Virtual Reality for the Treatment of Perinatal Mental health: A Rapid Scoping Review

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Abstract

Background: Mental health struggles are notably prevalent during the perinatal period, with studies highlighting increased rates of mood disorders among new parents, particularly since the COVID-19 pandemic. eHealth treatments have been growing in popularity, with research exploring innovative solutions such as virtual reality (VR), which offers a promising alternative or adjunct to established treatments through immersive technology.

Objective: This rapid scoping review aims to evaluate the available VR applications for treating perinatal mental health disorders, focusing on their effectiveness in reducing symptoms such as anxiety and depression, which are common during the perinatal period.

Methods: Adhering to the Joanna Briggs Institute guidelines and PRISMA-ScR, as well as making adjustments based on the Cochrane Rapid Reviews guidelines, a comprehensive search across five databases was conducted to identify relevant studies. Inclusion criteria consisted of studies utilizing VR interventions during the perinatal period with outcomes related to mental health symptoms. A total of 308 studies were screened, with 10 meeting the inclusion criteria for detailed analysis.

Results: The review included studies primarily conducted in high-income countries from 2019 to 2024. The majority (80%) were randomized controlled trials, employing VR through head-mounted displays. Studies predominantly targeted anxiety and depression, with VR environments ranging from nature scenes to therapeutic content. Results suggest a positive impact of VR interventions on reducing anxiety and depression levels among participants.

Conclusions: VR appears to be a promising option for managing perinatal mental health. The immersive nature of VR may provide opportunities for emotional relief and support during this critical period through immersive and engaging experiences which can reduce symptoms of anxiety and depression. However, the body of research remains limited, indicating a need for further studies to explore the long-term benefits and potential integration of VR into perinatal healthcare practices. The promising results from initial studies encourage continued exploration and development within this innovative therapeutic field.

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Review

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Keywords: virtual reality; mental health; pregnancy; perinatal; anxiety; depression.

Introduction

Mental health struggles are common during the perinatal period, defined as the time frame from one year before birth to 24 months after [1]. In fact, approximately 23% of mothers in Canada report experiencing symptoms of post-partum depression or anxiety disorders [2]. Specifically, prevalence rates for prenatal depression range from 20% to 40% and are around 17% for postpartum depression [3]. Similarly, prevalence rates range from 13%–21% for prenatal anxiety and from 11%–17% for postpartum anxiety [4]. These rates increased during the COVID-19 pandemic [4-10].

If left untreated, maternal and paternal mood disorders can have long-term negative effects on the parents, the child and thus the family as a whole . Since perinatal mood disorders are heterogenous and of varied severity, a variety of treatments exist. Current treatment methods include various psychotherapies (most notably cognitive–behavioral therapy (CBT)), psychopharmacology (though

pregnant individuals prefer not to take medication due to safety concerns during pregnancy), well-being enhancement (such as exercise, behavioral activation and mindfulness), larger systems approaches (such as community therapy, and peer support therapy) and eHealth programs. eHealth offers promising treatment modalities consisting of technology-based therapies including App or web-based psychoeducation modules, video or phone sessions, and text messages. Burgeoning evidence points to the effectiveness of eHealth programs to support perinatal mental health and the wellbeing of new parents [11]. In fact, a recent meta-analysis [12] indicated that there is a small effect of eHealth interventions for depression and anxiety, and a moderate effect for insomnia, during pregnancy.

One of the eHealth modalities that has been growing in popularity is Virtual Reality (VR). VR is commonly used with head-mounted displays (HMDs) which create an immersive experience that allows someone to interact with a world beyond reality [13]. Alternatively, semi-immersive VR exists in the form of cave automatic virtual environment (CAVE) systems (i.e., projector screens) or non-immersive VR in the form of monitor screens. These latter two methods have been proven to be less effective than fully immersive VR when eliciting feelings of presence compared to HMDs [14, 15]. Further, having a higher immersion increases the emotional impact for the user [15]. There is substantial evidence regarding the effectiveness of immersive VR in the treatment of anxiety and depression in general populations across a range of settings [16, 17], with emphasis on social anxiety, general anxiety and public speaking anxiety [16].

However, the effectiveness of VR to treat mood disorders and improve mental health during the perinatal period is relatively unexplored. A previous scoping review of nine studies that used VR to help people during their pregnancy and delivery found that VR is effective in the treatment of pregnancy-related anxiety and delivery pain management [18]. Suggested mechanisms include providing information about what to expect during delivery, through experiential exposure, and distraction from stressful pregnancy and childbirth-related events. However, the review was limited to VR being used for anxiety and pain reduction, or as an exercise tool. VR has mainly been used in the perinatal period for assisting during specific procedures such as during labor or surgery, as well as during various assisted reproductive procedures. This has provided evidence on how VR may be able to mitigate anxiety and stress related to a specific event. As a result, three systematic reviews and meta-analyses have been conducted, all of which found VR to be an effective and safe way to reduce labor-related pain and anxiety [19].

Nonetheless, there is a lack of evidence summarized in one review that focuses on the overall mental health of new and expecting parents. Given that poor perinatal mental health can lead to poor health outcomes for the child and the parent [9], there is a high importance in identifying treatment options for perinatal mood-related disorders and improving the overall mental health of parents. There is thus a clear need to synthesize and evaluate the research conducted to date using fully immersive VR to treat symptoms related to perinatal mood disorders and to support mental health during the perinatal period. Considering the novelty of the field of VR and the limited literature available, a rapid scoping review presents the most feasible option to summarize the available evidence. Particularly, it is important to understand what kind of VR technology has been used, how it has been used, and what the outcomes have been, in order to comprehensively present the available knowledge and guide future development and testing.

To thoroughly investigate the literature available about VR in supporting perinatal mental health, we conducted a rapid scoping review, which aims to answer the following research question: *What virtual reality (VR) applications are available for the treatment of perinatal mental health?* Our

synthesis focused on the following key objectives: 1) determining the types of VR technology employed in perinatal mental health treatment and the various ways they have been implemented; 2) identifying specific mental health symptoms that have been evaluated following VR interventions for perinatal mental health; 3) examining the characteristics of research studies that employ VR for perinatal mental health, including study settings, participant characteristics, and research designs; and 4) highlighting the principal findings of VR outcomes (feasibility and acceptability, mood or mental health symptom change) from the literature on this topic.

