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Can Virtual Reality Technology Reduce Anxiety Before a Cesarean Section in Primigravida Women?

Parto Mohammadi[1] | Kambiz Bahaadinbeigy[2] | Roghayeh Ershad Sarabi[2] | Khadijeh Moulaei[3] | Moghadameh Mirzai[4] | Sakineh Mirzaei Khalilabadi[5] | Mohsen Zarei Hajiabadi[2]

[1]Student Research Committee, Kerman University of Medical Sciences, Kerman, Iran | [2]Medical Informatics Research Center, Institute for Futures Studies in Health, Kerman University of Medical Sciences, Kerman, Iran | [3]Health Management and Economics Research Center, Health Management Research Institute, Iran University of Medical Sciences, Tehran, Iran | [4]Modeling in Health Research Center, Institute for Futures Studies in Health, Kerman University of Medical Sciences, Kerman, Iran | [5]Department of Obstetrics and Gynecology, School of Medicine, Rafsanjan University of Medical Sciences, Rafsanjan, Iran

Correspondence: Roghayeh Ershad Sarabi (a.ershadsarabi@gmail.com)

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ABSTRACT

Background: The emotional strains associated with impending cesarean sections pose significant challenges for primigravida women, potentially exacerbating anxiety levels and impacting overall well-being. Virtual reality (VR) technology has emerged as a nonpharmacological method for reducing preoperative anxiety.

Objectives: This study aims to investigate the effectiveness of VR in reducing preoperative anxiety in primigravida women undergoing cesarean sections.

Design: This is a quasi-experimental study involving 38 first-time pregnant participants undergoing cesarean surgery.

Method: In this study, 38 first-time pregnant women undergoing cesarean surgery were divided into two groups: an intervention group ($n = 19$) and a control group ($n = 19$). The intervention group watched a VR video depicting various aspects of cesarean delivery, while the control group received no intervention and was instructed to consult their doctors or medical centers for information. Anxiety levels were assessed using the APAIS questionnaire before and after the intervention. Data analysis was performed using SPSS 25, including statistical tests like chi-square, Mann–Whitney, Wilcoxon, and logistic regression.

Results: The intervention group experienced a significant reduction on average anxiety scores (11.63 ± 4.16) compared to the control group (14.78 ± 3.18) following the intervention. Within the intervention group, there was a statistically significant decrease in anxiety levels before and after the intervention ($p < 0.05$), indicating that the VR video intervention effectively reduced preoperative anxiety in pregnant women. Furthermore, there was a significant difference in anxiety levels between the control and intervention groups after the intervention ($p = 0.02$), whereas such a difference was not observed before the intervention ($p = 0.21$).

Conclusion: This study demonstrates that VR technology is an effective and nonpharmacological method for reducing preoperative anxiety in primigravida women undergoing cesarean sections. The findings highlight the potential of VR interventions to improve patient well-being, offering an accessible, cost-effective solution for anxiety management in healthcare settings. These results underscore the transformative role of VR in enhancing the preoperative experience and supporting positive surgical outcomes.

1 | Introduction

Preoperative anxiety is a common phenomenon experienced by diverse patient groups [1, 2]. Among adults, the prevalence of preoperative anxiety ranges from 60% to 80%, depending on the type of surgery, surgical technique, and anesthesia method [3]. Anxiety levels typically escalate from the moment patients become aware of the need for surgery until the day of the operation [4, 5]. Cesarean section surgery, a frequently performed procedure, often induces anxiety and fear in women before the operation [6]. Preoperative anxiety has been associated with increased demand for pain medication, poorer recovery, longer hospital stays, and diminished satisfaction with the childbirth experience [6–8]. Therefore, reducing anxiety in pregnant women undergoing cesarean section is paramount to their physical and mental well-being [8, 9]. One effective approach for alleviating preoperative anxiety is providing accurate and appropriate information to pregnant women through virtual reality (VR) technology [8]. Virtual reality offers a safe, cost-effective, and efficient means of creating immersive and engaging simulated environments using visual, auditory, and tactile stimuli [10–12]. Research in various fields has shown that preoperative VR usage reduces anxiety [10, 13–15]. Moreover, several studies have demonstrated the effectiveness of VR exposure therapy in treating phobias such as social anxiety [16, 17]. Moreover, VR has demonstrated significant anxiety-reducing effects in patients undergoing medical procedures, such as reducing preoperative anxiety in surgical patients [18] and alleviating anxiety in cancer patients receiving chemotherapy [19]. Additionally, VR mindfulness and relaxation programs have been used successfully to reduce generalized anxiety in individuals with chronic pain [20].

