the procedure. The authors reported that the virtual reality headset was highly effective in controlling the dental phobia for this patient, with the patient reporting that they were happy that the procedure had been completed without pain, increasing their confidence to undergo regular dental check-ups[31].

Meindl et al.[32] conducted a single-participant case study where VRET was used to reduce needle phobia. The participant was a 26-year-old male diagnosed with both autism spectrum disorder and a moderate intellectual disability who required annual blood tests. Due to the participant's severe needle phobia, venepunctures were normally conducted in a paediatric facility by five or more adults using physical restraint and no other patients in the facility at the time of the venepuncture. Before this study, an attempt that did not include virtual reality was made to desensitise the participant to needle exposure by using exposure therapy and differential reinforcement of other behaviours was undertaken that did not include generalisation to the doctor's office.

The study used a changing criterion design methodology to increase the participants' compliance with venepuncture. Each session commenced with the therapist gathering the required equipment and concluded when a pre-determined step was achieved or the participant demonstrated avoidance behaviour. When a targeted step was achieved the participant was rewarded with something to eat. On the other hand, if the participant exhibited avoidance behaviour the session was ceased and recommenced after one minute. One session was required without avoidance before the target step was increased. No more than four sessions were conducted per day. A total of 14 sessions were required for the participant to successfully complete all steps.

Upon completion of the desensitisation process, with all steps completed, generalisation was tested with four sessions conducted one week apart in the same environment but with a primary difference. In the first generalisation test the nurse who was present during the training process undertook a blood draw; in the second generalisation test, a new nurse undertook the blood draw; in the third, the patient's other arm was used, and in the fourth and final test, a new therapist accompanied the participant. Finally, maintenance was assessed by a follow-up session one month after the fourth generalisation test. The patient maintained the improved level of compliance in the test settings and over time, and the authors concluded that virtual reality combined with exposure therapy may be an effective intervention for medical phobias.

Combined synthesis

The primary question being examined by this literature review was the effect of virtual reality on the severity of patient fear or anxiety induced by needle phobia during medical procedures.

Jiang et al.[28] and Lacey et al.[29] conducted RCTs and found virtual reality to be an effective exposure therapy in adult patients with needle phobia. Lacey et al.[29] used the Severity Measures for Specific Phobia – Adults, a self-reporting measurement tool, and all participants reported a reduced level of anxiety (M = 15.1, SD = 10.7). Meindl et al.[32] conducted a successful single-participant case study of a patient with a diagnosis of autism spectrum disorder, finding that virtual reality combined with exposure therapy improved the patient's compliance when having blood drawn. Combined with the findings of Jiang et al.[28] and Lacey et al.[29], these results suggest that virtual reality exposure therapy has the potential to be an effective tool in desensitising patients to their needle phobia.

Two of the five studies[30,31] used virtual reality as a distraction therapy in the adult population and concluded that virtual reality could be used to reduce anxiety in dental patients. However, given that these studies were conducted in the context of dental care, it is not clear if the findings are transferrable to medical care. The lack of studies in other related areas presents the opportunity to translate the findings and experiences with virtual reality from dental care to different medical contexts, especially considering the common component of needle fear.

The secondary review questions we examined involved the types of virtual reality technology that were used, in terms of hardware and software. While all the studies used smart phones connected to virtual reality headsets, the software chosen by researchers was different in each study. The commonality of using mobile phones may be a result of the relatively low cost and availability of this technology. This implies that out of the myriad of virtual reality technologies on the market, no one option stood out as superior in terms of benefits to the patients. This has implications for practice and future studies to consider the different headset options and their impact on patient experience.

In summary, three of the studies[28,29,32] used virtual reality for VRET, with positive results in reducing patient fear and anxiety. These collective results suggest that VRET could be a successful therapy for patients with needle phobia. Two studies used virtual reality as a distraction therapy and found it to be an effective method of distraction for adults undergoing a needle-based procedure. Although further research is needed, overall, there is potential for virtual reality interventions to reduce needle phobia.