Methods

Protocol and Registration

To appropriately answer the research question and the objectives in our scoping review, we followed the guidelines set by the Joanna Briggs Institute [20] and the preferred reporting items for systematic reviews and meta-analyses extension for scoping review (PRISMA-ScR)[21]; we also followed the Interim guidance from the Cochrane rapid reviews methods group [22]. As such, we conducted the rapid scoping review in the following stages: pilot search, pilot screening, search strategy update, search, screening, extraction, synthesis. The review was registered with OSF [23] on March 6th, 2024.

Eligibility Criteria

The inclusion and exclusion criteria for studies can be seen in (Table 1).
Table 1. Eligibility criteria based on study population, concept, context and types of evidence.

	Inclusion Criteria	Exclusion Criteria
Population	• Participants must be in the perinatal period (pregnant or up to 24 months after birth of the infant) [1]	• Evaluation of the technology without human participants • Evaluation of the technology with human participants not in the perinatal period
Concept	• Studies that refer to the concept of immersive VR for the treatment of the perinatal mental health or its derivatives (i.e. pregnancy-related anxiety and postpartum depression) • Studies that provide information on: the VR technology including the hardware (i.e. standalone HMD, phone-based HMD or PC powered HMD) and program content (i.e. virtual environment design) • Studies that provide information on what elements of perinatal mood disorders (i.e. anxiety or depression) were assessed; and how these elements were assessed (i.e. quantitatively, qualitatively, or mixed-method)	• Studies that do not include any symptoms of mental health in their assessment • Studies that do not refer to the concept of immersive VR for the treatment of perinatal mental health or its derivatives (i.e. pregnancy-related anxiety and postpartum depression) • Studies that do not provide information on: the VR technology including the hardware (i.e. standalone HMD, phone-based HMD or PC powered HMD) and program content (i.e. virtual environment design) • Studies that do not provide information on what elements of perinatal mood disorders (i.e. anxiety or depression) were assessed; and how these elements were assessed (i.e. quantitatively, qualitatively, or mixed-method)
Context	• Any geographical location or setting of	• Studies in which participants did not try

	any nature where participants use VR technology in person	the VR technology
Type of Source	• Primary empirical research studies (e.g. RCTs [a], non-RCTS, quantitative, qualitative, and mixed methods studies) • Protocols for planned studies • Full-text articles • Full-text conference proceedings • Study registrations • Dissertations	• Reviews (e.g., systematic reviews, narrative reviews) • Editorial articles (e.g., perspective pieces, position statements) • Abstracts or posters • Articles for which we cannot obtain the full text
Language	• Written in English or French	• Non-English and non- French papers

Note. [a] RCT: randomized controlled trial

Information Sources

Five databases were searched: Medline, PsychInfo, Embase, EBM Reviews using Ovid as well as Web of Science. The search was done by CZ on February 20th, 2024. The search strategy was drafted in consultation with a psychology and psychoeducation librarian of the Université de Montréal (Dominic Desaulniers). Three concepts were identified to be used in the search strategy: virtual reality, mental health, and the perinatal period. The final search strategy can be found in Supplementary Material 1.

Selection of Sources of Evidence

Following the search, all identified studies were collected and uploaded into EndNote 21 (Clarivate Analytics, PA, USA). Records were then imported to the Covidence platform, where duplicates were removed, for the screening of the articles. The screening was conducted following all the steps set by PRISMA-ScR [21] for scoping reviews, with adjustments regarding the number of screeners per step based on the recommendations from Cochrane Rapid Reviews [22]. Step 1: One screener (CZ) screened for titles and abstracts. All the excluded studies, as well as 20% of the included studies, were screened by an additional independent screener (JJ). Step 2: One screener (CZ) screened the full-texts. All the excluded studies were screened by the additional independent screener (JJ). Any disagreements that arose between the screeners at each round of the selection process were resolved through a consensus discussion, or with a third reviewer (AM). The reference list of the studies included for full text in the review was also scanned to identify any relevant grey literature, however none was found.

Data Extraction and Quality of Assessment

The following data was extracted: title, year of publication, country, study design, participants sample size and characteristics, VR component (hardware and software), time between data collection sessions if applicable, mental health aspect being investigated, quantitative data collected related to mental health or VR, qualitative data fragments if applicable, and study outcomes (such as information on usability, acceptability, and VR's effect on mental health results). One extractor (CZ) independently extracted all the data required, and a second extractor (JJ) checked for correctness.

The quality of the studies was assessed with the National Institute of Health (NIH) Quality Assessment of Controlled Studies tool [24] by a single reviewer (CZ), with an additional reviewer verifying the judgements (JJ). The tool includes 14 questions answered with yes, no, cannot determine, not applicable, not reported. The tool is designed to assist reviewers for a critical appraisal of the studies, without focus on a numeric score. After answering the 14 questions, the studies are judged to be good (considers results to be valid), fair (acknowledges the results may

contain some bias but not enough to be deemed invalid) or poor (indicates significant risk of bias). Any studies included in the form of a registration or protocol were not assessed for their quality.

Synthesis of Results

To answer the research question, all the information found was synthesized both narratively and in tabular form so that the available VR treatments can be comprehensively presented. Results were categorized and reported based on the included studies general characteristics (author's name, year of publication, country, type of study, sample size, participant characteristics, study objective) in (Table 2), and specific characteristics (VR hardware and software, mental health measures, time between data collection, and reported findings) in (Table 3). The tables of both categories are proceeded by a narrative summary of the results.

Results

A total of 425 records were found. After removing all duplicates, a total of 308 were left for title and abstract screening. Out of these, 74 were assessed for full-text eligibility, out of which 10 were included for the data extraction. See (Figure 1) for details.

General Study Characteristics

As seen in (Table 2), the included studies (k = 10) were published between 2019 and 2024, with most in 2023 (k = 6, 60%) [24-29]. The majority of the studies (n=8, 80%) [25-32] were randomized-controlled trials (RCTs), while one was a pilot trial [33] and one was a laboratory experiment [34]. Out of the included studies, some (k =3) have not yet been conducted; one was a registration of a RCT that is still in the process of recruiting participants [26], and two were study protocols [27, 33]. The included studies were conducted across several countries, including in Turkey (k = 3) [25, 29, 32], Spain (k = 2)[27, 31], USA and China (k = 1)[34], Korea (k =1)[28], Denmark (k =1)[26], Switzerland (k =1)[26], Netherlands (k =1)[30]. Out of the studies already conducted (k = 7) [25, 28-32, 34], there was an average of 130.3 participants (N = 912 total), with an average age of 30.3 years old (two studies [28, 31] did not mention an age limit criteria), and average of 31.6 weeks gestation among those who were pregnant.