To the best of our knowledge, no prior investigation has been conducted to explore the impact of virtual reality technology on anxiety reduction before a cesarean section in primigravida women. Only one study [8] has investigated the effect of virtual reality video (VR) on reducing anxiety levels before cesarean delivery (CD) in both primiparous and multiparous women. Given the significance of pregnant women's physical and mental health at a global level and the potential of virtual reality technology, this study aimed to evaluate the efficacy of virtual reality in reducing preoperative anxiety among primigravida women.

2 | Material and Methods

2.1 | Study Design and Setting

This quasi-experimental study was conducted in Rafsanjan, Iran, following the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) checklist (see Appendix A). It comprised 38 primigravida women scheduled for cesarean section surgery, divided into an intervention group ($n = 19$) and a control group ($n = 19$).

2.2 | Video Design and Development

The 360-degree virtual reality video captures all facets of cesarean delivery, encompassing admission to the ward, entry into the operating room, administration of anesthesia, and the departure of the pregnant woman from the operating room (Figure 1). Similar to Noben et al.'s study [8], the video excludes any surgical content, such as the incision area. Recorded from the perspectives of anesthesiologists and obstetricians, the video culminates in a segment portraying family reunification. This approximately 7-min video is narrated in Farsi and was captured using a Samsung Gear 360 v2 camera, courtesy of Faza Zaman Qeshm Company, at Ali-ibn Abi Talib Hospital in Rafsanjan city (Kerman province, Iran).

It's important to note that patients and their physicians were actively engaged throughout the video development process, enabling the incorporation of their feedback regarding imagery, text, and sequence adjustments. The video was played using the r Player software on a mobile phone and viewed through a Quil VR Box virtual reality headset.

2.3 | Participants

This study was conducted on pregnant women seeking prenatal care at Ali-ibn Abi Talibږ Hospital in Rafsanjan city. All 56 pregnant women who were approached for participation accepted the invitation.

2.4 | Sample Size

After applying the inclusion and exclusion criteria, a total of 38 women met the eligibility requirements and were included in the study. This sample size was determined to be sufficient for evaluating the effects of the VR intervention on preoperative anxiety. The inclusion criteria included the necessity for cesarean section surgery, anxiety scores ranging above 11 (indicating moderate to high anxiety) during weeks 35 to 38 of pregnancy, residence in Rafsanjan, being primigravida, and having no prior exposure to operating rooms, anesthesia, or virtual reality interventions. We included individuals with no prior VR experience in our study to ensure that any observed effects on anxiety levels could be attributed specifically to the VR intervention rather than participants' familiarity or comfort with the technology. This approach helped minimize potential confounding factors and allowed us to assess the unique impact of VR on preoperative anxiety levels among participants who were new to this technology.

Moreover, high-risk pregnancies were identified based on established criteria, including but not limited to maternal age, medical history, and obstetric complications. These criteria were applied to ensure that participants requiring specialized care and attention were included in the study. Furthermore, the decision to conduct the initial assessment a week before the scheduled cesarean section was made to allow for a comprehensive evaluation of anxiety levels and adequate time for intervention planning if warranted. This approach aimed to mitigate potential preoperative anxiety and optimize maternal well-being during the perioperative period. Additionally, conducting assessments at 35 weeks gestation provided a suitable timeframe for capturing fluctuations in anxiety levels and