Discussion

The purpose of this rapid review was to investigate the effect of virtual reality on the severity of patient fear or anxiety induced by needle phobia during medical procedures. In addition, we examined the types and characteristics of the virtual reality systems that are in use, any side effects of virtual reality therapy and the characteristics of the patients who used or derived benefit from virtual reality for needle or needle-related phobias.

Only five journal articles were identified as meeting the inclusion criteria. Two of them described

using virtual reality as part of VRET for treating needle phobia. Exposure therapy encourages the confrontation of a feared stimulus with the aim of reducing the level of fear experienced[38].

Exposure therapy is the most effective empirically supported treatment for several anxiety disorders, including acrophobia, agoraphobia, arachnophobia, fear of flying, dental phobia, fear of driving and fear of snakes[39,40]. It uses systematic and controlled exposure to phobic stimuli with the aim of adjusting the inhibitory processes of the prefrontal cortex during exposure and inducing structural changes in the hippocampus following successful therapy[41]. It is also highly effective without exposing the patient to the actual fear-inducing stimuli[42]. The downside to exposure therapy is the cost of setting up the individual exposure scenarios[43]. VRET sessions require one simulation to be created which can be used for multiple sessions and, if clinically appropriate, multiple patients.

Two of the publications included in this rapid review were case studies that used virtual reality either as a distraction therapy or in conjunction with exposure therapy. Only one of these case studies examined a patient specifically with needle phobia. No RCTs were identified that focused specifically on adults with needle phobia, highlighting gaps in this area. Only one cross-sectional study that examined the effect of virtual reality as a distraction for reducing the anxiety levels experienced by people undergoing dental procedures. A contributing factor that we identified during our search is that research into virtual reality for needle phobia in adults has only emerged as recently as 2020[28]. Several studies were identified that researched virtual reality for paediatrics; however, research into using virtual reality with adults is only now emerging.

Several systematic reviews evaluating virtual reality as a method of distraction therapy were identified during this rapid review. The studies included in those systematic reviews were all excluded from this review as they related to paediatric patients; however, the systematic reviews indicated that virtual reality was an effective distraction modality in paediatric patients with needle phobia and this may be applicable to the adult population.

A key point to note is the distinction between VRET and virtual reality–based distraction therapy. Unlike VRET, distraction therapy does not focus on the treatment of the wearers' phobia, it distracts the wearer from the pain or fear-inducing stimulus. VRET is a longer-term solution to the patient's phobia, whereas distraction therapy is a potential solution to the acute clinical requirements of a situation where the patient is exposed to a phobic stimulus.

As a concept, distraction therapy has been previously studied for the management of BII and needle phobia in adults[44–47]; however, none of these studies used virtual reality as the means of distraction in the adult patient. Virtual reality is superior to traditional distraction therapy as it involves the wearer's auditory and visual processing and, in theory, demands more attention than the traditional methods of distraction[48,49]. The participant's sense of immersion in the virtual environment is increased by increasing the quality of the virtual reality headset[50] and the addition of auditory stimulus[51]. Virtual reality has been found to be beneficial for medical procedures in adult patients including burn dressing changes[52], minor procedures[53,54] and medication injections[55]. It has been found to reduce the level of pain experienced, thereby reducing the amount of analgaesia required. As a result of the reduction in pain experienced, patient satisfaction levels have been increased.

One of the strengths of this rapid review is that we followed the PRISMA guidelines and the framework for literature reviews as outlined by Peters et al.[19] and Arksey et al.[20] with additional steps outlined by Pluddemann et al.[21] to reduce bias and increase the outcome of the review. The PROSPERO registration and the rapid review protocol were published before conducting the review to increase the transparency of the findings. A possible limitation of this review is that the literature search was limited to five databases. It is possible that there are relevant publications in databases that were not searched.

Conclusions

Based on the studies identified, there is evidence, albeit limited, that virtual reality can alleviate the symptoms of needle phobia. We found a paucity of research about virtual reality as either a treatment for needle phobia or as a distraction therapy in adult patients. Most of the identified studies demonstrated benefits of virtual reality for needle phobia during dental procedures. A potential field of research exists for researchers as further research is required into the effectiveness of virtual reality as either a desensitisation procedure for treating needle phobia or a management technique for reducing fear and anxiety in the acute phase of needle exposure. Our team is conducting a feasibility study to

examine the use of virtual reality as a distraction therapy for a needle phobic patient during acute needle exposure.