Most studies only investigated the effects of VR with the pregnant person (k =9) [25-29, 31-34] , while one also investigated the effects with their partner [30]. The objectives of the included studies were varied, with some measuring aspects beyond mental well-being. However, the most targeted mental health outcome was anxiety (k = 5, 50%) [25, 29-32], stress (k = 2, 20%) [29, 34], and depression (k = 1, 10%) [26]. Nonetheless, as seen in the data extracted (Table 3), all studies measured secondary mental health symptom outcomes not related to their study objectives. Most studies (k = 9) [25, 27-34] used validated questionnaires to measure mental health symptoms, with only one study not mentioning the questionnaires to be used [26]. Anxiety was most commonly assessed (k = 8) [25, 27, 29-34] through the State Anxiety Inventory (STAI) (k = 5, 62.5%)[25, 27, 29, 31, 32], which is a 40-item questionnaire that measures both state anxiety (i.e., experienced in that exact moment and experienced generally), and trait anxiety (i.e., persistent, affecting the person long-term) [35]. This is followed by depression (k = 5) [26-29, 33], which was most frequently measured with the Edinburgh Postnatal Depression Scale (EPDS) (k = 2, 40%)[27, 28], which assesses depressive symptoms experienced in the previous week [27]. One [26] registration (k = 1, 10%) did not report their planned measure for depression.

Table 2. General characteristics of the included studies.

Study	Year of Publication	Country	Design	Sample size	Participant characteristics	Study Objective
Toker et al. [25]	2023	Turkey	RCT	88 Total 43 VR 45 control	18–45 years old (avg. 29), avg. 37.2 gestation weeks, single pregnancy, having had NST[a] at least once before, having regular antenatal follow-up, at least primary school graduates.	Effect of VR on one of the fetal movement. fetal heart rate, anxiety, fatigue, maternal satisfaction.
Sun et al. [34]	2022	USA and China	Laboratory experiment	63 Total 21 per group	18+ years old (avg. 31.8), between 8-14 weeks' gestational age (avg. 11 weeks), single pregnancy, not on any medication, no history of chronic disease, no use of tobacco and alcohol 24hrs prior to the study.	Effect of VR on physiological and affective responses to stress.
Noben et al. [30]	2019	Netherlands	RCT	97 Total 49 VR 48 control	18+ years old (avg. 32.6), had planned for elective CD[b] after 37 weeks of gestation (avg. 39 weeks), knowledge of the Dutch language. Not have placenta previa, pre-eclampsia, and a suspected congenital anomaly.	Effect of adding VR video to standard preoperative information in preoperative anxiety, patients' levels of anxiety and patient satisfaction scores of both women and their partners. Further, to see if VR would be feasible to implement, without causing any harmful side effects such as motion sickness.
Miskowiak et al. [26]	Registered in 2023	Denmark	RCT	146 Total	18-50 years old, speak and read Danish. High-Risk Pregnant Group: Past mental illness or psycho-social risk factors, unless they have schizophrenia or current substance use disorder or score of 9 or more on the Hamilton Depression Rating Scale. Low-Risk Pregnant Group: Absence of a personal or family history of mental illness, Absence of negative bias.	Effect of VR intervention to decrease the risk of post-partum depression.
Corbaz et al.[33]	2023	Switzerland	Pilot	70 Total 35 VR 35 control	18 years+, planned or unplanned CD at ≥34 weeks gestation not under anaesthesia, birth to a healthy baby, skin-to-skin contact is not possible or was prematurely interrupted, speaks French, does not have an established intellectual disability or psychoticillness, does not have photosensitive epilepsy.	Effect of VR on the childbirth experience of mothers undergoing a CD.

Jimenez-Baragan et al. [27]	2023	Spain	RCT	70 Total	18+ years old, positive value in the mental health screening, verbal and written understanding of Spanish, no diagnosis of psychiatric pathology, no victims of gender-based violence.	Effect of VR to improve mental well-being during pregnancy
Lee et al. [28]	2023	Korea	RCT	88 Total 44 VR 44 control	Avg. age 34.5, pregnancies after 20-week gestation (avg. weeks at start 28 and at follow-up 33.6) and no history of psychiatric disorders.	Effect of fetal images in VR in helping pregnant women to imagine or perceive fetal appearance and to determine the positive effect on mother-fatal attachment and the protective effect against depressive symptoms.
Estrella-Juarez et al. [31]	2022	Spain	RCT	343 Total 104 music 124 VR 115 control	Avg. age 31.7, full-term pregnancy (≥37 weeks' gestation) (avg. 37.4 weeks) and low-risk pregnancy, single pregnancy with no known fetal abnormality, no use of assisted reproductive technology, no perinatal complications, and no exposure to drugs or medications that were not prescribed by their gynecologist during the pregnancy.	Effect of VR and music therapy have on the physiology of pregnant women and fetuses, maternal anxiety, and the labor and birth process.
Sezer et al. [32]	2024	Turkey	RCT	102 Total 34 music 34 VR 34 control	18 years + (avg. 29.2), 32 gestation weeks + (avg. 35.9 weeks), single fetus, diagnosed with high-risk pregnancy, no visual or hearing impairment, no fetus anomaly, no major medical/mental illness, no fetal distress requiring medical intervention	Effect of VR and music on anxiety levels, the parameters of NST, and satisfaction levels of high-risk pregnant women during NSTs.
Kilic et al. [29]	2023	Turkey	RCT	131 Total 65 VR 66 control	18 years + (avg. 23.3), between 24 and 37 weeks of gestation (avg. 32.5 weeks) single pregnancy, no visual or hearing impairment, communicate in Turkish, , no psychiatric diseases leading to stress and anxiety or other diagnoses, such as preeclampsia, fetal distress, gestational diabetes mellitus, hemorrhage, and chronic diseases, and not pregnancy due to assisted reproductive techniques.	Effect of VR in reducing the anxiety and stress levels of pregnant women hospitalized due to pre-term birth term threats and increasing the level of attachment, and satisfaction with using VR headset.