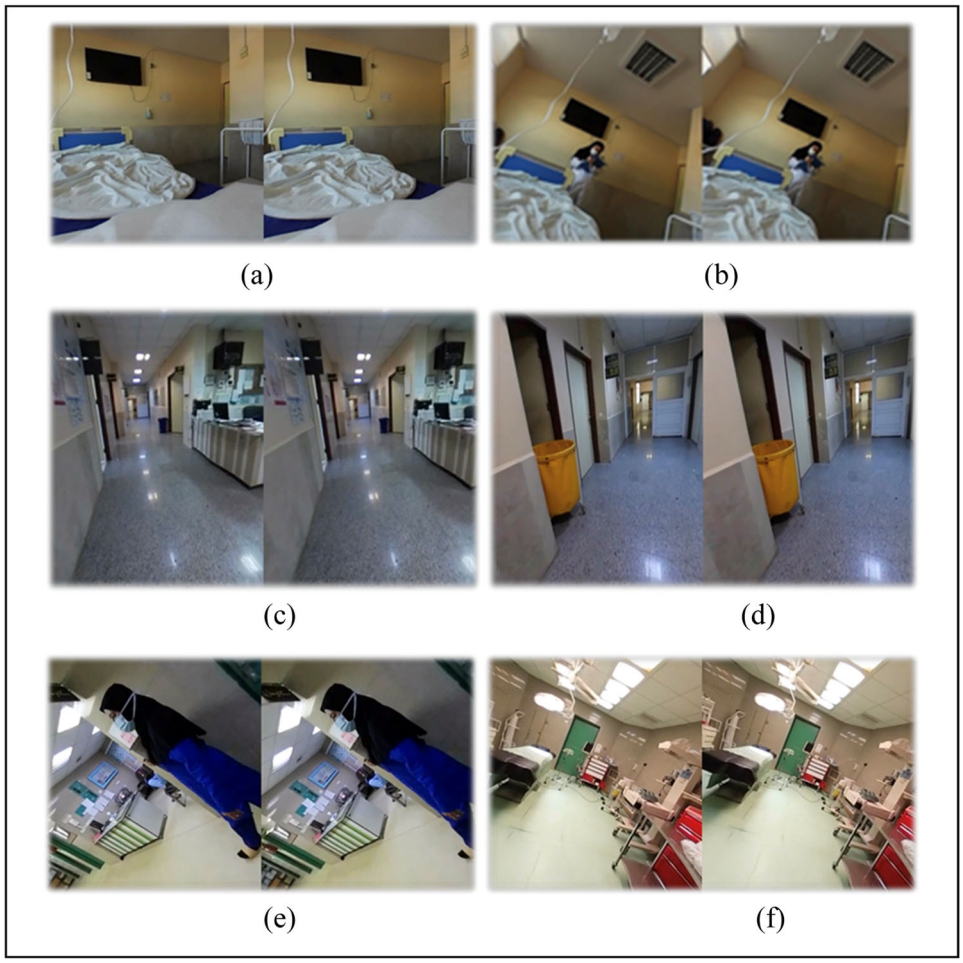

FIGURE 1 | Designed and developed a VR film. (a and b) Hospital rooms for the initial admission of pregnant women; (c and d) Hospital corridors; (e and f) Medical equipment and hospital beds in the delivery room.

implementing appropriate interventions tailored to each participant's needs [8].

Exclusion criteria included a history of psychiatric disorders, hearing or visual impairments, seizures or epilepsy, heart diseases, and current use of anti-anxiety medications.

2.5 | Sampling Method

For this study, a convenience sampling method was employed. Convenience sampling is a non-probability sampling technique where participants are selected based on their availability and willingness to participate in the study, rather than through random selection [21]. In this case, all pregnant women seeking prenatal care at Ali-ibn Abi Talib Hospital in Rafsanjan, who met the study's inclusion criteria, were invited to take part. The primary advantage of this method is that it allows for the inclusion of readily accessible participants, ensuring a practical and timely recruitment process. To ensure that any changes in anxiety were attributed solely to the VR intervention, only women with no prior experience with VR technology were included. This decision minimized potential confounding factors and helped isolate the impact of the VR intervention on preoperative anxiety.

2.6 | Random Allocation to Groups

Thirty-eight pregnant women were randomly and evenly allocated into two groups: control and intervention, with 19 participants in each group. They were randomly divided into two groups by choosing the number of participants from inside an envelope: the first group consisted of 19 people in the control group, and the second group included 19 people in the intervention group. The reasons for choosing cesarean section by women were:

- Fetal distress
- Malpresentation (breech or transverse lie)
- Placenta previa
- Previous cesarean section with no indication for vaginal birth after cesarean (VBAC)
- Failure to progress in labor
- Maternal medical conditions (such as hypertension or diabetes)
- Suspected macrosomia (large baby)
- Umbilical cord prolapse
- Maternal request for elective cesarean section

2.7 | Procedures

The duration of the study was 2 weeks and 1 week after completing the initial questionnaire, the participants in the control group once again completed the Amsterdam Preoperative Anxiety and Information Scale (APAIS) questionnaire. Throughout this 1-week interval, no intervention was administered to the control group. We requested that the participants in the control group obtain information about caesarean sections from their attending physicians or the medical centers they visit. The intervention group gathered at the Ali-ibn Abi Talib Hospital in Rafsanjan. One week after finishing the initial questionnaire, participants in the intervention group wore the Quil VR Box virtual reality headset, took their seats, and engaged in watching the virtual reality film. Following the video viewing, the participants proceeded to complete the APAIS questionnaire.