Author contributions

CG conceived and designed the study, CG performed the database searches, CG and TR screened and determined the eligibility of articles. CG performed the data extraction, data synthesis and risk of bias assessment under the supervision of TR. CG authored the paper with contribution and editing from TR and IB.

Declaration of conflicting interests

The authors have declared no competing interests with respect to the research, authorship and publication of this article.

References

1. Orenius T, LicPsych, Säilä H, Mikola K, Ristolainen L. Fear of injections and needle phobia among children and adolescents: An overview of psychological, behavioral, and contextual factors [Internet]. SAGE Open Nursing. 2018[cited 2023 Sep 14];4. DOI: 10.1177/2377960818759442
2. Cook LS. Needle phobia [Internet]. J Infus Nurs. 2016[cited 2023 Sep 14];39(5):273–9. DOI: 10.1097/NAN.0000000000000184
3. Botella C, Fernandez-Alvarez J, Guillen V, Garcia-Palacios A, Banos R. Recent progress in virtual reality exposure therapy for phobias: A systematic review [Internet]. Curr Psychiatry Rep. 2017[cited 2023 Sep 14];19(7):42. DOI: 10.1007/s11920-017-0788-4
4. McLenon J, Rogers MAM. The fear of needles: A systematic review and meta-analysis [Internet]. J Adv Nurs. 2019[cited 2023 Sep 14];75(1):30–42. DOI: 10.1111/jan.13818
5. Jenkins K. II. Needle phobia: A psychological perspective [Internet]. Br J Anaesth. 2014[cited 2023 Sep 14];113(1):4–6. DOI: 10.1093/bja/aeu013
6. Hamilton JG. Needle phobia: A neglected diagnosis. J Fam Pract. 1995;41(2):169–75.
7. Wong CW. Complexity of syncope in elderly people: A comprehensive geriatric approach [Internet]. Hong Kong Med J. 2018[cited 2023 Sep 14];24(2):182–90. DOI: 10.12809/hkmj17694
8. Sokolowski CJ, Giovannitti JA, Jr., Boynes SG. Needle phobia: Etiology, adverse consequences, and patient management [Internet]. Dent Clin North Am. 2010[cited 2023 Sep 14];54(4):731–44. DOI: 10.1016/j.cden.2010.06.012
9. Rava J, Rosenau KA, Wilkie K, Curcio E, Kuo A. Implementation of a minimal sedation protocol for patients with developmental disabilities and needle phobia [Internet]. Cureus. 2023[cited 2023 Sep 14];15(7):e42154. DOI: 10.7759/cureus.42154
10. Bjerring P, Arendt-Nielsen L. Depth and duration of skin analgesia to needle insertion after topical application of EMLA cream. Br J Anaesth. 1990[cited 2023 Sep 14];64(2):173–7. DOI: 10.1093/bja/64.2.173
11. Olk B, Dinu A, Zielinski DJ, Kopper R. Measuring visual search and distraction in immersive virtual reality. R Soc Open Sci. 2018;5(5):172331.
12. Garrett B, Taverner T, Masinde W, Gromala D, Shaw C, Negraeff M. A rapid evidence assessment of immersive virtual reality as an adjunct therapy in acute pain management in clinical practice [Internet]. Clin J Pain. 2014[cited 2023 Sep 14];30(12):1089–98. DOI: 10.1097/AJP.0000000000000064
13. Kilic A, Brown A, Aras I, Hui R, Hare J, Hughes LD et al. Using virtual technology for fear of medical procedures: A systematic review of the effectiveness of virtual reality-based interventions. Ann Behav Med. 2021[cited 2023 Sep 14];55(11):1062–79. DOI: 10.1093/abm/kaab016
