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Immersive Virtual Reality Application on Labor Pain, Anxiety and Satisfaction among Laboring Women

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Abstract
Background: Immersive virtual reality is one of the non-pharmacological approaches used for treating labor pain. **Aim:** Was to evaluate the effect of immersive virtual reality application on labor pain, anxiety and satisfaction among laboring women. **Design:** Used in this study was a quasi-experimental design. **Methods:** 120 laboring women were included in the purposive sample, of these; 60 were assigned to intervention (immersive virtual reality) group and another 60 woman to a control group. **Setting:** This study conducted at the Maternity and Childhood hospital at Zagazig University Hospitals, Sharkia Governorate, Egypt. **Tools:** Five tools were applied in the current study; a structured Interviewing questionnaire, Observational sheet of Labor (Partograph), Visual analogue scale, Anxiety Rating Scale, and Laboring women satisfaction questionnaire. **Results:** There was a statistically significant reduction in pain scores and labor anxiety scores during active phase of labor, second, third and fourth stage of labor between the immersive virtual reality and control groups. The majority of virtual reality group was satisfied with immersive virtual reality application. **Conclusion:** Virtual reality is a useful and effective non-pharmacological method for reducing labor pain and anxiety without having a major negative impact. Furthermore, its use brought satisfaction to laboring women. **Recommendations:** Utilizing of virtual reality is a crucial in maternity hospitals as a safe and non-pharmacological diversion method to lessen childbirth discomfort.

Keywords: Anxiety, Immersive Virtual Reality, Labor Pain & Satisfaction.

Introduction

Labor considered a critical experience in woman life because it accompanied by fear, anxiety, and even fear of death. It is a regular and painful uterine contraction that leads to progressive cervical dilation and effacement. Normal vaginal delivery defined by World Health Organization (WHO) as spontaneous expulsion of single mature viable fetus presenting by vertex from the natural birth canal within a reasonable time without any interference except episiotomy and without any complications to the mother and or the fetus **(Funai & Norwitz, 2023).** There are four stages of labor process. The longest stage of labor consists of three phases; latent, active and transition. Latent phase starts with the onset of regular uterine contractions until cervical dilatation. At 4 to 7 cm cervical dilation, the active phase begins. The second stage begins when cervical dilatation reaches 10 cm and ends with delivering of fetus **(El Sharkawy et al., 2022)**.

The third stage starts with the delivery of the fetus and ends with the delivery of the placenta. At the end, the first six hours immediately following the labor called fourth stage of labor which emphasizes the close maternal and infant observation needed at this time **(El Sharkawy et al., 2022).**

Labor pain is the most intense type of pain that lasts longer than acute pain and is experienced throughout the cervical dilatation, delivery of the fetus and placental delivery. Although birth pain is a normal process, intense pain can have negative impacts on the laboring woman, including increased neuroendocrine stress, extended labor and maternal acidemia. As a result, a significant reduction of pain intensity and duration is required, staying within acceptable limits **(Xu et al., 2022).**

There are a lot of methods mentioned by **Mohammadi et al., (2023)** for managing labor pain from pharmacotherapies, patient controlled analgesia (PCA), and nitrous oxide to acupuncture, hypnosis, yoga, hydrotherapy, massage, relaxation techniques, and transcutaneous electronic nerve stimulation (TENS). Non pharmacological pain management techniques are more often used among these strategies because they have less adverse effects. The most common type of analgesia for labor pain is epidural analgesia which has been found to be both safe and effective in this context, but it has been associated with prolonged labor and more surgical interventions. In addition, opioids, including pethidine, can lessen labor pain but increase woman nausea, vomiting, sleepiness and respiratory depression **(Baldo, 2021).**

Virtual Reality (VR) is an innovative computer-simulated technique that involves the utilization of a headset, which is connected to either a computer or a smartphone, to provide a visual image that is accompanied by sounds. This specific technology employs a variety of sensory distractions, such as auditory and visual stimulation, together with other sensory experiences, to reduce pain and anxiety **(Ahmed et al., 2023).**

Laboring woman can participate actively in the virtual environment by using a head mounted display (HMD), headphones, and a joystick for head tracking, music, manipulation, and navigation, respectively. Throughout this immersive experience, she can engage and find stimuli in a way that is similar to the real world as well as communicate with them **(Ahmed et al., 2023).**

Virtual reality (VR) is utilized in a range of healthcare settings to reduce pain, anxiety, and stress for both adult and pediatric patients during painful medical procedures like physical therapy, chemotherapy, wound care, dental work, and other common procedures like intravenous placement and venipuncture **Massov et al., (2023) & Musters et al., (2023).**

Recently, it gained interest in the labor and delivery field because its hypnotic, meditative, and visualization effect, which are proved to achieve the best results in reducing laboring women's anxiety, relaxing them, and lessening their pain Also it helps women to seek fewer pharmaceutical analgesics and experience fewer side effects **Massov et al., (2023)& Musters et al., (2023).**

Virtual reality technology is classified into immersive, semi-immersive, and non-immersive according to the degree of presence that users experience. To enhance users' experience and sensation of the virtual world, immersive VR merges some real-world elements into the virtual setting. Users in semi-immersive VR are only partially engaged with the virtual world since they are permitted to interact with the outside world while utilizing the technology. On the other hand, non-immersive VR consists of computer-generated techniques on a desktop where users interact with the virtual world via a joystick or mouse **(Hajesmaeel-Gohari et al., 2021).**

The neuromatrix theory of pain states that cognitive, sensory, and emotional inputs, together with variables that influence them like attention, may affect pain perception and ultimately a person's response to pain. Therefore, a person's ability to comprehend or pay attention to pain is limited when they are using their cognitive resources to focus on a task, such as watching or playing something in virtual reality, providing them with visual and auditory stimulation, or giving them positive affective experiences like success or enjoyment **(Momenyan, et al., 2021).**

The most important goal of maternity nursing care is reducing labor pain which is one of the most severe pains that woman can experience. It is imperative that nurses understand the causes of women's anxiety during childbirth and how these factors affect women's cognitive, emotional, and behavioral states **(Mohammadi et al., 2023).**

