



## RESEARCH ARTICLE

### EVALUATION OF THE EFFECT OF VIRTUAL REALITY GLASSES ON PAIN AND ANXIETY EXPERIENCED IN THE LATENT PHASE OF LABOUR FROM THE PERSPECTIVE OF PREGNANT WOMEN AND MIDWIVES: CASE STUDY

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#### ABSTRACT

**Aim:** The aim of this study was to evaluate the effects of virtual reality goggles on pain and anxiety in pregnant women undergoing labour induction. The labour process brings psychological pressures as well as physical pain, and especially conditions requiring labour induction may increase maternal anxiety and pain levels. In this study, the effects of virtual reality goggle application on pain and anxiety during labour were investigated. **Method:** This case study was conducted on two pregnant women undergoing labour induction in a State Hospital. In the virtual reality goggles application, participants were shown nature-themed videos and their pain and anxiety were evaluated. Pregnant women who passed to the active phase of labour refused the application in this phase. Data analysis was performed in IBM SPSS Statistics 22 programme. Midwives accompanying the pregnant women in the study were interviewed. **Results:** The virtual reality goggles intervention did not cause a significant change in the labour pain and anxiety scores of pregnant women. However, the participants stated that this intervention made the pain and stress they experienced more bearable, their attention could be distracted from the pain, and they passed the process faster and more comfortably. As a result of the interview with midwives, midwives stated that pregnant women were better co-operated in labour after virtual reality goggles intervention. **Conclusion:** In conclusion, it was concluded that if VRG reduces anxiety levels, it may also contribute to the alleviation of both anxiety and labour pain. However, more comprehensive and randomised controlled experimental studies are required to clearly demonstrate the direct effects of the virtual glasses intervention.

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## INTRODUCTION

Technological advancements have provided solutions to simplify and improve human life. The health and medical fields have shown great interest in these technological innovations and have adopted the latest technologies in their practices (Akıncı and Aydın Özkan, 2023). Virtual reality applications are also rapidly accepted in the field of health (Akıncı and Özkan, 2023). Virtual reality is defined as the combination of reality and imagination with fiction and technology, combining multidimensional interactive graphics prepared in computer environment with screen technologies, which directly immerses and affects the users directly into the world of models (Akıncı and Özkan, 2023). Virtual Reality technologies are used in the protection and maintenance of health in medicine and health services, early diagnosis of diseases, health education and rehabilitation of patients (Akıncı and Özkan, 2023; Sanchini and Marelli, 2020).

Virtual reality goggles (VRG) interventions, which have come to the agenda in recent years to relieve labour pain and anxiety, can reduce stress and anxiety by changing the mother's focal point. Because stress and anxiety can cause an increase in the severity of labour pain (Topkara *et al.*, 2024). Birth pains can traumatise the mother, fetus and the birth process (Pratiwi *et al.*, 2017; Topkara *et al.*, 2024; Karacan and Çevik., 2023). Oxytocin and prostaglandin gels or tablets administered to bring uterine contractions to a sufficient level, especially in cases where labour cannot start and the cervix cannot reach sufficient maturity, may increase these pains more (Gülmezoglu *et al.*, 2012; Bay and Bulut, 2020). Although the World Health Organisation (WHO) does not recommend induction for uncomplicated pregnancies of less than 41 weeks gestation (Rashidi *et al.*, 2022; World Health Organisation (2018), 10% of births worldwide are induced (World Health Organisation, 2022). For example, in the United States, labour induction increased from 9.5% in 1991

to 27.1% in 2018 (Rashidi *et al.*, 2022; Martin *et al.*, 2019). Oxytocin and prostaglandins used during labour may increase the mother's anxiety during the trauma period and in some pregnant women in the postnatal period, and may negatively affect the attachment and harmony between mother and baby and the mother's thoughts about her baby (Thul *et al.*, 2020). VRG applications provide the midwife with significant benefits in pain management and anxiety reduction during labour. VRG alleviates pain and reduces stress by distracting the mother, allowing the midwife to manage a more calm and controlled labour. It also offers a natural birth experience by reducing pharmacological interventions and strengthens trust between midwife and mother. VRG also has an impact on alleviating postnatal stress and fatigue, which supports maternal well-being. This study was conducted to evaluate the effect of VRG goggle intervention on labour-related pain and anxiety.