14. Levy F, Leboucher P, Rautureau G, Komano O, Millet B, Jouvent R. Fear of falling: Efficacy of virtual reality associated with serious games in elderly people [Internet]. Neuropsychiatr Dis Treat. 2016[cited 2023 Sep 14];12:877–881. DOI: 10.2147/NDT.S97809
15. Owens ME, Beidel DC. Can virtual reality effectively elicit distress associated with social anxiety disorder? J Psychopathol Behav Assess. 2015[cited 2023 Sep 14];37(2):296–305. DOI: 10.1007/s10862-014-9454-x
16. Rus-Calafell M, Gutierrez-Maldonado J, Botella C, Banos RM. Virtual reality exposure and imaginal exposure in the treatment of fear of flying: A pilot study [Internet]. Behav Modif. 2013[cited 2023 Sep 14];37(4):568–90. DOI: 10.1177/0145445513482969
17. Haby MM, Chapman E, Clark R, Barreto J, Reveiz L, Lavis JN. What are the best methodologies for rapid reviews of the research evidence for evidence-informed decision making in health policy and practice: A rapid review [Internet]. Health Res Policy Syst. 2016[cited 2023 Sep 14];14(1):83. DOI: 10.1186/s12961-016-0155-7
18. Tricco AC, Antony J, Zarin W, Strifler L, Ghassemi M, Ivory J et al. A scoping review of rapid review methods [Internet]. BMC Med. 2015[cited 2023 Sep 14];13:224. DOI: 10.1186/s12916-015-0465-6
19. Peters MD, Godfrey CM, Khalil H, McInerney P, Parker D, Soares CB. Guidance for conducting systematic scoping reviews [Internet]. Int J Evid Based Healthc. 2015[cited 2023 Sep 14];13(3):141–6. DOI: 10.1097/XEB.0000000000000050
20. Arksey H, O'Malley L. Scoping studies: Towards a methodological framework [Internet]. Int J Soc Res Methodol. 2005[cited 2023 Sep 14];8(1):19–32. DOI: 10.1080/1364557032000119616
21. Pluddemann A, Aronson JK, Onakpoya I, Heneghan C, Mahtani KR. Redefining rapid reviews: A flexible framework for restricted systematic reviews [Internet]. BMJ Evid Based Med. 2018[cited 2023 Sep 14];23(6):201–3. DOI: 10.1136/bmjebm-2018-110990
22. Gilbertson CJ, Rasekaba T, Blackberry I. Exploring the feasibility of using virtual reality as a nonpharmacological intervention to alleviate patient fear of needles during medical treatment: A study protocol [Internet]. J Periop Nurs. 2023[cited 2023 Sep 14];36(3):e-13–e-18. DOI: 10.26550/2209-1092.1268
23. Hastings C, Fisher CA. Searching for proof: Creating and using an actionable PICO question [Internet]. Nurs Manage. 2014[cited 2023 Sep 14];45(8):9–12. DOI: 10.1097/01.NUMA.0000452006.79838.67
24. The world's #1 systematic review tool [Internet]. Melbourne: Veritas Health Innovation;[cited 2023 Sep 14]. Available from: www.covidence.org
25. Sterne JAC, Savovic J, Page MJ, Elbers RG, Blencowe NS, Boutron I et al. RoB 2: A revised tool for assessing risk of bias in randomised trials [Internet]. BMJ (Clinical research ed). 2019[cited 2023 Sep 14];366:l4898. DOI: 10.1136/bmj.l4898
26. Moola S, Munn Z, Tufanaru C, Aromataris E, Sears K, Sfetcu R et al, editors. Systematic reviews of etiology and risk. In Aromataris E, Munn Z, editors. Manual for evidence synthesis. Adelaide: The Joanna Briggs Institute; 2017.