In labor rooms, maternity nurses perform a variety of tasks including aiding in obstetrical operations and promoting both the psychological and physical well of mothers. Throughout all stages of labor, nurses have a crucial responsibility in giving pregnant women clear, impartial and succinct information about both drug- and non-drug-based methods that effectively reduce pain and reduce anxiety. They also provide a reassuring and psychologically helpful environment. In reality, it might be very hard for nurses to physically lessen labor discomfort. Therefore, nurses working in labor units are responsible for assessing how women perceive their pain, documenting and evaluating the pain, and providing options for pain treatment **(Ahmed et al., 2023).**

Nurses should be aware of the most recent scientific studies on strategies to relieve pain and reduce anxiety in order to guarantee that women have access to reliable and neutral knowledge about labor pain relief procedures, to help women determine what level of pain is acceptable to them, and to give them the freedom to select a pain relief method. There has been an increasing interest in the use of virtual reality (VR) in pregnancy and childbirth to reduce anxiety and pain **(Aboushady et al., 2023)**.

The most recent randomized controlled trial study in Iran by **Mohammadi et al., (2023)** demonstrated a statistically significant decrease in labor pain and fear in the VR group compared to control group that don't use VR.

Significance of the study

There has been an obvious increase in the rate of cesarean deliveries in recent years. According to the Egyptian Ministry of Health, Egypt tops the globe in the percentage of cesarean section (CS) births, which account for 75.0–80.0% of all deliveries. This is in contrast with the average of 25.0–30.0% worldwide **(El-Gundy, 2023)**. Fear of labor pain is the most significant factor influencing women's decisions to choose a cesarean section as a method of delivery. Immersive Virtual Reality Application is one of the non-pharmacological options that suggested by WHO for managing pain and anxiety in various a clinical setting as labor **(Xu et al., 2022)**. There is increasing evidence that VR is effective in the reduction of labor

pain, anxiety and increase women satisfaction therefore the maternity nurse has a crucial role in advising laboring women to choose vaginal delivery and apply immersive virtual reality during it to decrease labor pain and anxiety.

Aim of the study

Was to evaluate the effect of immersive virtual reality application on labor pain, anxiety and satisfaction among laboring women.

This was accomplished through the following objectives:

- Assess the pain level and pain dimensions experienced by laboring women.
- Determine anxiety level among laboring women.
- Develop and implement immersive virtual reality application for improving laboring women's pain and anxiety.
- Evaluate the effect of immersive virtual reality application on laboring women's pain, anxiety.
- Assess laboring women's satisfaction about immersive virtual reality application.

Hypothesis: The following research hypotheses were generated in order to meet the study's aim:

H1: Women going into labor who use the immersive virtual reality application will feel less pain than those who don't employ it.

H2: Laboring women who use the immersive virtual reality application will feel less anxious than those used standard medical treatment.

H3: Laboring women who use immersive virtual reality application will report more satisfaction about it.

The operational definitions:

- **Immersive Virtual Reality (VR)** is a non-pharmacological treatment that uses guided imagery and glasses to create a pleasant environment. It can also quickly remove the patient from a clinical feeling and replace it with a more comfortable one.
- **Pain** refers to the discomfort that laboring women experience.
- **Cognitive pain** is the amount of time that laboring women spent thinking about pain.
- **Affective pain** refers to pain unpleasantness.
- **Sensory pain** means worst pain intensity.

Subjects and Methods:

Study design:

A quasi-experimental design which included two groups of women (the VR group and the control group) with pre and post intervention was employed to accomplish the study's aim.

Study setting:

The study was conducted at the labor and delivery unit of the maternity hospital at Zagazig University Hospitals in Sharkia Governorate of Egypt. This hospital has five floors in total. The operating unit which located in the fifth floor consists of two normal labor rooms, one observation room with five beds and four surgery rooms. The laboring unit, which has 20 beds, is located on the fourth floor and this particular location was chosen because of its high turnover rate and ability to offer free and reasonably maternity care services to any woman, regardless of whether she lives in an urban or rural area.

Sample Type: 120 laboring women were chosen as a purposive sample from the above mentioned setting.

Sample Size: According to **(El Sharkawy et al., 2022)**, found that Mean ±Sd of pain VAS post virtual reality in study group was (6.93± 1.63) versus (8.13± 2.17) in control group , confidence level is 95.0% two side with power of study 90.0%. Add 10.0% to avoid drop out. Sample size calculated using Open Epi, The total number is 120 as 60 women in each group.

Inclusion criteria: Laboring women between the ages of 18 and 39 years old in 37-42 weeks gestation with a singleton pregnancy in active phase of the first stage of labor from (4-7 cm) cervical dilation that underwent vaginal birth with cephalic presentation. Also they have no history of chronic disease or mental illness or pregnancy problems.

Exclusion criteria: Women require alternate analgesic methods (epidural analgesia or other opioids), anomalies pertaining to the fetus or placenta, incapacity of laboring women to identify and evaluate the level of pain.

Tools for collecting data: Five instruments were used to collect data.

Tool I: A structured Interviewing questionnaire: Based on a survey of the literature, the researchers created it in Arabic in order to collect data. It consists of two parts.

First part: Demographic data such as the women's age, education level, occupation…etc.

Second part: Previous and current Obstetric history was given including the number of parity, gravidity, gestational age per week…etc.

Tool II: Observational sheet of Labor (Partograph): It was adopted from the **WHO, (1994).** It is a flowchart / graphical labor monitoring record. This device has three main sections: **the fetal condition;** which includes the degree of molding, the color of the liquor, and the fetal heart rate, **the progress of labor;** which includes the cervical dilation, the head descent, and the uterine contractions, **and the maternal condition;** which includes the vital signs (temperature, pulse, and diastolic blood pressure), the drugs and IV infusions received; and the urine analysis for albumin, protein, and volume.

Tool III: Visual analogue scale (VAS): which measures the intensity and severity of pain: It was

adapted from **Crichton, (2001)**. The woman is asked to mark on the line that most accurately represents her level of pain. Pain dimensions (cognitive pain, affective pain and sensory pain) are also measured. This tool takes 2 to 5 minutes to finish.