## METHOD

This study is a case presentation conducted in a state hospital delivery room to evaluate the effects of VRG on labor pain and anxiety in two pregnant women undergoing induction. Participants were selected using a purposive sampling model, and pregnant women who provided informed consent were included in the study, with the understanding that they could withdraw at any point. The intervention used a Samsung Gear VR headset (model SM-R322NZWATUR) and was applied for 20 minutes during the latent phase of the first stage of labor. In the second phase of the study, two midwives were interviewed for 10 minutes in the delivery room to assess the benefits of VRG technology from their perspective. In this study structured interview model used to participants. Interview: Interviews are conducted with individuals or experts to explore certain aspects or clarify a topic.

**Structured Interview:** Questions are predetermined and standardized, with set response options. This type of interview is suitable for obtaining in-depth information (Uslu And Demir, 2023).

**The interview questions were:** 1. Can you evaluate the effects of VR glasses on pain and anxiety management during labor from a midwife's perspective? 2. Were you able to observe the direct effects of VR application on pain and anxiety levels? 3. What are the benefits of VR glasses for midwives in the delivery room?

To collect data, the study used a personal information form, the State-Trait Anxiety Inventory (STAI) for state and trait anxiety, the Visual Analog Scale (VAS) for pain, the patient's vital signs, and the APGAR score.

- The individual information form included the patient's sociodemographic characteristics (age, residence, education level, occupation).
- The Visual Analog Scale (VAS), developed by Hayes & Patterson (1921), assessed the severity and intensity of pain experienced during labor. The VAS is a straight line with extremes defined from 0 (no pain) to 10 (worst pain).

- The STAI, composed of two subscales, evaluates different aspects of anxiety: the State Anxiety Scale (S-Anxiety) and the Trait Anxiety Scale (T-Anxiety). State anxiety reflects a temporary emotional state characterized by tension and apprehension (Spielberger *et al.*, 1970). In contrast, trait anxiety represents a chronic tendency to perceive situations as threatening, leading to higher anxiety levels. Each subscale consists of 20 items rated on a Likert scale (0 to 3). Scores of 30 or higher indicate high anxiety levels (Spielberger *et al.*, 1970).

Data analysis was performed using IBM SPSS Statistics 22 (SPSS Inc., Chicago, IL). Descriptive categorical data were presented as frequency (n) and percentage (%), while quantitative data were shown as mean, standard deviation, skewness, kurtosis, and minimum and maximum values. Non-parametric tests were used for comparisons of scale scores. The Mann-Whitney U test was used to compare medians between two groups, and the Spearman correlation coefficient was used to examine the relationship between scale scores. The significance level was set at  $p < 0.05$ . No missing data were identified.

**Case Report 1.** The Ministry of Health has announced that Prostaglandin E2 can be used for induction after 38 weeks of pregnancy. It was stated that the application aims to achieve cervical patency within 12 hours (Bayand Bulut., 2020). On 08.06.2024, a 40+6-week G2P1A0 pregnant woman admitted to our hospital was administered proppess vaginal ovule (PGE 2/ Dinoprostone 10 mg vaginal ovule) (Nien *et al.*, 2023) at 07:45. In the first vaginal examination, cervix dilatation was multiparous and no effacement was detected. The pregnant woman was informed about VRG, one of the methods of coping with pain, and it was explained that it could be applied if she volunteered. The pregnant woman stated that although her first pregnancy was normal, she became pregnant by IVF method after 9 years, that she was very worried about her baby and herself, and that she was afraid of labour pain and labour. In stage I of labour, in the latent phase (dilatation: 2-3 cm, effacement: 30%), VAS pain scale was applied at 09:45 (score: 4) and a video of a walk with a nature view was shown with VRG for 20 minutes. During this time, 3 contractions with an intensity of 80s and 5 minute intervals were observed. Ten minutes after the application, the VAS pain scale was applied to the pregnant woman again (score: 6). The pregnant woman stated that she felt pain during this process, but it was easier to overcome the pain and the process felt shorter. The pregnant woman stated that she preferred to continue labour accompanied by a midwife and refused the continuation of VRG application. At the end of labour, the baby's Apgar score was recorded as above 7.