It should be noted that we chose a treatment-as-usual control model to assess VR's effectiveness in reducing pre-Cesarean anxiety for primigravida women. This approach let us compare VR against standard care, reflecting its potential real-world benefits in routine clinical practice. Additionally, our choice of a treatment-as-usual control aligns with the practical realities of clinical settings. In many healthcare facilities, patients may not have access to alternative interventions beyond standard care protocols. Therefore, evaluating the efficacy of VR technology within the context of routine clinical practice provides valuable insights into its real-world applicability and potential benefits for patients.

2.8 | Study Instrument

It should be mentioned that the Amsterdam preoperative anxiety and information scale (APAIS) questionnaire was used to measure women's anxiety before entering the study (Appendix B). The APAIS questionnaire, developed by Moerman et al. [22], is a validated tool for assessing preoperative anxiety and information needs. This questionnaire consists of six concise and carefully designed questions that aim to gauge a patient's levels of anxiety relating to an upcoming surgery, as well as their desire for specific information about the procedure. The questionnaire items were assessed using a five-point Likert scale, spanning from “completely agree” to “completely disagree” (completely disagree = 1 to completely agree = 5). Scores within the range of 7–10 indicated low anxiety, while scores between 11 and 15 signified moderate anxiety, and scores surpassing 16 denoted high anxiety levels. Furthermore, scores ranging from 2 to 4 indicated a lack of necessity for preoperative information, scores between 5 and 7 pointed to a moderate need, and scores from 8 to 10 indicated a high need for such information [22]. In this study, the Persian version of this questionnaire was used. The validity and reliability of the Persian version of this questionnaire have been confirmed in the study by Nikandish et al. [23].

2.9 | Bias

In addressing potential sources of bias, efforts were made to ensure comparability between the intervention and control groups. Both groups consisted of first-time pregnant women undergoing cesarean surgery, with similar sample sizes ($n = 19$ each) and demographics. The random allocation of participants into the intervention and control groups helped minimize selection bias. Additionally, blinding procedures were implemented to reduce the risk of performance and detection bias. The use of standardized anxiety assessment tools, such as the APAIS questionnaire, helped maintain consistency in measuring outcomes across both groups. Statistical analyses, including chi-square, Mann–Whitney, Wilcoxon, and logistic regression tests, were employed to control for potential confounding variables and strengthen the validity of the study findings. These methodological approaches aimed to enhance the reliability and generalizability of the results regarding the effectiveness of VR in reducing preoperative anxiety in primigravida women undergoing cesarean sections.

2.10 | Data Analysis

The collected questionnaire data, encompassing anxiety scores, scores indicating the need for preoperative information, and demographic particulars, were subjected to analysis utilizing SPSS version 22. Descriptive statistics (mean, standard deviation, frequency, and percentage) were applied to elucidate the data's characteristics. Demographic variables between the control and intervention groups were compared using Chi-square or Fisher's exact tests. The Wilcoxon test was employed to compare anxiety levels before and after the intervention within each of the control and intervention groups. The Mann–Whitney test was used to compare anxiety levels before and after the intervention in both groups. Additionally, logistic regression analysis was employed to examine the influence of demographic information on post-intervention anxiety levels between the two groups.

2.11 | Ethical Considerations

Approval was granted by the Ethics Committee of Kerman University of Medical Sciences (IR.KMU.REC.1401.123). The involvement of pregnant women was entirely voluntary, affording individuals the autonomy to withdraw from the study whenever desired. Written informed consent was obtained from all participants before their involvement in the study. Each participant was provided with a copy of the consent form for their records, and their signed consent was securely stored in compliance with institutional protocols.

3 | Results

3.1 | Participants

Figure 2 exhibits the STROBE diagram, illustrating the flow of participants.

The majority of intervention group participants were over 27 years old (57 out of 100, 9%), whereas the majority of control group participants were 27 years old or younger (73 out of 100, 7%). Most

participants in both groups had an educational level higher than a high school diploma (89% in the intervention group and 68% in the control group). Additionally, the majority of participants in both groups were at 35 weeks of pregnancy (42 out of 100 in both the intervention and control groups) (Table 1).