Scoring system for tool III: The level of pain is represented on a scale from 0 to 10 (being the most painful). Score 0 means no pain, 1 to 3 mild pain, 4 to 7 denotes moderate, and 8 to 10 means it is severe. The number that best reflected the women's perception of the intensity of her pain was asked to be chosen from visual analogue scale.

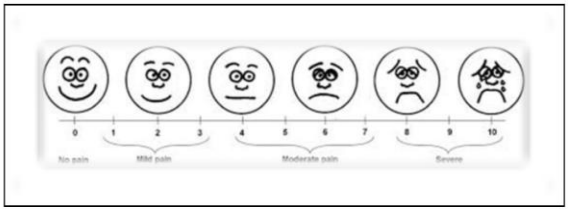

Figure (1): Visual analogue scale (VAS)
Adapted from: Crichton, (2001): Visual analogue scale (VAS). Clin Nurs, 10(5), 706-6.

Tool IV: Anxiety Rating Scale was employed to measure the sensitivity and accuracy of anxiety level during childbirth **(Bloch, 2009)**.

Scoring system for tool IV:

Anxiety Rating Scale is a straight line of 10 score, where 0 on the left denotes "no anxiety" and 10 on the right, "the most severe anxiety." The expectant mothers indicate their level of worry with lines, with a total score ranging from 0 to 10. There were six primary components to the anxiety rating scale score. First part 0 which represent balanced mood. Second part from 1-2 reflect slight fear and worry. Third part was from 3-4 indicated mild fear. Fourth part (5-6) displays moderate fear. Fifth part from 7-8 represent strong agitation and the six part from 9-10 indicated out of control behavior.

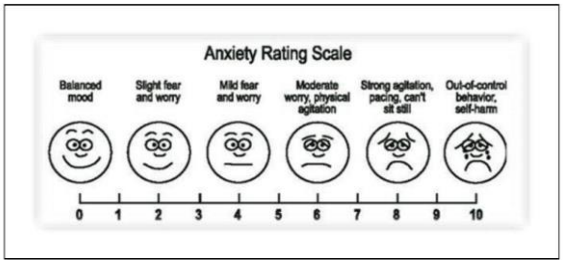

Figure (2): Anxiety Rating Scale
Adapted from: Bloch, (2009): Healing from Depression, Anxiety Rating Scale, 1st edition, Clestial arts, chapter (1), California, p; 386.

Tool V: Laboring women satisfaction questionnaire: This tool was prepared by the researchers about women's satisfaction about immersive virtual reality application. It is composed of 7 questions such as using the application is easy; the application attracted my interest and reduce fear, the application's degree of immersion to divert attention.

Scoring system for tool V:

Each question in **tool V** scored as (1) unsatisfied, (2) for satisfied, and (3) for highly satisfied. The women 'satisfaction about virtual reality (VR) during labor was evaluated giving a total score of 7- 21. Firstly mean score of 7 items was calculated by summing responses of items then divided by 7. Then mean score was divided as follow:

From (1) to (1.66) was unsatisfied.
From (1.67) to (2.33) was satisfied.
From (2.34) to (3) was highly satisfied.

Validity of tools:

Three expert professors from faculty of nursing, Zagazig University (two professors of obstetrics and gynecological nursing and one professor of community health nursing) along with two specialists from the university's faculty of medicine (in obstetrics and gynecologic medicine) assessed the five tools and the immersive virtual reality application for thoroughness. The suitability and legibility of the entries were also assessed. The panel verified the validity of the tools in terms of both their look and contents. Along with other necessary but small adjustments, a few sentences and parts were modified.

Tools Reliability:

Using the Cronbach's alpha coefficient test, the reliability of the tools was determined. It was 0.823, 0.815 and 0.735 for tool III (VAS), tool IV (Anxiety Rating Scale) and tool V (laboring women satisfaction questionnaire) respectively.

A pilot study:

It was carried on 10.0% (12 women in labor) of the study sample, randomly selected and not part of the main study group to evaluate the tools' clarity and ease of use. Estimating the time needed to fill the tools was also made easier by it. In accordance to the results of the pilot study, minor modifications were implemented, including rewording and eliminating certain questions.

Fieldwork:

The researchers met the laboring women who have the inclusion criteria and were willing to participate in the study when they attended the previously study setting in the first stage of labor. In order to gather the baseline data, the researchers introduced themselves to the laboring women and explained the purpose of the study to them. The researchers then obtained laboring women consent to gain their cooperation. The laboring women were met 3 days per week (Saturday, Monday and Wednesday) by the researchers. These days, the hospital's delivery flow rate was high from 9:00 am to 4 pm, in order to reach

the planned sample size, the researchers met with 1 to 3 women each day. The current study was conducted from the first of June 2023 to the end of November 2023, over a period of six months at labor unit in maternity hospitals at Zagazig university hospital. In order to achieve the study's aim, the following phases were chosen and completed.

Preparatory phase:

The researchers looked over modern and historical literature that was pertinent to the study issue during this phase in order to get a thorough theoretical and practical realize of every component of the research intervention. The researchers reviewed books, journals, textbooks, online resources from periodicals, newspapers, and scientific publications. Then, the creation of a study tool and immersive virtual reality application were finished. It was written in Arabic and covers the theoretical components, training for immersive virtual reality application and how to apply it to decrease using of pharmacological drugs for pain relief. **The control group,** which included laboring women, only received prescription pharmaceuticals from their doctors and did not participate in the virtual reality application. On the other hand, the intervention group received immersive virtual reality application and did not take any prescriptions for pain management.

Assessment phase:

After an explanation of the research objectives, each parturient woman in the immersive virtual and control groups was asked to complete the structured interviewing questionnaire to complete it (tool I), which was intended to gather the women's demographic information and previous and current obstetric history. The questions were asked in Arabic, and the researchers noted the responses on the sheet. For each woman, this phase took between five and ten minutes to complete. Using tool II(Partograph) to evaluate the state of labor to each laboring women, completing this assessment required a varied amount of time. **After that** the researchers utilized the VAS (tool III) to measure pain and the Anxiety Rating Scale (tool IV) to measure anxiety before applying immersive virtual reality application (pre intervention).Then the researchers repeated measured VAS and ARS (post-intervention) at cervical dilation 4-5 cm and 7-10 cm of the first stage of labor, second stage of labor, before episiotomy suturing, third stage of labor, during suturing of episiotomy and fourth stage of labor. For each laboring women, the pre-intervention assessment took about five minutes to complete. The control group was assessed first to prevent researchers from becoming overlapped between the two groups.