Note. [a]NST: non-stress test; [b]CD: cesarean delivery

Specific Study Characteristics

As seen in (Table 3), the studies used different VR hardware to conduct the experiments. Half of the studies (k = 5) [25, 28, 30-32] used a VR device compatible with a smartphone, while the other half [26, 27, 29, 33, 34] used standalone VR headsets. Half of the studies (k = 5, 50%) [25, 29, 31, 32, 34] had nature environments as the visual stimuli in VR with the aim of aiding the participant to relax, while the other types of stimuli were fetal/baby images (k = 2, 20%) [28, 33] to help the bonding experience between parent and baby, CD informative videos (k = 1, 10%) [30], and activities such as mindfulness/breathing exercises (k = 1, 10%) [27] and cognitive exercises (k = 1, 10%) [26]. The interventions and data collection were carried out over different periods of time, depending on the study, with almost half (k = 4, 40%) [25, 31, 32, 34] only requiring one VR session. Most studies (k = 8, 80%) [25, 27-32, 34] collected pre and post VR intervention data relating to the mental health symptoms of the participants. Out of these, a minority (k = 3, 37.5%) also conducted follow-up assessments long after the VR intervention had been administered (1-week and 1-month after birth [33], 1-2 weeks after birth [30], and up until 10 months after birth [26]).

Of the studies that were already conducted and thus reported findings (k = 7, 70%) [25, 28-32, 34], the outcomes of the VR interventions were positive. Regarding anxiety, studies (k = 6, 85.7%) found a decrease in symptoms after VR intervention [25, 29-32, 34]. Specifically, it was found that VR environments with more green spaces, such as parks, decreased anxiety and increased happiness compared to urban VR environments without green spaces [34]. It was also found that VR intervention showing fetal images lead to lower depression scores of the participants compared to the participants receiving no VR intervention [28]. Undergoing VR intervention also showed a decrease in self-reported stress [29]. Results were also positive about the VR intervention in terms of subjective experience, with studies reporting participant satisfaction with the VR intervention and willingness to recommend it to other pregnant women [25, 29, 32].

Table 3. Specific characteristics of the included studies.

Study	VR components	Time between data collection	Mental health measures	Reported findings
Toker et al. [25]	Device: Headset (EverestVR-0023-3d-spm-HB000002QTQG model) used with a Smartphone. Software: Nature video.	n/a	STAI TX-I and the VAS[a]-Fatigue applied before and after NST, the NSNCS[b], and the Virtual Reality Application Form.	• VR led to statistically higher NSNCS results. • STAI-TX scores decreased significantly after the procedure for both groups. • VAS-F showed statistical intragroup and intergroup differences after procedure. • All the participants were satisfied with the VR application during the NST, the majority wanted to use the application in the following NST applications (83.3%), and they recommended it to other pregnant women (95.0%). • 68.0% and 27.5% of women reported feeling comfortable and happy, respectively.
Sun et al. [34]	Device: VR headset (iQIYI Qiyu 2Pro, iQIYI,	n/a	Trier Social Stress Test, serial physiological	• Participants experiencing green space environments during the recovery

	Inc., Beijing, China). Software: three 5-min videos with non-, moderate, and high level of urban green space exposure were created.		measurement (i.e., BP[c], HR[d], and SCL[e]), saliva collection, Positive and Negative Affect Scale, Perceived Stress Scale and surveyed participants' lived experience and attitudes toward green space and feelings of VR motion sickness. Data was collected pre and post VR intervention.	period had greater decreases of systolic BP, diastolic BP, HR, SCL, salivary alpha-amylase, and salivary cortisol, especially for the high green space group. In high and middle green exposure participants reported higher overall positive scores after recovery compared to their scores before recovery. • Participants in the high green space group had a significant increase in overall positive affect score and decreased negative affect scores. • Thus, green space increased happiness and decreased anxiety.
Noben et al. [30]	Device: VR glasses with participants' smartphone Software: 360° VR video that shows all the aspects of a CD. The video was recorded from the partner's in the operating room. The video ends at the ward, where the family is reunited. The video lasts 285 seconds and is narrated with a Dutch voice-over.	Prior to admission for CD, on day of admission and 1-2 weeks after CD	VAS-Anxiety, Tilburg Pregnancy Distress Scale, Childbirth Perception Scale,. Pregnancy and Childbirth Questionnaire,. Data was collected pre and post -VR intervention.	• Increase in the VAS-A score for the women in the VR group compared to the control group. • Increase in the VAS-A score for the for the partners of the women in VR group compared to the control group • VR group without a history of emergency CD, perceived a higher quality of care than the control group. • There was no significant difference in scores on the Tilburg Pregnancy Distress Scale subscales for both time points 1 and 2 between the VR group and the control group.
Miskowiak et al. [26]	Device: Computer and VR Software: exercises to modify negative cognitive bias and improve emotion regulation.	VR intervention to be performed over 5 weeks. Last data collected 10 months after birth.	No specific questionnaire/collected data mentioned	• Expected outcomes regarding specific symptoms not reported but the authors believe VR has potential to offer a simple, non-invasive method to bolster mental health in expectant mothers, which could also positively impact their infants.
Corbaz et al. [33]	Device: HMD for the mother and 360 2D camera for the partner/ co-parent/midwife Software: The camera will film the baby and broadcast the live video to the HMD. The mother will be able to witness the first care of her baby, see him/her being weighed and measured and watch the skin-to-skin contact between the baby and the mother's partner/co-parent for visual and	Data collected right after birth, 1-week after birth and 1 month after birth	Childbirth Experience Questionnaire, City Birth Trauma Scale, Birth Satisfaction Scale Revised, Mother–Infant Bonding Scale, Hospital Anxiety and Depression Scale.	• Expected outcomes are improved childbirth experiences when the mother and baby are physically separated as VR can provide visual and auditory contact for that period.