A statistically significant difference in age between the intervention and control groups was observed ($p < 0.05$), necessitating logistic regression analysis to control for its effect on post-intervention anxiety levels between the two groups (Table 1).

Table 2 displays anxiety level results before and after the intervention separately for intervention and control group. The intervention group experienced a greater reduction in mean anxiety scores (11.63 ± 4.16) compared to the control group after the intervention (14.78 ± 3.18). Moreover, a significant difference in anxiety levels before and after the intervention was found in the intervention group ($p < 0.05$). These results indicate that the VR video intervention significantly reduced preoperative anxiety in pregnant women.

The anxiety level comparison before and after the intervention in both groups is presented in Table 3. After the intervention, a significant difference in anxiety levels was observed between the control and intervention groups ($p = 0.02$), whereas such a difference was not observed before the intervention ($p = 0.21$).

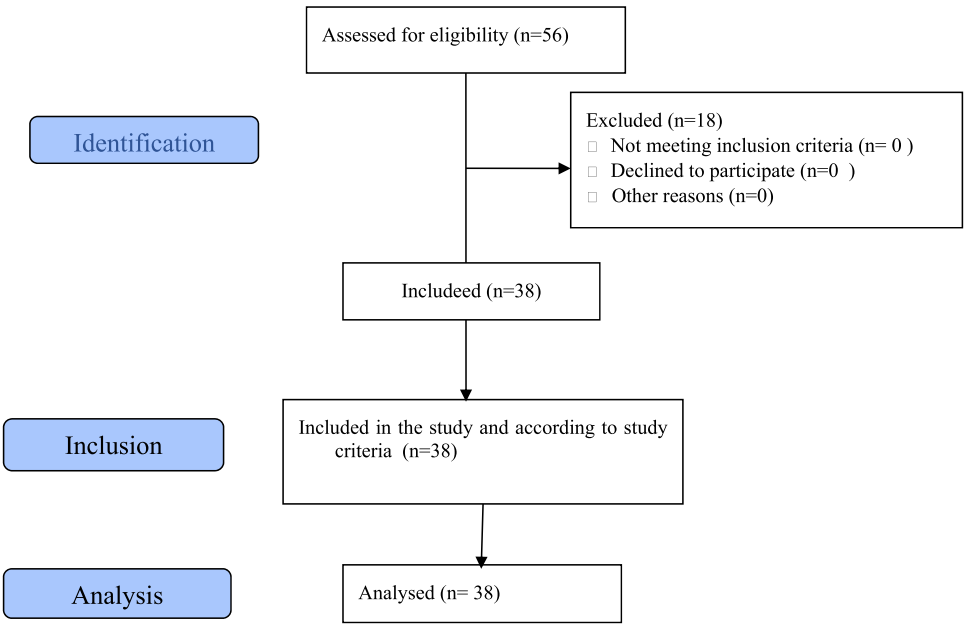

FIGURE 2 | STROBE flow diagram.

TABLE 1 | Demographic information of pregnant women.

Variable		Intervention group	Control group	Chi-square test	*p*-value
Age	<= 27	8 (42.1%)	14 (73.7%)	3.88	0.04
	> 27	11 (57.9%)	5 (26.3%)		
Education	High school diploma	2 (10.5%)	6 (31.6%)	2.53	0.23
	Higher than a high school diploma	17 (89.5%)	13 (68.4%)		
Gestational Age (week)	35	8 (42.1%)	8 (42.1%)	0.18	0.91
	36	6 (31.6%)	5 (26.3%)		
	37	5 (26.3%)	6 (31.6%)		

TABLE 2 | Anxiety level comparison before and after the intervention in each group.

	Mean ± SD		
Group	Before the intervention	After the intervention	*p*-value
Intervention	14.21 ± 3.06	11.63 ± 4.16	0.008
Control	15.10 ± 2.84	14.78 ± 3.18	0.55

TABLE 3 | Anxiety level comparison before and after the intervention in both groups.