Planning and Implementation phase:

First: The control group received standard care from the time of admission until delivery, in accordance with the Standard of Routine Hospital Care (SRHC), including ongoing monitoring of the labor progress (cervical dilatation, membrane condition, uterine contraction, and descent of the fetal head) labor pain and anxiety level**.**

Second: **The Intervention group (Immersive Virtual reality group)** received standard care and a brief explanation from the researchers regarding the purposes for which virtual reality is being used. Also the researchers discussed immersive VR in details and how it will be used for each laboring woman in the intervention group received. Then, the researchers gave Arabic booklet explaining the immersive VR application for them. Additionally, it was provided to every nurse in the laboring unit.

Then using (tool III& tool IV) to measure pain and anxiety level. The tell-show-do method was the one the researchers used to demonstrate the VR headset (Figure 3). This method included giving the laboring woman instructions on how to use a headset in a virtual reality setting (tell), showing her how to choose and display different virtual environments simultaneously (show), and then letting her use it.

Figure (3) :Virtual reality headset.

Adapted from: Ahmed, A., Hassan, S., Mohammed, H., et al. (2023): Effect of Virtual Reality on Labor Pain intensity, Duration of the first stage, Anxiety and Satisfaction levels among Primigravida. Egyptian Journal of Health Care, 14(4):33-46.

A range of virtual environments, featuring various natural views and soothing music, were available for each laboring woman in the VR group to choose from it. These environments included the blue ocean, blue deep, green environment, blue moon, red savannah, orange sunset, red fall, baby sounds and white winter (figure 4&5). After that the headset was worn. The researchers instructed the women to be more ease, as they sense of living in or visiting new locations and the researchers were available at their bedsides if they needed any assistance.

Laboring women could move their heads to change the direction of their vision and use hand controls to mimic snapping underwater photos. Stop using immersive VR after that if laboring women experience any discomfort. Lastly, alcohol was used to clean the VR headset before it was given to another laboring woman to avoid infection.

Evaluation included utilizing the same tools (tool II, III, IV) to measure the duration of labor, level of pain, pain dimensions and anxiety level in two groups. At the end of the study (before discharge), the researchers evaluated laboring women in the intervention group about their satisfactions after using immersive virtual reality application **(tool V)**.

Figure (4): The VR's environment of natural scenery. A sample picture of the 360 degrees video; when the patient turns her head to the right, she would see the whole see and when she moves her head up, she will see the sky while she hears sea waves sound.

Figure (5): The VR's environment of natural scenery. A sample picture of the 360 degrees video; when the patient turns her head to the right, left, up and down, the appropriate scene would place in front of her eyes as if she literally is in the environment.

Figure 4 & Figure 5 Adapted from: Momenyan, Safaei, & Hantoushzadeh, (2021): Immersive virtual reality analgesia in un-medicated laboring women (during stage 1 & 2): a randomized controlled trial. Obstet. Gynecol; 48(1): 110-116.

Administrative and Ethical consideration: All ethical considerations were made using the ethical code (ID/Zu.Nur.REC#:0087) when the research of the current study was approved by the Research Ethics Committee (REC) of Zagazig University's Faculty of Nursing. Before any of the tools used, the purpose of the study was stated in order to gain the confidence and trust of each laboring woman. Women who consented to participate in the study were told that the procedures employed would not have an adverse effect on laboring women, and that the data obtained would be kept private. The women had the right to withdraw from the research at any time and without explanation. This was accomplished by formally requesting authorization from the Zagazig University Hospitals' maternity hospital directors. These queries followed up on correspondence from the nursing faculty outlining the purpose of the research, the kinds of data collection tools that would be employed, and the anticipated outcomes of its intervention.

Statistical analysis: All data were collected, tabulated and statistically analyzed using SPSS 20.0 for windows (SPSS Inc., Chicago, IL, USA 2011)). Quantitative data were expressed as the mean ± SD and qualitative data were expressed as absolute frequencies (number) & relative frequencies (percentage). Percent of categorical variables were compared using Chi-square test or Fisher's exact test when appropriate. The student "t" test was used for comparison of means of two independent groups of quantitative data which were normally distributed. P-value < 0.05 was considered statistically significant, p-value < 0.01 was considered highly statistically significant, and p-value ≥ 0.05 was considered statistically non-significant.