27. Joanna Briggs Institute. Checklist for case reports: Critical appraisal tools for use in JBI systematic reviews [Internet]. Adelaide: Joanna Briggs Institute; 2020[cited 2023 Sep 14]. Available from: https://jbi.global/sites/default/files/2021-10/Checklist_for_Case_Reports.docx
28. Jiang MYW, Upton E, Newby JM. A randomised wait-list controlled pilot trial of one-session virtual reality exposure therapy for blood-injection-injury phobias [Internet]. J Affect Disord. 2020[cited 2023 Sep 14];276:636–45. DOI: 10.1016/j.jad.2020.07.076
29. Lacey C, Frampton C, Beaglehole B. oVRcome - Self-guided virtual reality for specific phobias: A randomised controlled trial [Intetnet]. Aust N Z J Psychiatry. 2023[cited 2023 Sep 14];57(5):736–44. DOI: 10.1177/00048674221110779
30. Cheruvatoor JJ, Kaini L, Hanafiah MABMA, Sihabubdin MAB, Marla V. Use of virtual reality (VR) as an audio-visual distraction tool in the reduction of dental anxiety during local anesthesia [Internet]. J Pharm Res Int. 2021:102–8. DOI: 10.9734/jpri/2021/v33i31B31696
31. Kunusoth R, Colvenkar S, Alwala AM, Bharadwaj S, Boyapati R. A simple technique to manage anxiety during tooth extraction [Internet]. Cureus. 2022[cited 2023 Sep 14];14(9):e29275. DOI: 10.7759/cureus.29275
32. Meindl JN, Saba S, Gray M, Stuebing L, Jarvis A. Reducing blood draw phobia in an adult with autism spectrum disorder using low-cost virtual reality exposure therapy [Internet]. J App Res Intellect Disabil. 2019[cited 2023 Sep 14];32(6):1446–52. DOI: 10.1111/jar.12637
33. Page MJ, Moher D, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD et al. PRISMA 2020 explanation and elaboration: Updated guidance and exemplars for reporting systematic reviews [Internet]. BMJ. 2021[cited 2023 Sep 14];372:n160. DOI:10.1136/bmj.n160.
34. Alaki SM, Alotaibi A, Almabadi ES, Alanquri E, editors. Dental anxiety in middle school children and their caregivers: Prevalence and severity [Internet]. J Denr Oral Hyg. 2012[cited 2023 Sep 14];4(1): 6–11. Available from: www.academicjournals.org/app/webroot/article/article1379688126_Alaki%20et%20al.pdf
35. Armfield JM, Milgrom P. A clinician guide to patients afraid of dental injections and numbness. SAAD Dig. 2011;27:33–9.
36. McLenon J, Rogers MAM. The fear of needles: A systematic review and meta-analysis [Internet]. J Adv Nurs. 2019[cited 2023 Sep 14];75(1):30–42. DOI: 10.1111/jan.13818
37. Hamilton M. The assessment of anxiety states by rating [Internet]. Br J Med Psychol. 1959[cited 2023 Sep 14];32(1):50–5. DOI: 10.1111/j.2044-8341
38. Tolin DF, Kaplan JS. Exposure therapy for anxiety disorders [Internet]. Psychiatr Times. 2011[cited 2023 Sep 14];28(9):33. Available from: www.psychiatrictimes.com/view/exposure-therapy-anxiety-disorders
39. Donnelly MR, Reinberg R, Ito KL, Saldana D, Neureither M, Schmiesing A et al. Virtual reality for the treatment of anxiety disorders: A scoping review [Internet]. Am J Occup Ther. 2021[cited 2023 Sep 14];75(6):7506205040. DOI: 10.5014/ajot.2021.046169
40. Cobb AR, O'Connor P, Zaizar E, Caulfield K, Gonzalez-Lima F, Telch MJ. tDCS-Augmented in vivo exposure therapy for specific fears: A randomized clinical trial [Internet]. J Anx Disord. 2021[cited 2023 Sep 14];78:102344. DOI: 10.1016/j.janxdis.2020.102344
41. Parsons TD, Rizzo AA. Affective outcomes of virtual reality exposure therapy for anxiety and specific phobias: a meta-analysis [Internet]. J Behav Ther Exp Psychiatry. 2008[cited 2023 Sep 14];39(3):250–61. DOI: 10.1016/j.jbtep.2007.07.007