Variable	Groups		*p*-value
	Intervention (Mean ± SD)	Control (Mean ± SD)	
Before the intervention	14.21 ± 3.06	15.10 ± 2.84	0.21
After the intervention	11.63 ± 4.16	14.78 ± 3.18	0.02

4 | Discussion

In this study, the effect of virtual reality technology on reducing anxiety before a cesarean section in primigravida women was investigated. The results of this study reveal compelling evidence of the effectiveness of the VR video intervention in reducing preoperative anxiety among pregnant women undergoing cesarean sections. The intervention group experienced a greater reduction in mean anxiety scores compared to the control group after the intervention. Moreover, a significant difference in anxiety levels before and after the intervention was found in the intervention group highlighting the positive impact of virtual reality technology in this context. Moreover, the statistical analysis demonstrated after the intervention, a significant difference in anxiety levels between the control and intervention groups, whereas such a difference was not observed before the intervention this result further supports the benefits of incorporating virtual reality technology into preoperative care.

Dehghan et al. [14] demonstrated that exposure to VR reduced preoperative anxiety in children undergoing abdominal surgery. Similarly, Yang et al. [4] found that VR experiences in patients undergoing arthroscopic surgery improved anxiety and increased satisfaction. They believed that virtual reality is a technology that immerses users in artificial environments through sensory input from computer or smartphone-connected sensors. It enhances awareness, clarity, interactivity, and kinesthetic feedback. The level of immersion affects user engagement [4]. Park et al. [15] reported reduced preoperative anxiety in children undergoing various surgical procedures (orthopaedic, dental, ophthalmic, etc.) through VR experiences. They found that pairing a VR tour of the operating theatre for children via a head-mounted display with a concurrent mirroring display for parents was a very effective method to reduce preoperative anxiety and increase parental satisfaction [15]. This effectiveness may be attributed to the immersive nature of VR, which allows children to familiarize themselves with the surgical environment in a non-threatening way, thus reducing anxiety. Additionally, parents being able to observe their child's experience through the mirroring display can provide reassurance and enhance their satisfaction with the healthcare process. In another study, Bekelis et al. [24] investigated patients undergoing spinal fusion and observed that the VR intervention group exhibited greater satisfaction and better preparedness for surgery. By assessing a new application of VR in the perioperative setting, they demonstrated that patients exposed to a preoperative immersive VR experience had increased satisfaction with the surgical encounter. They also believed that by harnessing the power of this technology, hospitals can create an immersive environment that minimizes stress and enhances the perioperative experience [24].

Furthermore, another study [13] conducted a study demonstrating that VR technology had a positive impact on anxiety reduction in adult patients facing cardiac surgery. This research indicated that in the preoperative environment, immersive technologies had a modest impact on anxiety states compared to baseline. However, immersive VR technologies showed a more significant positive impact across a broader range of anxiety states when compared to baseline measures [13]. These findings suggest that immersive VR can be an effective and cost-efficient nonpharmacological approach for reducing preoperative anxiety in older adult patients preparing for cardiac surgery. Furthermore, Rousseaux et al. [10] also investigated the use of VR intervention in patients undergoing cardiac surgery. Their study revealed that a VR intervention session successfully reduced both anxiety and perceived pain in these patients. Importantly, their research delved into the phenomenological aspects of virtual reality experiences, including factors such as absorption, dissociation, time perception, immersion, and presence. They found that these aspects were efficient in decreasing perceptions of both pain and anxiety among the patients [10]. However, Nooban's study [8] showed no significant reduction in preoperative anxiety in women without a history of emergency cesarean section, although there was a reduction in anxiety and a trend towards anxiety reduction in women with a history of emergency cesarean section. VR offers a significant advantage by providing a visual reality-based experience and a sense of presence. This helps patients adjust their expectations toward the operation. Furthermore, VR videos can be easily created in different languages, making them more accessible than written information, particularly for individuals with low literacy [8].

Looking beyond these specific findings, VR technology presents a substantial advantage in the realm of preoperative anxiety management. By immersing patients in a visual, reality-based experience, VR provides a profound sense of presence, allowing individuals to acclimate to the surgical environment and procedures. This immersive aspect can play a pivotal role in helping patients adjust their expectations and alleviate apprehension surrounding the upcoming operation. Additionally, one of VR's standout strengths lies in its versatility when it comes to language accessibility. VR videos can be effortlessly created in different languages, breaking down linguistic barriers that may exist in healthcare settings. This accessibility is particularly advantageous for individuals with low literacy levels, as videos, in general, are often more comprehensible and user-friendly than written information. The capacity to provide vital preoperative information in various languages enhances patient comprehension and promotes inclusivity in healthcare practices. Moreover, recent advancements in VR technology have made it increasingly accessible in healthcare settings. Low-cost headsets and software innovations have lowered barriers to entry, enabling broader adoption across diverse clinical

environments [25]. For example, mobile VR platforms can be deployed in outpatient settings or remote regions where resources are limited, allowing for the expansion of therapeutic interventions such as exposure therapy for posttraumatic stress disorder (PTSD) management during medical procedures [26]. This improved accessibility can help bridge gaps in care delivery for underserved populations.