**Case Report 2.** A 40+3 W G2P1A0 pregnant woman who was admitted to our hospital on 08.06.2024 was administered proppess vaginal ovule at 07:30 (PGE 2/ Dinoprostone 10 mg vaginal ovule). In the first vaginal examination, cervix dilatation was taken as multiparous and no effacement. The pregnant woman stated that she wanted to participate in the practice and that she was worried about labour pains and labour and wanted to manage the process well. In the latent phase of labour (dilatation: 2cm effacement: less), 10:15' vas pain scale was applied (0) and a video of a walk with a nature view was watched with VRG for 20 minutes. During this time,

there was 1 contraction with an intensity of 100. VAS pain scale was applied to the pregnant woman again 10 minutes after the application (0). The pregnant woman stated that she felt very relaxed during this process, did not feel any contractions and was ready to cooperate with midwives in labour. The pregnant woman refused to continue the VRG application, saying that she wanted to be mobilised for the rest of labour. The baby's Apgar Score was 9 at the end of labour.

## RESULTS

**Table 1. Analysing the demographic information of the participants**

Variables	Categories	n	%
Educational status University	University graduate	2	100
Occupation	Housewife	2	100
Place of residence	District	2	100
Social security	Yes	2	100
Planned pregnancy	Yes	2	100
Was the gender of the baby desired	Yes	2	100
If there were any problems,	Ever	2	100
What were they	Nausea- vomiting	1	50
	Bleeding	1	50
Birth experience	Positive	2	100
Did she receive childbirth training	Yes	2	100
Midwife from whom she received childbirth training	Midwife	2	100
Afraid of childbirth	Yes	1	100
Afraid of childbirth pain	Yes	2	100
Age	Mean $\pm$ SD	40.5 $\pm$ 40.1	
	Min-max	40-43	

**Table 2. Descriptive statistics of the scales used in the study**

Scales	Mean $\pm$ SD	Median	Min-Max
STAI- State anxiety	41 $\pm$ 5.65	41	37-45
STAI - persistence anxiety	43.5 $\pm$ 14.84	43.5	33-54
VAS 1. Application	2 $\pm$ 2.82	2	0-4
VAS 2. Application	3 $\pm$ 4.24	3	0-6

Descriptive statistics of the scales used in the study are given in the table above.

**Table 3.** The table compares demographic characteristics based on STAI I-II (State-Trait Anxiety Inventory) and VAS scores using the Mann-Whitney U test. It indicates that variables such as participants' education level, place of residence, family structure, issues experienced during pregnancy, and fear of childbirth do not significantly affect STAI State, STAI Trait, VAS 1, and VAS 2 scores ( $p > 0.05$ ). (Supply Doc. 1).

In the table above, Spearman correlation analysis was performed to examine the relationship between quantitative

variables and scale scores. A significant, positive and very strong correlation was found between STAI state anxiety and STAI trait anxiety ( $p < 0.001$ ).

A significant, positive and very strong correlation was found between VAS 2 score and state and trait anxiety ( $p < 0.001$ ). Accordingly, it can be said that as the VAS 2 score increases, state and trait anxiety will also increase.

### Interview with two midwives

*Can you evaluate the effects of VRG on pain and anxiety management during labor from the perspective of a delivery room midwife?*

**Midwife:** 'Dealing with mothers' pain and anxiety levels and ensuring their relaxation is our top priority while working in the labor ward. Since we started using virtual reality glasses, we have particularly applied this intervention during challenging labor processes such as inductions. Mothers report feeling distracted and experiencing less pain while watching nature-themed videos. This is a significant advantage for us because keeping the mother calm during labor makes it easier for us to manage the birth process.