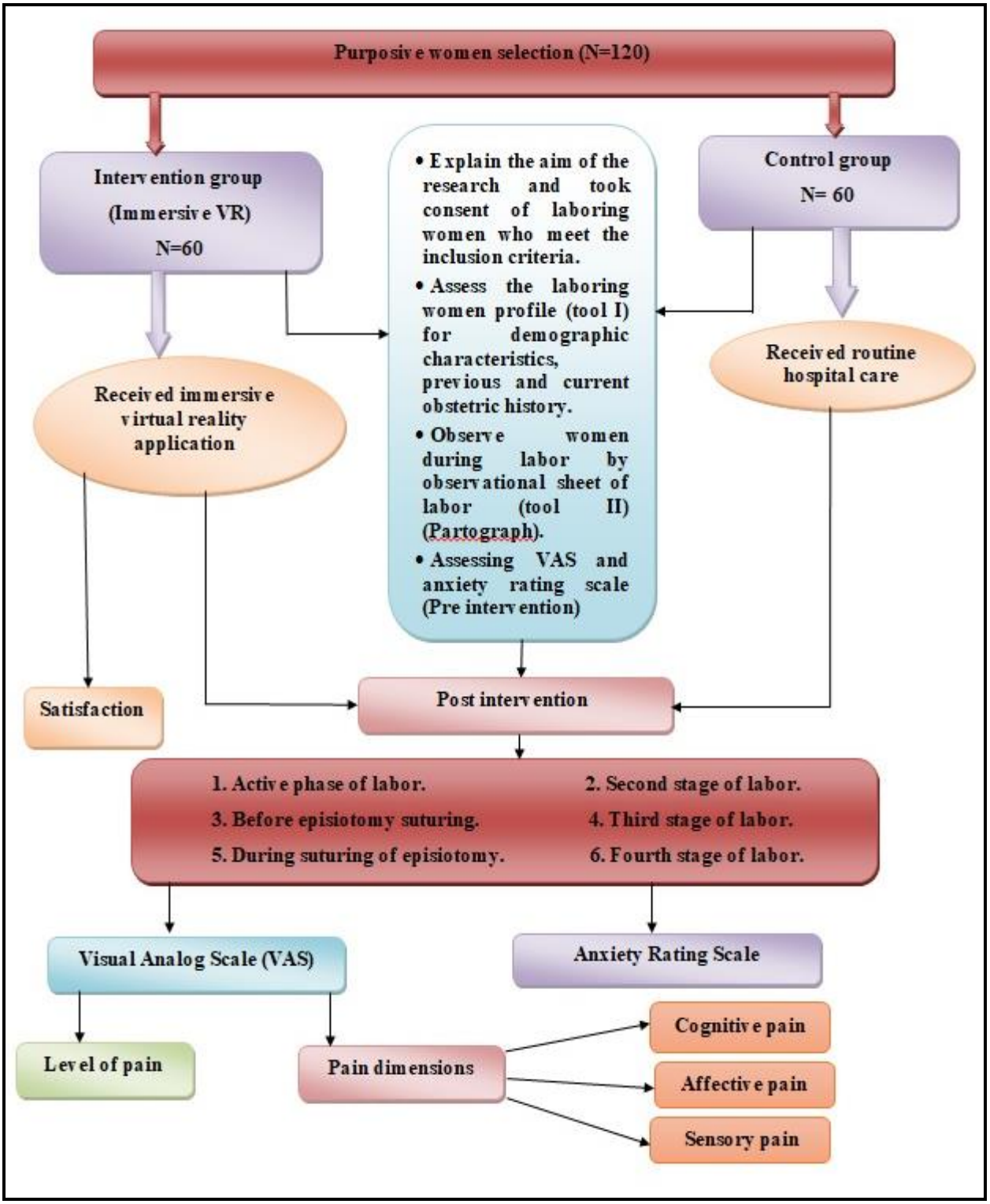

Figure (6): Flowchart of the study.

Results

Table (1): Distribution of the Studied Laboring Women According to their Demographic Characteristics (n=120):

Demographic characteristics	Intervention group (Immersive VR) (n=60)		Control group (n=60)		Test
	No.	%	No.	%	
Age (years)					
19 - <30	52	86.7	48	80.0	FET (0.463)
30 - 39	8	13.3	12	20.0	
Mean± SD	25.98±4.32		26.43±5.15		
Level of education					
Read and write	4	6.7	7	11.7	
Primary school	3	5.0	6	10.0	
Preparatory school	6	10.0	8	13.3	χ2=2.848 P=0.584
Secondary school	29	48.3	24	40.0	
University	18	30.0	15	25.0	
Residence					
Urban	19	31.7	23	38.3	FET (0.566)
Rural	41	68.3	37	61.7	
Occupation					
House wife	43	71.7	39	65.0	FET (0.556)
Working	17	28.3	21	35.0	

FET: Fisher exact test, χ 2: Chi square test, non-significant (p>0.05)

Table (2): Distribution of the Studied Laboring Women According to their Previous and Current Obstetric History (n=120):

Previous and current obstetric history	Intervention group (Immersive VR) (n=60)		Control group (n=60)		Test
	No.	%	No.	%	
Gravida					FET (0 .789)
Primigravida	7	11.7	9	15.0	
Multigravida	53	88.3	51	85.0	
Parity					FET (0 .840)
Primi para	37	67.3	34	64.2	
Multi para	18	32.7	19	35.8	
Gestational age (weeks) (Mean± SD)	38.87 ±0.873		38.95±1.08		t=0.465 p=0.643
History of previous abortion					FET (0.807)
No	49	81.7	51	85.0	
Yes	11	18.3	9	15.0	
Type of episiotomy					χ2= 2.567 p=0 .277
Mido-lateral	51	85.0	56	93.3	
Median	8	13.3	4	6.7	
J- shape	1	1.7	0	0.0	
Duration of episiotomy repair (minutes) (Mean± SD)	10.43±0.722		13.57±2.17		t=-10.597 p=<0.001**
Hearing about Virtual Reality Application					FET (0.847)
No	41	68.3	39	65.0	
Yes	19	31.7	21	35.0	
Source of information about Virtual Reality Application					χ2 =1.085 P=0.581
Friend	2	10.5	4	19.0	
Internet	12	63.2	10	47.6	
TV	5	26.3	7	33.3	

*FET: Fisher exact test, χ 2 : Chi square test, t=student t-test , on-significant(p>0.05), **: statistically highly significant(p<0.01).*

Table (3): Distribution of Mean Labor Duration of the Studied Laboring Women throughout the Three Stages of Labor (n=120):

Stage of labor	Intervention group (Immersive VR) (n=60) (Mean± SD)	Control group (n=60) (Mean± SD)	t-test (p-value)
The first stage (hours)	8.02±0.77	8.62±1.12	-3.417 (<0.001**)
The second stage (minutes)	44.30±6.91	49.63±8.45	-3.781(<0.001**)
The third stage (minutes)	12.60±1.61	14.48±1.91	-5.815(<0.001**)

t-test was used, ***: statistically highly significant(p<0.01).*

Table (4): Distribution of the Studied Laboring Women According to their Level of Pain during the Stages of Labor (n=120):