Additionally, VR technology is proving to be a cost-effective alternative to traditional therapeutic methods. While initial setup costs may seem high, they are often offset by reduced long-term expenses related to training, personnel, or physical infrastructure [27]. For example, VR-based rehabilitation programs have demonstrated comparable outcomes to in-person therapy at significantly lower costs [28]. By reducing the need for repeated hospital visits or specialized equipment, VR offers an economically sustainable option for healthcare providers. Similarly, Sarkar et al. [29], emphasized that the economic feasibility of VR solutions is largely attributed to their scalability and the potential for remote deployment, reducing geographic and logistic barriers to care. Pandita et al. [30], also emphasized that VR platforms enable flexible, patient-centered therapeutic approaches that can be easily adapted to individual needs, further enhancing cost efficiency while ensuring consistent treatment quality.

Another crucial advantage of VR technology in healthcare lies in its scalability, which significantly contributes to its potential for widespread implementation [31]. Unlike traditional therapeutic methods that often require extensive physical resources or specialized personnel, VR platforms can be easily scaled across diverse clinical settings. This scalability is particularly evident in the use of cloud-based VR systems, enabling centralized updates and consistent delivery of therapeutic content to multiple locations without significant additional costs [32, 33]. For example, mobile VR systems, requiring only a smartphone and compatible headset, have been deployed to provide effective care in remote or underserved regions, thereby addressing healthcare access disparities [34]. Moreover, modular designs of VR platforms allow for tailored interventions suitable for specific patient populations, enhancing reach and efficacy [35]. These characteristics demonstrate how scalable VR solutions can minimize logistical challenges, reduce infrastructure dependency, and expand accessibility in resource-limited settings, making them indispensable in modern healthcare systems.

While Nooban's study [8], highlighted the effectiveness and challenges of VR interventions in managing preoperative anxiety, the broader implications of VR technology in healthcare are undeniable. Its immersive capabilities provide patients with a profound sense of presence, easing apprehensions about surgical procedures, while its adaptability across languages fosters inclusivity and improved comprehension, particularly for individuals with low literacy levels. Additionally, the scalability and cost-effectiveness of VR solutions, facilitated by advancements in mobile and cloud-based platforms, enable widespread implementation in diverse healthcare settings. These features allow VR to bridge gaps in care delivery, extend therapeutic interventions to underserved regions, and offer sustainable alternatives to traditional methods. Collectively, these qualities underscore VR's transformative potential in modern healthcare, making it a versatile and indispensable tool for improving patient outcomes and experiences.

In examining the dynamics of the VR intervention, it becomes clear that several specific aspects contributed significantly to the observed reduction in preoperative anxiety scores. First, the immersive nature of the VR experience, which allows users to virtually explore the surgical environment, plays a crucial role in helping patients familiarize themselves with the procedure and reduce their fears. Additionally, the use of calming visual and auditory stimuli within the VR videos may have had a direct impact on anxiety reduction by promoting relaxation. The interactivity and sensory engagement in the VR experience were also key factors, as they allowed patients to become more actively involved in the process, which likely enhanced their coping mechanisms. Furthermore, the ability to tailor the VR content to individual needs, such as providing the intervention in different languages, increased accessibility and helped address potential barriers related to literacy and language comprehension. Overall, it was the combination of immersion, sensory engagement, and customization that was most effective in lowering anxiety levels among the intervention group, reinforcing the value of VR as an innovative tool for preoperative anxiety management.

4.1 | Study Limitations

This study has several limitations that should be acknowledged. First, the sampling process was prolonged due to the application of specific inclusion criteria, which narrowed the pool of eligible participants. Furthermore, the high costs associated with filming and acquiring VR cameras for video viewing posed financial constraints. Additionally, obtaining permission to conduct video recordings in sensitive hospital environments, such as inpatient wards and operating rooms, was a challenging and time-intensive process that impacted the overall progress of the study.