42. Lacková DHVSE. Phobia treatment with the help of virtual reality [Internet]. 2015 IEEE 13th International Scientific Conference on Informatics. 2015[cited 2023 Sep 14]. DOI: 10.1109/Informatics.2015.7377818
43. Raghav K, Van Wijk AJ, Abdullah F, Islam MN, Bernatchez M, De Jongh A. Efficacy of virtual reality exposure therapy for treatment of dental phobia: A randomized control trial [Internet]. BMC Oral Health. 2016[cited 2023 Sep 14];16:25. DOI: 10.1186/s12903-016-0186-z
44. Grider B, Luiselli JK, Turcotte-Shamski W. Graduated exposure, positive reinforcement, and stimulus distraction in a compliance-with-blood-draw intervention for an adult with autism [Internet]. Clin Case Stud. 2012[cited 2023 Sep 14];11(3):253–60. DOI: 10.1177/1534650112448
45. Oliver NS, Page AC. Fear reduction during in vivo exposure to blood-injection stimuli: Distraction vs. attentional focus [Internet]. Br J Clin Psychol. 2003[cited 2023 Sep 14];42(Pt 1):13–25. DOI: 10.1348/014466503762841986
46. Oliver NS, Page AC. Effects of internal and external distraction and focus during exposure to blood-injury-injection stimuli [Internet]. J Anx Dis. 2008[cited 2023 Sep 14];22(2):283–91. DOI: 10.1016/j.janxdis.2007.01.006
47. Penfold K, Page AC. The effect of distraction on within-session anxiety reduction during brief in vivo exposure for mild blood-injection fears [Internet]. Behav Ther. 1999[cited 2023 Sep 14];30(4):607–21. DOI: 10.1016/S0005-7894(99)80028-8
48. Gupta A, Scott K, Dukewich M. Innovative technology using virtual reality in the treatment of pain: Does it reduce pain via distraction, or is there more to it? Pain Med. 2018[cited 2023 Sep 14];19(1):151–9. DOI: 10.1093/pm/pnx109
49. Indovina P, Barone D, Gallo L, Chirico A, De Pietro G, Giordano A. Virtual reality as a distraction intervention to relieve pain and distress during medical procedures: A comprehensive literature review [Internet]. Clin J Pain. 2018[cited 2023 Sep 14];34(9):858–77. DOI: 10.1097/AJP.0000000000000599
50. Hoffman HG, Seibel EJ, Richards TL, Furness TA, Patterson DR, Sharar SR. Virtual reality helmet display quality influences the magnitude of virtual reality analgesia [Internet]. J Pain. 2006[cited 2023 Sep 14];7(11):843–50. DOI: 10.1016/j.jpain.2006.04.006
51. Johnson S, Coxon M. Sound can enhance the analgesic effect of virtual reality [Internet]. R Soc Open Sci. 2016[cited 2023 Sep 14];3(3):150567. DOI: 10.1098/rsos.150567
52. Faber AW, Patterson DR, Bremer M. Repeated use of immersive virtual reality therapy to control pain during wound dressing changes in pediatric and adult burn patients [Internet]. J Burn Care Res. 2013[cited 2023 Sep 14];34(5):563–8. DOI: 10.1097/BCR.0b013e3182777904
53. Shrestha M, Singh NS, Sheth SJ, Odor AM, Jiang L. Virtual reality distraction for anxiety and pain reduction during trigger point injection procedures [Internet]. Pain Med. 2019[cited 2023 Sep 14];20(3):640 (AAPM 2019 Annual meeting abstracts). DOI: doi.org/10.1093/pm/pny317
54. Smith V, Warty RR, Kashyap R, Neil P, Adriaans C, Nair A et al. A randomised controlled trial to assess the feasibility of utilising virtual reality to facilitate analgesia during external cephalic version [Internet]. Sci Rep. 2020[cited 2023 Sep 14];10(1):3141. DOI: 10.1038/s41598-020-60040-3
55. Basak T, Demirtas A, Yorubulut SM. Virtual reality and distraction cards to reduce pain during intramuscular benzathine penicillin injection procedure in adults: A randomized controlled trial [Internet]. J Adv Nurs. 2021[cited 2023 Sep 14];77(5):2511–8. DOI: 10.1111/jan.14782