Labor phase	Intervention group (Immersive VR) (n=60)						Control group (n=60)						χ2 (p-value)
	Mild		Moderate		Severe		Mild		Moderate		Severe		
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	
Before intervention	19	31.7	36	60.0	5	8.3	16	26.7	41	68.3	3	5.0	1.082 (0.582)
Post intervention													
Active Phase of first stage of labor													
4-5cm cervical dilatation	11	18.3	44	73.4	5	8.3	9	15.0	38	63.3	13	21.7	4.195 (0 .123)
7- 10 cm cervical dilatation	7	11.7	41	68.3	12	20.0	5	8.3	19	31.7	36	60.0	20.400 (<0.001**)
Second stage of labor	2	3.3	37	61.7	21	35.0	3	5.0	17	28.3	40	66.7	13.525 (0.001**)
Before episiotomy suturing	15	25.0	36	60.0	9	15.0	8	13.3	21	35.0	31	51.7	18.178 (<0.001**)
Third stage of Labor	19	31.7	33	55.0	8	13.3	10	16.7	15	25.0	35	58.3	26.497 (<0.001**)
During suturing of episiotomy	2	3.3	34	55.7	25	41.0	1	1.7	20	33.3	39	65.0	7.018 (0.030*)
Fourth stage of labor	48	80.0	12	20.0	0	0.0	17	28.3	43	71.7	0	0.0	FET (<0.001**)

χ 2 : Chi square test FET: Fisher exact test non-significant(p>0.05)
*: Statistically significant (p<0.05) **: Statistically highly significant (p<0.01)

Table (5): Comparison of the Studied Laboring Women Regarding their Mean Score of Pain Dimensions throughout the Stages of Labor (n=120):

Pain dimensions	Stage of labor	Intervention group (Immersive VR) (n=60) Mean ± SD	Control group (n=60) Mean ± SD	P-value	Power
Cognitive pain	**Before intervention**	8.33±0.59	8.12±2.15	0.467	1.0
	Post intervention				
	• Active phase of first stage of labor	7.45±0.53	8.55±0.50	<0.001**	1.0
	• Second stage	6.30±0.59	8.52±0.50	<0.001**	1.0
	• Third stage of Labor	5.32±0.74	6.53±0.70	<0.001**	1.0
	• Fourth stage of labor	2.90±0.77	4.12±0.82	<0.001**	1.0
Affective pain	**Before intervention**	**8.42±0.50**	**8.52±0.40**	0.228	1.0
	Post intervention				
	• Active phase of first stage of labor	7.37±0.52	8.55±0.50	<0.001**	1.0
	• Second stage	7.40±0.61	8.52±0.50	<0.001**	1.0
	• Third stage of Labor	5.05±0.79	6.60±0.64	<0.001**	1.0
	• Fourth stage of labor	2.60±0.61	4.22±0.73	<0.001**	1.0
Sensory	**Before intervention**	7.22±0.65	7.10±0.77	0.358	1.0

Pain dimensions	Stage of labor	Intervention group (Immersive VR) (n=60)	Control group (n=60)	P-value	Power
		Mean ± SD	Mean ± SD		
pain	**Post intervention**				
	• Active phase of first stage of labor	7.20±0.57	8.55±0.50	<0.001**	1.0
	• Second stage	6.44±2.15	8.52±0.50	<0.001**	1.0
	• Third stage of Labor	4.55±0.81	6.60±0.64	<0.001**	1.0
	• Fourth stage of labor	2.18±0.39	4.25±0.75	<0.001**	1.0

*t-test was used, **: statistically highly significant(p<0.01)*

Table (6): Distribution of the Studied Laboring Women According to their Anxiety Level (n=120):

Labor phase	Intervention group (Immersive VR) (n=60)								Control group (n=60)								χ2 (p-value)
	Slight		Mild		Moderate		Strong agitation		Slight		Mild		Moderate		Strong agitation		
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	
Before intervention	38	63.3	13	21.7	9	15.0	0	0.0	34	56.7	15	25.0	11	18.3	0	0.0	0.565 (0.754)
Post intervention																	
Active phase of first stage of labor																	
4-5cm cervical Dilatation	22	36.7	16	26.7	13	21.6	9	15.0	6	10.0	11	18.3	31	51.7	12	20.0	17.861 (<0.001**)
7-10cm cervical dilatation	18	30.0	20	33.3	19	31.7	3	5.0	1	1.7	3	5.0	39	65.0	17	28.3	44.472 (<0.001**)
Second stage of labor	7	11.7	9	15.0	26	43.3	18	30.0	1	1.7	2	3.3	15	25.0	42	70.0	21.506 (<0.001**)
Before episiotomy suturing	16	26.7	22	36.7	10	16.6	12	20.0	9	15.0	13	21.7	11	18.3	27	45.0	10.091 (0.018*)
Third stage of Labor	21	35.0	15	25.0	19	31.7	5	8.3	2	3.3	11	18.3	31	51.7	16	26.7	24.953 (<0.001**)
During episiotomy suturing	1	1.7	3	5.0	46	76.7	10	16.7	1	1.7	8	13.3	17	28.3	34	56.7	28.713 (<0.001**)
Fourth stage of labor	49	81.7	8	13.3	3	5.0	0	0.0	22	36.7	31	51.6	6	10.0	1	1.7	25.832 (<0.001**)

*χ 2 : Chi square test *: Statistically significant(p<0.05) **: Statistically highly significant(p<0.01).*