The small sample size in our study limits the generalizability of the findings to broader populations. Studies with larger and more diverse samples are needed to ensure that the observed outcomes are applicable across different demographic and clinical settings. Additionally, the generalizability of our findings may also be limited by the specific population included in this study, which primarily focused on women undergoing cesarean sections. Future research should explore VR interventions in diverse clinical contexts to confirm the broader relevance of our findings.

Another key limitation is the possibility that the anxiety reduction observed in the VR group was not solely due to the VR intervention itself but also influenced by participants feeling more proactive and informed about the cesarean section process. This sense of empowerment could independently contribute to anxiety reduction, potentially confounding the direct effects of VR. Future studies should consider designs that can better distinguish between the effects of VR technology and the psychological benefits of increased engagement and understanding.

Moreover, the absence of an active control group further limits our ability to make direct comparisons between the VR intervention and other anxiety-reduction strategies. For instance, alternative interventions, such as traditional education sessions or relaxation techniques, might yield comparable outcomes. Incorporating active control groups in future research would enhance the robustness of the study design and provide a more comprehensive understanding of VR's relative efficacy.

In summary, while our study highlights the promising potential of VR technology in reducing preoperative anxiety, these findings should be interpreted with caution due to the limitations outlined. Future studies addressing issues such as small sample sizes, the lack of generalizability, the influence of participant engagement, and the inclusion of active control groups are crucial to validate and expand upon these results.

5 | Conclusion

In this study, the effect of virtual reality technology on reducing anxiety before a cesarean section in primigravida women was investigated. This study's results underscore the promising potential of virtual reality technology, specifically through VR video interventions, in mitigating preoperative anxiety among primigravida women undergoing cesarean sections. The statistically significant reduction in anxiety levels observed within the intervention group, coupled with the notable disparity between the control and intervention groups post-VR intervention, highlights the effectiveness of this innovative approach. By integrating virtual reality into the preoperative care of expectant mothers, healthcare providers can offer a valuable tool to ease anxiety and improve the overall childbirth experience. This not only benefits the emotional well-being of mothers but also holds the promise of enhancing the health outcomes of both mothers and infants during cesarean sections. As we move forward, it is imperative to conduct further research and implement VR interventions more widely within clinical settings to fully explore their broader impact and benefits for maternal healthcare, ultimately enhancing the overall quality of care provided to pregnant women.

Author Contributions

Parto Mohammadi: visualization, writing – review and editing, writing – original draft, investigation, methodology, data curation. **Kambiz Bahaadinbeigy:** conceptualization, visualization, validation, methodology, data curation. **Roghayeh Ershad Sarabi:** visualization, writing – review and editing, validation, writing – original draft, funding acquisition, investigation, conceptualization, project administration, resources, supervision. **Khadijeh Moulaei:** writing – original draft, writing – review and editing. **Moghadameh Mirzai:** formal analysis, validation, visualization. **Sakineh Mirzaei Khalilabadi:** formal analysis, validation, visualization. **Mohsen Zarei Hajiabadi:** resources.

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Disclosure

The lead author Roghayeh Ershad Sarabi affirms that this manuscript is an honest, accurate, and transparent account of the study being reported; that no important aspects of the study have been omitted; and that any discrepancies from the study as planned (and, if relevant, registered) have been explained.

Ethics Statement

Approval was granted by the Ethics Committee of Kerman University of Medical Sciences (IR.KMU.REC.1401.123). The involvement of pregnant women was entirely voluntary, affording individuals the autonomy to withdraw from the study whenever desired. Informed consent was acquired from all participants before their involvement.

Consent

The authors have nothing to report.

Conflicts of Interest

The authors declare no conflicts of interest.

Data Availability Statement

The data that support the findings of this study are available from the corresponding author upon reasonable request. All data relevant to this study are available from the corresponding author upon request. The tables included in the manuscript provide a summary of the data and relevant findings.

Transparency Statement

The lead author Roghayeh Ershad Sarabi affirms that this manuscript is an honest, accurate, and transparent account of the study beingre ported; that no important aspects of the study have been omitted; and that any discrepancies from the study as planned (and, if relevant, registered) have been explained. The corresponding author takes complete responsibility for the integrity of the data and the accuracy of data analysis.

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Supporting Information

Additional supporting information can be found online in the Supporting Information section.