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Original Article

Effect of Virtual Reality as a Training Strategy on Obstetric Nursing Students' Skills, Self-confidence and Satisfaction regarding Cardiopulmonary Resuscitation during Pregnancy

[(1)] **Elham Abozied Ramadan Said,** [(2)] **Ola Abd-Elwahab Afifi Araby** [(3)] **Nesma Abd-Elaziz Ibrahim EL Desoky**

1.2 Assistant Professor of Obstetrics and Gynecological Nursing, Faculty of Nursing, Benha University

3, Lecturer of Obstetrics and Gynecological Nursing, Faculty of Nursing, Benha University. Egypt.

Abstract

Background: Virtual reality (VR) is a cutting-edge technology that has the potential to help nursing students enhance their skills in virtual hospital environments. It offers a wide range of sensory information, enabling the user to engage with objects in a virtual environment. **Aim**: This research aimed to evaluate effect of virtual reality as a training strategy on nursing students' skills, self-confidence and satisfaction regarding cardiopulmonary resuscitation during pregnancy. **Research design:** A quasi-experimental research design (two groups "control /study", ″Posttest only″) was utilized. **Setting:** The research was conducted at obstetric clinical skills laboratory/ faculty of nursing/ Benha University. **Sampling:** 110 nursing students who were studying the course of obstetrics and gynecological nursing; selected by a systematic random sample. **Tools of data collection:** Four tools were implemented: Structured self-administered questionnaire (Personal characteristics and Nursing students' knowledge questionnaire) Observational checklist for cardiopulmonary resuscitation, nursing student's self-confidence questionnaire, and student's satisfaction questionnaire. **Results:** There was a highly statistically significant difference between the control group and the VR group on the overall mean score of the nursing students' knowledge and skills after using VR. There was a statistically significant difference between the control group and the VR group in terms of students' satisfaction and self-confidence. **Conclusion:** Virtual reality as a training strategy had a clear effect on improving obstetric nursing students' knowledge, skills, self-confidence and satisfaction regarding cardiopulmonary resuscitation during pregnancy. **Recommendations:** It is recommended that future research endeavors capitalize on the implications of employing VR within the educational landscape.

Keywords: Cardiopulmonary Resuscitation, Satisfaction, Self-confidence Skills, Training Strategy, Virtual Reality.

Introduction

A complex and life-threatening medical emergency, cardiac arrest (CA) in expectant women necessitates prompt and sufficient treatment for both the mother and the fetus. An indispensable remedy for CA is early cardiopulmonary resuscitation. A specialized, multidisciplinary, and well-trained team is necessary to provide care for both patients in the context of pregnancy CA, which is a unique circumstance. To enhance outcomes, it is necessary to include specialists in adult, obstetric, and neonatal intensive care (***Bórtoli et al., 2024).***

Approximately one in 30,000 pregnancies are complicated by cardiac arrest, which is an uncommon clinical circumstance associated with pregnancy. The hazards of cardiac arrest for both the mother and the developing infant are increased during pregnancy, which can occur for a variety of reasons in the general population (***Alqarni et al., 2024).***

Particularly after 20 weeks of gestation, the maternal pathophysiology of expectant women undergoes significant modifications in comparison to that encountered prior to pregnancy. The efficacy and administration of cardiopulmonary resuscitation (CPR) can be influenced by the physiological changes that occur during pregnancy. One illustration is the reduction in mean arterial pressure that results from a 30%-50% increase in cardiac output and a 30% decrease in systemic vascular resistance. Increased afterload due to aortic compression and a decrease in cardiac return from the inferior vena the result of the expanding uterus is cava compression, which can occur as early as 12–14 weeks of gestation. The chest compression of expectant women is also impeded by obesity, breast hypertrophy, raised diaphragm, and flared ribcage ***(Zhang et al., 2024).***

Consequently, basic CPR protocols need to be adjusted to accommodate CPR in pregnant women. The following modifications are necessary to reduce pressure on the veins and increase the likelihood of returning to spontaneous circulation: assuming the patient has a difficult airway, inserting intravenous lines above the diaphragm, training the appropriate personnel to perform perimortem caesarean sections (PMCS), and considering the patient's left lateral uterine displacement when applying chest compressions.