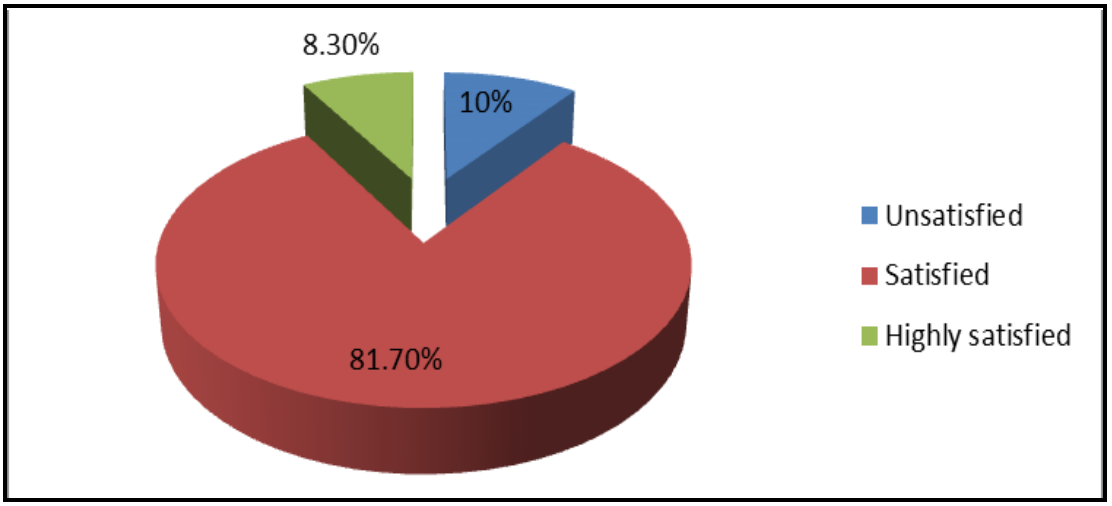

Figure (7): Distribution of the Studied Laboring Women in the Intervention Group According to their Satisfaction about Immersive Virtual Reality Application (n=60).

Table (1): Indicates that nearly all of the sample, in both the intervention (immersive VR) and control groups, was between the ages of 19 and 30 years old. The mean age of the immersive virtual reality group was 25.98±4.32 years, while the control group's mean age was 26.43±5.15 years. Additionally, 68.3% and 61.7% of the sample, respectively, were living in rural areas. Furthermore, a higher percentage of participants in the intervention group (48.3%) and participants in the control group (40.0%) had a secondary school. In terms of occupation, 71.7% and 65.0%, respectively, of the individuals in both groups were housewives. The characteristics of the two groups were similar. In general, there was no statistically significant difference in the intervention groups' demographic features compared to the control groups.

Table (2): Shows that laboring women in the intervention group (immersive VR) had gestational age was 38.87 ±0.873 weeks, while in the control group, it was 38.95±1.08 weeks. The majority of women (85% & 93.3%) in the intervention and control groups, respectively, received mido-lateral episiotomy. Furthermore, the duration of episiotomy repair in the intervention group was 10.43±0.722 minutes, while it was 13.57±2.17 minutes in the control group. This difference was statistically significant at (p=<0.001). The results showed that there were no statistically significant variations in gravidity, parity, or gestational age between the two groups. Furthermore, nearly third of the intervention group (VR) and control group heard about virtual reality applications from internet.

Table (3): Demonstrates that the intervention (immersive VR) group experienced shorter first, second, and third stages of labor than the control group, with statistically significant differences (p=<0.001) between the two groups.

Table (4): Illustrates the pain levels experienced by the intervention (immersive VR) and control groups at different stages of labor. The outcome showed that, following the use of VR, there was a statistically significant difference between the intervention (immersive VR) and control groups .There was a reduction in pain scores during active phase of labor at cervical dilatation(7-10cm) and during second ,third and fourth stage of labor. Additionally, there was a very statistically significant difference (P <0.001) between the intervention and control groups both before and throughout the episiotomy suturing process after application of VR.

The effectiveness of the virtual reality (VR) intervention on the pain aspects across the labor stages is seen in **table (5).** After the implementation of virtual reality, there was a highly statistically significant decrease in the mean scores of labor pain (cognitive, affective, and sensory) among the intervention group compared to the control group during all phases of the labor. In both the first and second stages, the intervention group's mean score for cognitive pain was substantially lower (7.45±0.53, 6.30±0.59, respectively) than that of the control group (8.55±0.50) (<0.001). During the first and second stages, there was a statistically significant decrease in the mean score of affective pain between the two groups (7.37±0.52, 7.40±0.61&8.55±0.50, 8.52±0.50, respectively). Additionally, the control group's (8.55±0.50) and the intervention group's (7.20±0.57) mean sensory pain scores throughout the first stage were significantly different (<0.001).

Regarding anxiety level **table (6)** reveals that there was a significant decrease in labor anxiety scores in the first, second, and third stages of labor with a highly statistically significant difference between the intervention (immersive VR) and control groups (P<0.001). This reduction occurred immediately after the intervention, at cervical dilatation 4-5 cm and at cervical dilatation 7-10 cm. Also, there was a very statistically significant difference (P<0.001) in the anxiety scores between the intervention (immersive VR) and control groups both before and during episiotomy suturing.

The laboring women's satisfaction with the immersive VR application is illustrated in **Figure (7):** The majority of them (81.70%) was satisfied with the VR application, according to the results. 8.30% of them expressed highly satisfaction with the immersive VR application, whereas others expressed unsatisfied.

Discussion

Virtual Reality (VR) is a cheap, low-risk, non-invasive pain management technique with few side effects and no potential for drug addiction. VR holds great promise as a safe substitute for or addition to current pharmaceutical analgesia during childbirth. Integrating VR into obstetric care necessitates understanding how laboring women perceive their level of discomfort and their preferences **(Ahmed et al., 2023)**. One of the most upsetting human sensations has always been pain, which has led to the introduction of numerous medical procedures to manage it. The rapidly evolving field of virtual reality technology has recently caught the interest of medical professionals. Few studies have been conducted on the effectiveness of this unique strategy in managing labor pain **(Wang et al., 2020)**.

According to the demographic characteristics of the study sample, the current study's findings revealed that the majority of the women in both groups were between the ages of 19 and 30 years. The control group had a mean age of 26.43±5.15 years, while the intervention group had a mean age of 25.98±4.32.

More than half of the women in both groups were housewives and lived in rural areas, and over one-third of them had completed secondary education. This result was in line with the research done by **Aboushady et al., (2023);** they found that over half of the women were in their 20 and 30 years. Similarly, **Ahmed et al., (2023)** reported that, in both groups, the majority of women had completed secondary education, and over half of them were housewives.

As a regard of women's obstetrics profiles in both groups, medio-lateral episiotomy was done in most of the women. The intervention group's mean episiotomy repair time in minutes was 10.43±0.722, while the control group's was 13.57±2.17. This result was in accordance with **Aboushady et al., (2023)** who asserted that nine minutes were needed for episiotomy repair in the experimental group and fifteen minutes in the control group.