	auditory contact.			
Jimenez-Baragan et al. [27]	Device: Oculus GO VR glasses Software: 14 minutes application with three modules on the use of mindfulness techniques based on breathing, mindfulness and passive muscle relaxation.	VR intervention to be performed for 14 minutes a day for 6 weeks.	EPDS, Generalized Anxiety Disorder-2, STAI, Symptom Checklist-90-R, Temperament and Character Inventory-Revised, Usability Evaluation APP-M-health, Whooley questions, Pregnancy satisfaction questionnaire. Data will be collected pre and post VR intervention.	• Expected outcomes are optimized mental health of the pregnant woman through a reduction of anxiety and depressive symptoms, promotion of normal childbirth through an improved satisfaction of pregnancy follow-up and a reduction of the burden on the health system.
Lee et al. [28]	Device: VR headset used with a smartphone. Software: Fetal images were generated in VR from the data obtained through ultrasonography of the subject's own fetus.	Data collected 2 and 4 weeks after the first assessment.	Cranley method for maternal fetal attachement evaluation, the Condon method for antenatal emotional attachement, EPDS and Postpartum Depression Screening Scalewere administered before and after VR intervention. A self-report house developed questionnaire to determine how much the participants understood the appearance of the fetus.	• Proportion of lower scores at the follow-up compared to baseline for the EPDS test was higher in the intervention group than in the control group with no statistical significance. • Mean value of 1 subscale of the Cranley test, interaction with the fetus, showed a greater increase in the intervention group than the control group.
Estrella-Juarez et al. [31]	Device: Bnext three-dimensional (3D) glasses, used with a smartphone inserted into the front part of the glasses. Software: Images of the ocean floor with relaxing sounds that accompanied the 3D images	n/a	STAI administered before and after intervention.	• Results from the VR group were similar to those of the music therapy group, showing a decrease in the levels of total anxiety and trait anxiety, while no difference was present for control group.
Sezer et al. [32]	Device: Virtual reality glasses is a device that work on compatible smartphones. Software: Nature videos and listening to relaxing music.	n/a	STAI-S, VAS administered before and after intervention.	• VR and music groups had significantly lower mean posttest STAI-S scores than their pretest scores. • VR and music groups had a significantly higher mean VAS-satisfaction score than the control group regarding the intervention. • All participants in the VR group noted that they would like to use VR technology during their next NSTs. • All VR and music group participants recommended those applications to other pregnant women.
Kilic et al. [29]	Device: Oculus Quest 2.	The VR intervention consisted of	The Stress Subscale of Depression Anxiety Stress Scale, STAI, The Prenatal	• For posttest scores in terms of the state anxiety, stress, and prenatal attachment, a statistically significant difference was

	Software: Nature images accompanied by nature sounds.The scenery includes a forest and a lake at the outskirts of a mountain accompanied by the sounds of birds, bees, and water.	watching 6 videos 3 times a day for 2 days. Data was collected before intervention on day 1 and after intervention on day 2.	Attachment Inventory. The questionnaires were administered before and after intervention.	determined between both groups. For the VR group there was a statistically significant difference between pretest and posttest in terms of anxiety and stress, and a non-statistically significant difference in prenatal attachment scores. For the control group there was a statistically significant difference in terms of stress and prenatal attachement scores. • All the participants in the intervention group stated satisfaction with watching videos through VR headset. 90.5% of the pregnant women wished to use VR headset again in their next pregnancy, and 96.8% would recommend watching nature images with VR headset to other pregnant women.

Note. [a]VAS: Visual Analogue Scale; [b] NSNCS: Newcastle Satisfaction Nursing Care Scale; [c]BP: blood pressure; [d]HR: heart rate; [5]SCL: skin conductance level

Risk of Bias Assessment

The studies were assessed for their bias using the NIH Quality Assessment of Controlled Studies tool [24], except the registrations and protocols. Thus, seven out of the ten studies included (70%) were assessed, and both reviewers (CZ and JJ) agreed on the outcomes. Four out of seven (57%) were rated as fair, while the other three (42%) were rated as good. Thus, the results of the included studies can be considered valid.

Discussion

Summary of Evidence

Perinatal mood disorders can have long-term negative effects on the parent and the child if left untreated [9]. Amongst the treatment options more eHealth approaches are now being offered including VR, which has been shown to be an effective tool to treat symptoms of social anxiety, general anxiety, as well as other forms of anxiety, and depression in the general population [16, 17]. Little is, however, known about whether VR can be used to support mental health during the perinatal period, beyond those that focus on mental health changes arising due to fear of childbirth or medical procedures related to pregnancy. Thus, this rapid scoping review aimed to identify the current literature available that uses VR in supporting perinatal mental health by answering the following research question: *What virtual reality applications are available for the treatment of perinatal mental health?*

We found limited literature in the field, with the earliest study being published in 2019 and most studies being published in 2023. This indicates how novel the research is to date and that this field is growing in popularity. Thus, it may be possible that in the upcoming years more research will be available. All of the included studies provided fully immersive VR experiences by using HMDs as their VR hardware. The type of HMD varied amongst the studies, with half of our included studies using HMDs compatible with a smartphone. These latter types of HMDs work by inserting a smartphone in front of the headset, thus allowing users to view the VR environment through the HMD lenses played on the smartphone. These types of HMDs are a more affordable alternative to

other headsets, but often lack direct user interaction and strong computing power [36]. In fact, all the studies that used this device showed images or videos, often of nature environments [25, 28, 30-32] and did not allow interaction with the environment. Contrary, two of the studies using stand-alone HMDs described more interactive VR experiences, with Jimenez et al. [27] using mindfulness techniques and Miskowiak et al. [26] conducting cognitive exercises. Out of the studies that developed their own VR environment, one [34] created urban spaces (with different levels of green nature spaces) and found that green spaces increased happinesses and decreased anxiety, while another study [28] that developed VR images of the fetus specific for each participant found greater attachment between the mother and the fetus. One study [30] found their developed VR environment, a CD information program, to have no significant effect on the anxiety of the patients or their partner compared to the control group, except for those with a history of emergency CD. No study compared the effectiveness of different VR interventions, or different environments within the same intervention, which would be helpful to determine whether one VR intervention can be more beneficial over another or differential effects by outcome.

VR interventions were most commonly used to mitigate symptoms of anxiety, which was often measured through questionnaires such as the STAI, as well as depression, which was most frequently measured with the EPDS questionnaire. However, though anxiety and depression were measured, mitigating their symptoms was not always the primary objective of the study. In fact, only five out of the eight studies measuring anxiety aimed to test the effect of VR on anxiety and only one out of the five studies measuring depression aimed to test whether VR has the potential to decrease post-partum depression. Furthermore, all studies monitored symptoms of the pregnant person but only one study also included the partner, even though it has been found in the literature that symptoms of paternal mental illness have a negative effect on child development [10].