*Have you observed the direct effects of VR application on pain and anxiety levels?*

**Midwife:** Based on my one-to-one observations, there may not be a direct reduction in pain, but the mothers appear more relaxed and focused on the process. Supporting the mother's relaxation with VRG, especially in the early stages of labor, facilitates a more harmonious interaction with us during the later stages. However, when the active phase begins, some mothers choose to discontinue the application; this is left to their preference.

*What are the benefits of VRG for delivery room midwives?*

**Midwife:** The most significant benefit of this technology is that it makes the mother's pain and anxiety levels more manageable. This allows us to handle the birth process more calmly and in a controlled manner. It enhances the effectiveness of the care we provide and may reduce the need for pharmacological interventions. However, more extensive research is necessary to understand the long-term and direct effects of this practice on both mothers and midwives.

## DISCUSSION AND

## RECOMMENDATION

Virtual reality has emerged as a promising non-pharmacological intervention for managing acute and chronic pain across various medical settings (Gershon *et al.*, 2003; Ahmadpour *et al.*, 2019; Carus *et al.*, 2022; Deo *et al.*, 2020). In the context of labor and delivery, researchers have explored the potential of virtual reality to alleviate pain and anxiety experienced by women during childbirth (Solis-Vargas *et al.*, 2021). Existing studies present mixed results regarding the effectiveness of virtual reality in this domain. The findings from this study indicate that the use of VRG did not significantly affect anxiety and pain scores in the selected

**Table 3. Examination of the relationship between quantitative variables and scale scores**

Variables		STAI- State anxiety	STAI - Persistence anxiety	VAS 1. Application	VAS 2. Application
Age	r	1.000	1.000	1.000	1.000
	p	0.999	0.999	0.999	0.999
STAI- State anxiety	r	1	1.000**	1.000	1.000**
	p		0.001	0.999	0.001
STAI - Persistence anxiety	r	1.000**	1	1.000**	1.000**
	p	0.001		0.001	0.001
VAS 1. Application	r	1.000**	1.000**	1	1.000**
	p	0.001	0.001		0.001
VAS 2. Application	r	1.000**	1.000**	1.000**	1
	p	0.001	0.001	0.001	

\*\* $p < 0.001$

sample. One randomized controlled trial reported that using immersive virtual reality during labor did not significantly impact the childbirth experience for women, including pain and anxiety measures (Carus *et al.*, 2022). Some studies showing positive effects while others did not demonstrate significant benefits. These findings align with the results of our study (Mahalan and Smitha, 2023; Massov *et al.*, 2023 ).

In this study, it was found that as pain scores increased, both state and trait anxiety levels also increased. However, participants indicated that they managed the labor process more comfortably and were distracted from pain and stress while using VR goggles. This is an important finding that suggests VRG may help reduce stress. Some studies have explained that diverting attention through VR can effectively reduce stress and anxiety, supporting our results (AkinciandÖzkan 2023; Ayed *et al.*, 2019). A systematic review and meta-analysis of randomized controlled trials found that virtual reality interventions during labor effectively reduced anxiety, suggesting that immersive virtual reality could have a place as an adjunctive treatment in labor and delivery units (Wong *et al.*, 2020; Hajesmaeel- Gohari *et al.*, 2021; Xu *et al.*, 2022). The diversity in findings may be attributed to variations in study designs, the specific VR interventions used, and the individual characteristics and preferences of the participating women. The results of the interviews conducted in this study are as follows: Midwives stated that the application of virtual reality goggles positively contributed to the pain and anxiety management of mothers during the birth process. They noted that VRG helped mothers relax by distracting them from pain and increased cooperation during labor, making the process more harmonious. However, they emphasized that more research is needed to clarify the direct effects of the application. The examples below support the results obtained from our interviews.

Virtual reality has emerged as a promising technology to assist pregnant women during the childbirth process. Midwives have reported that the application of virtual reality goggles can positively contribute to the pain and anxiety management of mothers during childbirth (Setiawan *et al.*, 2019; Nugraha *et al.*, 2018; Hajesmaeel-Gohari *et al.*, 2021). They have noted that VRG help mothers relax by distracting them from pain and increase cooperation during labor, making the process more harmonious (Hajesmaeel-Gohari *et al.*, 2021). This observation aligns with research showing that virtual reality is an effective tool for reducing anxiety and pain among laboring women.