As regard to duration of labor in the studied women, the present study reported a shorter duration of the first, second and third stages of labor in the immersive VR group compared to the control group. This is because the discomfort and anxiety that come with going through labor raise catecholamine and cortisol levels, which in turn cause abnormalities in uterine contractions and lengthen the duration of the labor stages. Through the lessening of pain and the lowering of anxiety, VR has the ability to relieve pain. Therefore, by making this adjustment, the first stage's duration can be shortened by successfully preventing the spike in catecholamine and adrenaline levels **(Ebrahimian & Bilandi, 2021)**. This result was in agreement with **Ahmed et al., (2023)** who reported that The VR group's labor duration was shorter than the control group. Similarly, **Hussein et al., (2022),** indicated that the duration of the first stage of labor differed significantly between the VR and the control groups. Moreover, it relatively matches with a study of **El Sharkawy et al., (2022)**, who found that there was a statistically significant variation in the length of the different phases of labor. Conversely, **Amiri et al., (2019)** found that following the use of VR, no statistically significant variation in the length of labor was found.

According to level of pain of the studied laboring women, the current study showed that after using virtual reality during all stages of labor, the intervention group's mean scores of labor pain (cognitive, affective, and sensory) decreased significantly. This could be due to the way VR places women in unfamiliar settings that prevent the mind from processing pain signals. This reduces the pain cycle probably because the user is distracted and their brain is occupied with a large amount of data introduced in the simulated setting, which prevents the mind from interpreting pain sensations **(Carus et al., 2021)**.

This result was supported by **Ahmed et al., (2023)** study who stated that in comparison to the control group, the VR group had a reduced mean labor pain score. In the same line, **El Sharkawy et al., (2022)** emphasized the effectiveness of using virtual reality apps to divert women going through the early stage of labor and help them control their discomfort. This result was in a harmony with a study carried out by **Carus et al., (2021)** who also declared that immersion virtual reality lowers pain scores and generally improves the experience of labor. Additionally, **Wong et al. (2021)** stated that the VR group experienced a notable reduction in pain, while the control group experienced an impressive increase in discomfort. This suggests that the use of VR was effective in reducing labor pain for studied women as compared to the control group.

This result was in accordance with **Gür & Apay, (2020)** study who noted that using VR can lessen the intensity of labor pain during the active phase of the first stage of. This also matched with **Momenyan et al., (2021)**, who reported that, in contrast to the control group, a notable decrease in sensory pain was only seen in the VR group during the initial stage of labor.

Our findings indicate that VR significantly reduced pain intensity prior to episiotomy suturing and during the episiotomy repair process, with highly significant statistical differences between the intervention and control groups. In the same line, a study conducted by **Aboushady et al., (2023)** stated that during the episiotomy repair procedure and one hour following the procedure, the study group's pain levels decreased. This result matched with **Mohamed et al., (2022)** who founded that immediately following the episiotomy and an hour later, there was a highly statistically significant difference in pain assessments between the study and control groups.

In relation to anxiety level of the studied laboring women of this study, the intervention group (immersive VR) saw a significant reduction in anxiety levels following intervention when compared to the control group. This might be because virtual reality has the power to take a person's mind off of stressful, frightful, angry, or uncomfortable experiences. This approach is based on the idea that the mind is limited in its capacity to conduct two thoughts at once. As a result, when one's mind is focused on an intensely exciting situation, the senses operate as a diversion from the excitement. This finding was concurred with **Ahmed et al., (2023)** who mentioned that every study participant reported that virtual reality helped them feel less anxious. VR is a very useful and efficient technology that can be

used to reduce work-related anxiety without having any negative side effects. In addition, **Aboushady et al., (2023)** found that an hour after utilizing VR and immediately following episiotomy repair, there was a reduction in anxiety scores, with a highly statistically significant difference between the study and control groups.

In this respect, **El Sharkawy et al. (2022)** study found that VR had a positive effect on the participants' anxiety levels throughout the first stage of labor. Also, **Akin et al. (2021)** reported that women's anxiety levels have been found to decrease when fetus photos are displayed to them through VR. This was in harmony with **Momenyan et al. (2021)** who reported that the study group's mothers showed reduced anxiety levels as compared to their control group peers. Likewise, **Sahin & Basak, (2020)** study who found that the VR group's anxiety level was statistically significantly lower than the control group. **Wu et al., (2020)** reported similar results.

These findings were contradicted to **Carus et al. (2021)**, who revealed that there was no statistical difference in the anxiety scores between the intervention and control groups.

Level of satisfaction after the use of immersive VR applications in the intervention group in the current study demonstrated that the majority of women expressed satisfaction with the use of immersive VR. This suggests that laboring woman satisfaction with childbirth was positively improved by the usage of immersive VR. The effectiveness of VR apps, which have been demonstrated to lower catecholamines by lowering pain and anxiety, may help to explain this. This reduction has thus been linked to enhanced blood flow from the mother to the fetus, which promotes more effective uterine contractions and helps to avoid protracted labor. As a result, it influences the mother's satisfaction with delivery in a good way **(Ahmed et al., 2023)**. This result was supported **Aboushady et al., (2023)** who reported that the use of VR was considered satisfactory by half of the studied women. The current finding is also consistent with a study of **El Sharkawy et al., (2022),** who illustrate that most women expressed satisfaction with the use of VR. Moreover, **Abd Rahman et al., (2021)** spotlighted that the VR group had a higher mean score for maternal laboring satisfaction than the control group.

Conclusion

According to the study's findings, the use of immersive virtual reality application in labor units has been shown to reduce labor pain, anxiety, and boost laboring women's satisfaction while also diverting them during episiotomy repair. This innovative, non-pharmacological approach is efficacious. In the end, the findings validated the research hypothesis.

Recommendations

In the light of the present research results, the researchers suggested the following recommendations:

- Maternity facilities should use immersive virtual reality application as an alternate, non-pharmacological therapy to effectively control labor pain.
- Raising pregnant women's knowledge of the potential of virtual reality to lessen labor pain (especially in prenatal care).
- Using pre-hospital education and specially created VR content to grab patients' attention.

Future researches:

- Replicate the findings on a bigger sample to establish the value of immersive virtual reality and determine how best to deploy it.

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