Overall, the results of the studies were positive for the effects of VR on mental health, with studies showing lower anxiety [25, 29-32, 34] and depression [28] symptoms after the intervention. Participants also indicated willingness to recommend VR to other pregnant people. While other treatment methods for perinatal mood disorders are considered well-established and credible, the evidence-base for VR’s effectiveness is promising but still in its infancy. However, VR enables more flexibility with various ways in which it could be employed and explored as a mental health treatment modality. The trend noticed while conducting this review is that research in this field is growing, implying that in the next years will bear more evidence about VR’s use for perinatal mood disorders. The increase of research may lead to the development of standardized treatments using VR, which could thereby establish its credibility as a treatment modality.

Quality assessment suggested that all included studies were deemed to be of fair to good quality. The number of participants included was appropriate for all the studies, as well as the participant randomization method. This may be attributed to most studies being RCTs and thus sample size was determined based on power analyses. Most studies, explicitly set the inclusion criteria for pregnant participants to not have a history of mental health illness, however one proposed study [26] purposely included participants with a history of mental illness to compare their outcomes to those without a history. As this is a registration, its findings are yet to be published. Almost half of the studies [25, 31, 32, 34] already conducted and one study protocol [33] administered VR in one session only, and their interventions still showed positive results. Being able to successfully implement VR in one session may increase its feasibility, as it could be offered for therapy during in-patient visits without requiring each participant to own a headset for at home use. Further, most

studies only assessed the outcomes of the VR immediately post-intervention, with only three conducting follow-up assessments (1-week and 1-month after birth [33], 1-2 weeks after birth [30], and up until 10 months after birth [26]). Thus, most studies are only able to determine the immediate effects of VR. Future research should consider evaluating mental health over a longer period and implementing VR across multiple sessions to assess long-term and dose-response effects. Psychotherapy typically requires 12 to 16 sessions to show meaningful change in treating postpartum depression [37], with some cases requiring fewer; therefore, VR therapy may need similar standards to ensure efficacy. Additionally, the VR interventions included in this review were standalone, it would therefore be beneficial for future studies to explore the benefits of using VR as an adjunct to treatment such as CBT, third-wave psychotherapy or interpersonal psychotherapy.

Limitations

Our review focused on synthesizing existing evidence on the use of VR to support perinatal mental health. Given the emerging nature of this field, a rapid scoping review was the most feasible approach to capture the breadth of research within a limited timeframe. While comprehensive, this methodology might not provide the depth of insights that a systematic review conducted over a longer period could offer, especially as relevant studies continue to emerge. Additionally, our search was primarily concentrated in medical and psychological databases. Important contributions cataloged in different databases from fields like computer science or engineering discussing more in-depth technological aspects of the VR technology, could have been overlooked. The search of grey literature was limited and examined only citations within included studies in adherence to rapid review protocols, which might have restricted our access to some pivotal works. Language barriers also pose a limitation; most included studies were conducted in non-Anglophone and non-Francophone countries, raising the possibility that other relevant studies were conducted in these countries however not published in English or French and thus were not found.

Conclusions

This rapid scoping review highlighted the growing interest in VR technologies for in the use of treatment for mental health problems during the perinatal period. Despite the limited body of literature, the available studies, primarily published between 2019 and 2023, suggest a promising application of VR for treating conditions like perinatal anxiety and depression, which are prevalent during this sensitive time. However, the research remains in its beginning stages, lacking comparative analyses to establish the effectiveness of different VR approaches. The positive outcomes reported in these initial studies, such as reduced anxiety and depression symptoms, as well as subjective satisfaction with VR interventions, offer a hopeful perspective on the role of VR in perinatal mental health.

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Conflicts of Interest

None declared.

Abbreviations

CBT: cognitive-behavioral therapy
CD: cesarean delivery

EPDS: Edinburgh postnatal depression scale
HMDs: head-mounted displays
RCT: randomized controlled trial
STAI: state anxiety inventory
VAS: visual analogue scale
VR: virtual reality
NST: Non-Stress Test
CD: cesarean delivery
VAS: Visual Analogue Scale
NSNCS: Newcastle Satisfaction Nursing Care Scale
BP: blood pressure
HR: heart rate
SCL: skin conductance level

References

1. Helfer ER. The perinatal period, a window of opportunity for enhancing parent-infant communication: An approach to prevention. Child Abuse & Neglect. 1987;11(4):565-79. doi: 10.1016/0145-2134(87)90082-2.
2. Maternal Mental Health in Canada. Statistics Canada; Available from: https://www150.statcan.gc.ca/n1/pub/11-627-m/11-627-m2019041-eng.htm
3. Jahan N, Went RT, Sultan W, Sapkota A, Khurshid H, Qureshi AI, Alfonso M. Untreated Depression During Pregnancy and Its Effect on Pregnancy Outcomes: A Systematic Review. Cureus. 2021. doi: doi.org/10.7759/cureus.17251.
4. Kendig S, Keats PJ, Hoffman CM, Kay BL, Miller SE, Simas MAT, et al. Consensus Bundle on Maternal Mental Health: Perinatal Depression and Anxiety. Journal of Obstetric, Gynecologic & Neonatal Nursing. 2017;46(2):272-81. doi: doi.org/10.1016/J.JOGN.2017.01.001.
5. Chen H, Selix N, Nosek M. Perinatal Anxiety and Depression During COVID-19. The Journal for Nurse Practitioners. 2021;17(1):26-31. doi: doi.org/10.1016/j.nurpra.2020.09.014.
6. Gorgui J, Tchuente V, Pages N, Fareh T, King S, Elgbeili G, Bérard A. The impact of prenatal maternal mental health during the COVID-19 pandemic on birth outcomes: two nested case-control studies within the CONCEPTION cohort. Canadian Journal of Public Health. 2023;114(5):755-73. doi: doi.org/10.17269/s41997-023-00814-0.
7. Kotlar B, Gerson ME, Petrillo S, Langer A, Tiemeier H. The impact of the COVID-19 pandemic on maternal and perinatal health: a scoping review. Reproductive Health. 2021;18(1). doi: 10.1186/s12978-021-01070-6.
8. Lebel C, Mackinnon A, Bagshawe M, Tomfohr-Madsen L, Giesbrecht G. Elevated depression and anxiety symptoms among pregnant individuals during the COVID-19 pandemic. Journal of Affective Disorders. 2020;277:5-13. doi: doi.org/10.1016/j.jad.2020.07.126.
9. Berthelot N, Lemieux R, Garon-Bissonnette J, Drouin-Maziade C, Martel É, Maziade M. Uptrend in distress and psychiatric symptomatology in pregnant women during the coronavirus disease 2019 pandemic. Acta Obstetricia et Gynecologica Scandinavica. 2020;99(7):848-55. doi: doi.org/10.1111/aogs.13925.
10. Scarlett H, Moirangthem S, Waerden DVJ. The impact of paternal mental illness on child development: an umbrella review of systematic reviews and meta-analyses. European Child & Adolescent Psychiatry. 2023. doi: doi.org/10.1007/s00787-023-02261-1.
11. Mackinnon LA, Silang K, Penner K, Zalewski M, Tomfohr-Madsen L, Roos EL. Promoting Mental Health in Parents of Young Children Using eHealth Interventions: A Systematic Review and Meta-analysis. Clinical Child and Family Psychology Review. 2022;25(3):413-34. doi: doi.org/10.1007/s10567-022-00385-5.
12. Silang AK, Sohal RP, Bright SK, Leason J, Roos L, Lebel C, et al. eHealth Interventions for Treatment and Prevention of Depression, Anxiety, and Insomnia During Pregnancy: Systematic Review and Meta-analysis. JMIR Mental Health. 2022;9(2):e31116. doi: doi.org/10.2196/31116.
13. Wohlgenannt I, Simons A, Stieglitz S. Virtual Reality. Business & Information Systems Engineering. 2020;62(5):455-61. doi: doi.org/10.1007/s12599-020-00658-9.
14. Voigt-Antons J-N, Lehtonen E, Palacios PA, Ali D, Kojic T, Moller S. Comparing Emotional States Induced by 360° Videos Via Head-Mounted Display and Computer Screen. 2020 Twelfth International Conference on Quality of Multimedia Experience (QoMEX)2020.
15. Fonseca D, Kraus M. A comparison of head-mounted and hand-held displays for 360° videos with focus on attitude and behavior change. Proceedings of the 20th International Academic Mindtrek Conference2016.
16. Baghaei N, Chitale V, Hlasnik A, Stemmet L, Liang HN, Porter R. Virtual reality for