**Limitations of the Study:** The study was conducted with only two pregnant women, and they accepted the application only during the latent phase. Another limitation is the high cost of VRG in the region where the study was conducted. Nevertheless, investigating labor pain and anxiety in a larger group of induced pregnant women may provide more comprehensive information.

## CONCLUSION

The findings of the study suggest that the use of virtual reality goggles can have positive effects on both pregnant women and midwives, potentially reducing pain and stress. Integrating this technology into midwifery care could contribute to a more positive and manageable labor process, promoting collaboration between the midwife and the mother. However, more qualitative and quantitative studies are needed to clearly establish the effects of this method.

## REFERENCES

- Akinci, G., Aydın Özkan, S. (2023). Systematic Analysis of Postgraduate Theses Using Virtual Reality Glasses for Reducing Pain and/or Anxiety in Midwifery and Nursing in Turkey.Ordu University J Nurs Stud 2024, 7(1), 284-293 DOI:10.38108/ouhcd.1273106
- Karacan, E. Akköz Çevik, S. (2023). The Effect of Virtual Reality Applications on Childbirth and Birth Satisfaction in Pregnant Women Having Normal Vaginal Delivery: A Systematic Review. J Tradit Complem Med. 2023;6(1):48-57 DOI:10.5336/jtracom.2022-90916
- Sanchini V, Marelli L. (2020). Data protection and ethical issues in European P5 eHealth. P5 eHealth: An agenda for the health. Technologies of the Future, 173-189. DOI: 10.1007/978-3-030-27994-3\_10
- Topkara FN, Dağlı E, Reyhan Aktaş F (2024) A Literature Review on The Use of Virtual Reality Application In Labor Pain Management During Normal Childbirth, Journal of Health Sciences Institute, 9(2): 250-256 DOI: 10.51754/cusbed.1322429
- Pratiwi, I. G., Husin, F., Ganiem, A. R., Susiarno, H., Arifin, A., & Wirakusuma, F. (2017). The effect of virtual reality on pain in primiparity women. International Journal of Nursing and Health Science, 4(4), 46-50.
- Moralat, D. G., Türkmen, Ü. A., & Altan, A. (2011). Doğum analjezisi. Ok Meydanı Tıp Dergisi, 27(1), 5-11
- Massov, L., Robinson, B., RodriguezRamirez, E., & Maude, R. (2023). Virtual reality is beneficial in decreasing pain in