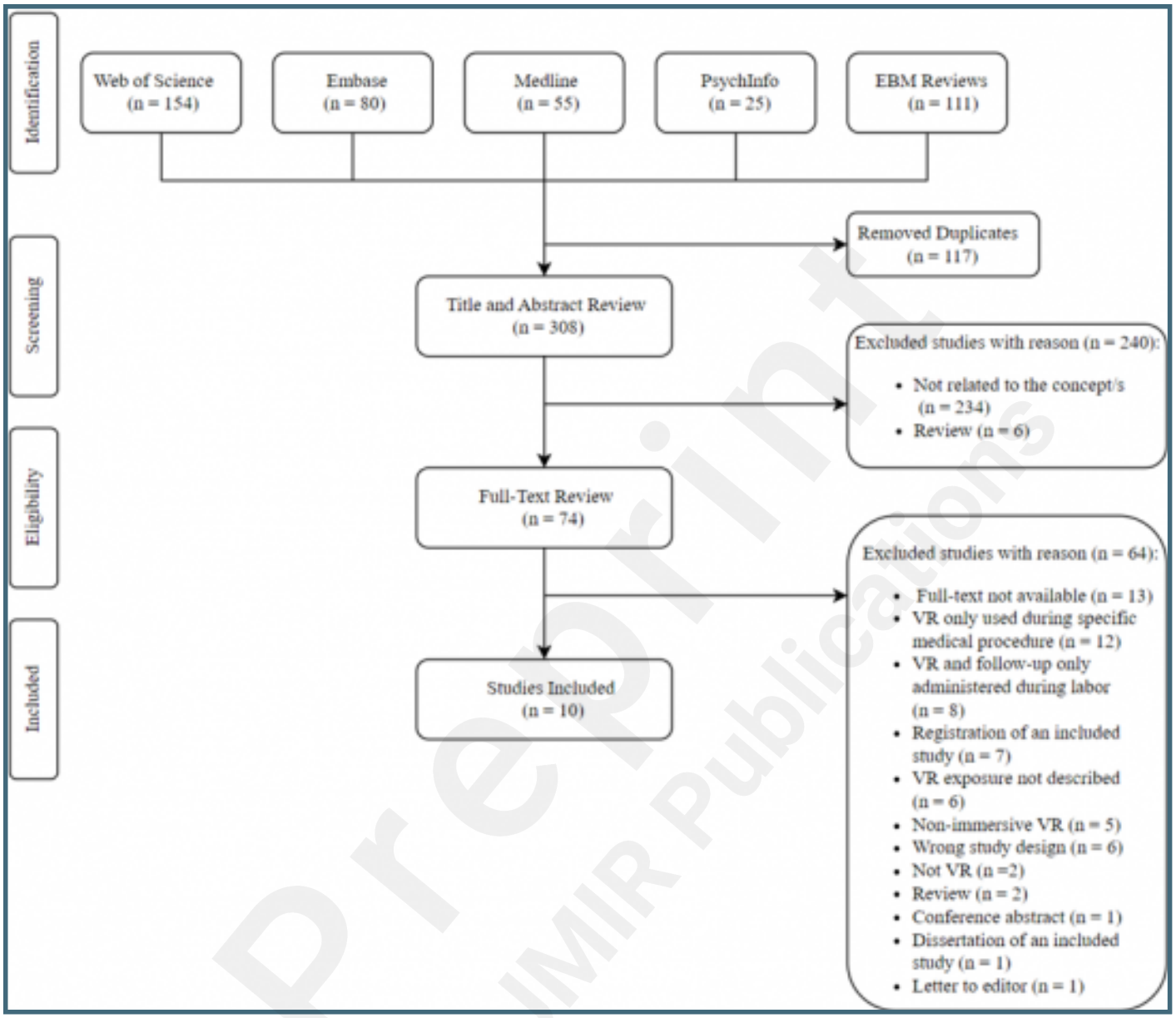
supporting the treatment of depression and anxiety: Scoping review. JMIR Mental Health. 2021 September;8(9) (no pagination).
17. Falconer JC, Rovira A, King AJ, Gilbert P, Antley A, Fearon P, et al. Embodying self-compassion within virtual reality and its effects on patients with depression. BJPsych Open. 2016;2(1):74-80. doi: doi.org/10.1192/bjpo.bp.115.002147.
18. Hajesmaeel-Gohari S, Sarpourian F, Shafiei E. Virtual reality applications to assist pregnant women: a scoping review. BMC Pregnancy Childbirth. 2021 Mar 25;21(1):249. PMID: 33765969. doi: 10.1186/s12884-021-03725-5.
19. Özer E, Çetinkaya Şen Y, Canlı S, Güvenç G. Effects of Virtual Reality Interventions on the Parameters of Normal Labor: A Systematic Review and Meta-Analysis of Randomized Controlled Trials. A Meta-Analysis of Virtual Reality Interventions on the Parameters of Normal Labor. Pain Manag Nurs. 2024 Feb;25(1):93-9. PMID: 37880013. doi: 10.1016/j.pmn.2023.09.012.
20. Aromataris E, Lockwood C, Porritt K, Pilla B, Z J. JBI Manual for Evidence Synthesis; 2020 [updated 2024]; Available from: https://synthesismanual.jbi.global.
21. Tricco CA, Lillie E, Zarin W, O'Brien KK, Colquhoun H, Levac D, et al. PRISMA Extension for Scoping Reviews (PRISMA-ScR): Checklist and Explanation. Annals of Internal Medicine. 2018 Sep 4;169(7):467-73. doi: doi.org/10.7326/M18-0850.
22. Garritty C, Gartlehner G, Kamel C, King V, Nussbaumer-Streit B, Stevens A, et al. Interim Guidance from the Cochrane Rapid Reviews Methods Group. 2020 March.
23. Zorzi C, Jean J, Mackinnon A. Virtual reality for the treatment of perinatal metal health: a rapid scoping review. OSF Registries. 2024 March 6. doi: doi.org/10.17605/OSF.IO/VFZC7.
24. National Heart, Lung and Blood Institute Study Quality Assessment Tools. 2021 [updated July 2021]; Available from: https://www.nhlbi.nih.gov/health-topics/study-quality-assessment-tools.
25. Toker E, Gökduman Keleş M. The effect of virtual reality on fetal movement, fetal heart rate, maternal satisfaction, fatigue, and anxiety levels and vital signs of pregnant women during non-stress test: A randomized controlled trial. Health Care for Women International. 2023:1-17. doi: 10.1080/07399332.2023.2223159.
26. Miskowiak KW. Prenatal Affective Cognitive Training to Reduce the Risk of Postpartum Depression (PACT) (PACT). ClinicalTrials.gov: National Library of Medicine; 2023 [updated 2023-09-28]; Identifier NCT06046456]. Available from: https://clinicaltrials.gov/study/NCT06046456.
27. Jimenez-Barragan M, Del Pino Gutierrez A, Garcia JC, Monistrol-Ruano O, Coll-Navarro E, Porta-Roda O, Falguera-Puig G. Study protocol for improving mental health during pregnancy: a randomized controlled low-intensity m-health intervention by midwives at primary care centers. BMC Nurs. 2023 Sep 7;22(1):309. PMID: 37674184. doi: 10.1186/s12912-023-01440-4.
28. Lee KN, Kim HJ, Choe K, Cho A, Kim B, Seo J, et al. Effects of Fetal Images Produced in Virtual Reality on Maternal-Fetal Attachment: Randomized Controlled Trial. Journal of Medical Internet Research. 2023;25. doi: 10.2196/43634.
29. Kılıç S, Yılmaz DS. Virtual Reality Headset Simulating a Nature Environment to Improve Health Outcomes in Pregnant Women: A Randomized-Controlled Trial. Clinical Nursing Research. 2023;32(8):1104-14. doi: 10.1177/10547738231184923.
30. Noben L, Goossens ATMS, Truijens MES, Berckel VGMM, Perquin WC, Slooter DG, Rooijen VJS. A Virtual Reality Video to Improve Information Provision and Reduce Anxiety Before Cesarean Delivery: Randomized Controlled Trial. JMIR Mental Health. 2019;6(12):e15872. doi: 10.2196/15872.
31. Estrella-Juarez F, Requena-Mullor M, Garcia-Gonzalez J, Lopez-Villen A, Alarcon-

Rodriguez R. Effect of Virtual Reality and Music Therapy on the Physiologic Parameters of Pregnant Women and Fetuses and on Anxiety Levels: A Randomized Controlled Trial. J Midwifery Womens Health. 2023 Jan;68(1):35-43. PMID: 36383473. doi: 10.1111/jmwh.13413.
32. Sezer YN, Aker NM, Yücel A, Çalışıcı D. The effect of virtual reality and music on anxiety, non-stress test parameters, and satisfaction of high-risk pregnant women undergoing non-stress tests: Randomized controlled trial. European Journal of Obstetrics & Gynecology and Reproductive Biology. 2024;296:52-8. doi: doi.org/10.1016/j.ejogrb.2024.02.038.
33. Corbaz F, Boussac E, Lepigeon K, Gomes Dias D, Marcadent S, Desseauve D, Horsch A. 'connEcted caesarean section': creating a virtual link between MOthers and their infanTs to ImprOve maternal childbirth experieNce - study protocol for a PILOT trial (e-motion-pilot). BMJ Open. 2023 Jun 7;13(6):e065830. PMID: 37286319. doi: 10.1136/bmjopen-2022-065830.
34. Sun Y, Li F, He T, Meng Y, Yin J, Yim IS, et al. Physiological and affective responses to green space virtual reality among pregnant women. Environ Res. 2023 Jan 1;216(Pt 1):114499. PMID: 36208780. doi: 10.1016/j.envres.2022.114499.
35. Skapinakis P. Spielberger State-Trait Anxiety Inventory. Encyclopedia of Quality of Life and Well-Being Research2014. p. 6261-4.
36. Angelov V, Petkov E, Shipkovenski G, Kalushkov T. Modern Virtual Reality Headsets. 2020 International Congress on Human-Computer Interaction, Optimization and Robotic Applications (HORA)2020.
37. Grunberg AV, Geller AP, Durham K, Bonacquisti A, Barkin LJ. Motherhood and Me (Mom-Me): The Development of an Acceptance-Based Group for Women with Postpartum Mood and Anxiety Symptoms. Journal of Clinical Medicine. 2022;11(9):2345. doi: doi.org/10.3390/jcm11092345.

Supplementary Files

Figures

Prisma flowchart used to identify relevant studies.



Multimedia Appendixes

Supplementary Material 1 - Search Strategy.
URL: http://asset.jmir.pub/assets/1cf9534e7052330b9cab8b9fa0ad5608.docx

Prisma-Scr Checklist.
URL: http://asset.jmir.pub/assets/3dccc7d82401ca7f9fd0a5e0d840e938.docx