- labouring women: A preliminary study. *Australian and New Zealand Journal of Obstetrics and Gynaecology*. <https://doi.org/10.1111/ajo.13591>.
- Gülmezoglu, A. M., Crowther, C. A., Middleton, P., & Heatley, E. (2012). Induction of labour for improving birth outcomes for women at or beyond term. *Cochrane database of systematic reviews*, (6). <https://doi.org/10.1002/14651858.CD004945.pub3>
- Bay, F., & Bulut, Ö. Ü. (2020). Labor Induction: Maternal, Fetal-Neonatal Effects, The Role of Midwives. *KTO Karatay University Journal of Health Sciences*, 1(1), 4-14.
- Spielberger, C. D., Gorsuch, R. L., Lushene, R., Vagg, P. R., & Jacobs, G. A. (1970). *Manual for the State-Trait Anxiety Inventory*. Consulting Psychologists Press.
- Rashidi M, Maier E, Dekel S, Sütterlin M, Wolf RC, Ditzen B, Grinevich V, Herpertz SC. Peripartum effects of synthetic oxytocin: The good, the bad, and the unknown. *Neurosci Biobehav Rev*. 2022 Oct;141:104859. doi: 10.1016/j.neubiorev.2022.104859.
- Thul TA, Corwin EJ, Carlson NS, Brennan PA, Young LJ. Oxytocin and postpartum depression: A systematic review. *Psychoneuroendocrinology*. 2020 Oct;120:104793. doi: 10.1016/j.psyneuen.2020.104793.
- Nien YC, Kung HF, Chen MJ, Chen WC. Dinoprostone tablet versus continuous vaginal insert (Propess®) for elective induction in low-risk nulliparous women at term. *Taiwan J Obstet Gynecol*. 2023 Nov;62(6):858-862. doi: 10.1016/j.tjog.2023.03.016.
- World Health Organization. (2022). WHO recommendations on induction of labour, at or beyond term: web annex: evidence-to-decision framework. World Health Organization.
- Setiawan, A., Agiwahyunto, F., & Arsiwi, P. (2019, January 17). A Virtual Reality Teaching Simulation for Exercise During Pregnancy. *kassel university press*, 14(01), 34-34. <https://doi.org/10.3991/ijet.v14i01.8944>
- Nugraha, A S., Faza, A N., Indayani, W., Haryanto, H., & Setiawan, A. (2018, September 1). A Natural Childbirth Training Simulation in Virtual Environment For Prospective Midwife. <https://doi.org/10.1109/icitacee.2018.8576901>
- Wong, M S., Spiegel, B., & Gregory, K D. (2020, June 2). Virtual Reality Reduces Pain in Laboring Women: A Randomized Controlled Trial. *Thieme Medical Publishers (Germany)*, 38(S 01), e167-e172. <https://doi.org/10.1055/s-0040-1708851>
- Carus, E G., Albayrak, N., Bildirici, H M., & Gür-Özmen, S. (2022, April 23). Immersive virtual reality on childbirth experience for women: a randomized controlled trial. *BioMed Central*, 22(1). <https://doi.org/10.1186/s12884-022-04598-y>
- Xu, N., Chen, S., Liu, Y., Jing, Y., & Gu, P. (2022, October 12). The Effects of Virtual Reality in Maternal Delivery: Systematic Review and Meta-analysis. *JMIR Publications*, 10(4), e36695-e36695. <https://doi.org/10.2196/36695>
- Hajesmaeel-Gohari, S., Sarpourian, F., & Shafiei, E. (2021, March 25). Virtual reality applications to assist pregnant women: a scoping review. *BioMed Central*, 21(1). <https://doi.org/10.1186/s12884-021-03725-5>
- Gershon, J., Zimand, E., Lemos, R., Rothbaum, B O., & Hodges, L F. (2003, December 1). Use of Virtual Reality as a Distractor for Painful Procedures in a Patient with Pediatric Cancer: A Case Study. *Mary Ann Liebert, Inc.*, 6(6), 657-661. <https://doi.org/10.1089/109493103322725450>
- Ahmadpour, N., Randall, H., Choksi, H., Gao, A., Vaughan, C W., & Poronnik, P. (2019, July 12). Virtual Reality interventions for acute and chronic pain management. *Elsevier BV*, 114, 105568-105568. <https://doi.org/10.1016/j.jbiocel.2019.105568>
- Deo, N., Khan, K S., Mak, J., Allotey, J., Carreras, F G., Fusari, G., & Benn, J. (2020, June 23). Virtual reality for acute pain in outpatient hysteroscopy: a randomised controlled trial. *Wiley*, 128(1), 87-95. <https://doi.org/10.1111/1471-0528.16377>
- Solis-Vargas, A., Contreras-Alcázar, I., & Sulla-Torres, J. (2021, January 1). Development of a Virtual Pet Simulator for Pain and Stress Distraction for Pediatric Patients using Intelligent Techniques. *Science and Information Organization*, 12(2). <https://doi.org/10.14569/ijacsa.2021.0120267>
- Uslu Fatih, Demir Erdi (2023). A Qualitative Data Collection Technique: In-depth Interview. *Hacettepe University Journal of Faculty of Letters*: 40(1), 289-299 doi:10.32600/huefd.1184085
- Mahalan, N., & Smitha, M. V. (2023). Effect of audio-visual therapy on pain and anxiety in labor: A randomized controlled trial. *European Journal of Obstetrics & Gynecology and Reproductive Biology*: X, 20, 100240. <https://doi.org/10.1016/j.eurox.2023.100240>

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