Furthermore, maternal survival following cardiac arrest is contingent upon the early identification of the condition, the location of the occurrence, the time interval between cardiac arrest and the perimortem caesarean section, and any other confounding factors. The initial resuscitation measures should be initiated at the site of the incident. If these measures are unsuccessful in enhancing the maternal condition, a perimortem caesarean section should be performed if the gestational age exceeds 20 weeks (***Khan et al., 2023)***

A realistic and immersive environment has been created for learners to practice clinical VR simulation shows great promise as a tool for training and education in the medical and nursing fields, allowing students to practice their abilities and make decisions in a risk-free environment. Virtual reality (VR) simulations significantly surpass more conventional training methods like cadavers, animal models, or mannequins. The use of VR simulation training has the potential to significantly improve the education and retention of healthcare professionals in the management of various obstetric scenarios, such as cardiopulmonary resuscitation (***Kim et al., 2024).***

The immersive experience offered by VR technology has the potential to improve the satisfaction of nursing students with the skills they

have acquired and the training method they have used. This can result in a higher degree of triage accuracy and a shortened task completion time. Their self-assurance in responding to fictional crises can be boosted by this as well. Nurses can practice responding to cardiopulmonary resuscitation (CPR) in a very realistic and dynamic setting with this degree of immersion. Furthermore, virtual reality trainings eliminate the logistical limitations often associated with traditional training, allowing for more flexibility and the ability to repeat training sessions (***Falcone et al., 2024)***

In cardiopulmonary arrest, nurses are frequently the initial responders, and they should be capable of initiating basic emergency care without delay. In order to give the woman, the best chance of returning to spontaneous circulation (ROSC), basic emergency care is essential. This includes quickly mobilizing expert resuscitation teams and competently performing Basic Life Support (BLS) until these teams arrive. Right now, nurses must be well-prepared to deal with this serious issue. The most efficient way to practice CPR is with regular, high-quality training that makes use of modern technology, like VR training (***Sathianathan et al., 2020).***

Significance of the study

Effective cardiopulmonary resuscitation (CPR) is of paramount significance, as cardiac arrest is a significant global cause of mortality. It is imperative to administer high-quality chest compressions in order to preserve the perfusion of essential organs and enhance the likelihood of survival. The rate of maternal cardiac arrest was 7.6 per 100,000 pregnancies. Serious repercussions, including maternal or fetal mortality, may result from this ***(Nazir et al., 2024)***

Cardiac arrest is still a rare but serious event, it occurs in 1: 12,000 admissions for delivery however, it is associated with significant mortality with a case fatality rate of 42%, Therefore, it is imperative to prepare for this scenario by providing carers with training and ensuring that resuscitation apparatus is readily accessible. Pregnant women who have underlying cardiovascular vitae (CV) issues are more likely to experience adverse outcomes for the mother or the fetus ***(Pawar et al., 2023).*** The training requirements in these critical situations are no longer met by conventional training and teaching methods. Conversely, the absence of practical opportunities in clinical practice has been mitigated by the utilization of intelligent VR simulation technology to train CPR skills ***(Aksoy et al., 2023).***

Practical training that utilizes virtual reality technology offers numerous benefits, including the ability to learn in a safe and controlled environment, increased engagement and focus, improved skills through experiential learning, emotional realism, the ability to make mistakes safely, repeatable and controlled exposure to stressful situations, the ability to learn anywhere, anytime, and at a low cost, the ability to enhance self-confidence, the promotion of collaboration and teamwork, and the ability to track performance and yield measurable results ***(Conrad et al., 2024).***

So, the study aims to evaluate effect of virtual reality as a training strategy on obstetric nursing students' skill, self-confidence and satisfaction regarding cardiopulmonary resuscitation during pregnancy.

Aim of the study:

This study aims to evaluate effect of virtual reality as a training strategy on obstetric nursing students' skills, self-confidence and satisfaction regarding cardiopulmonary resuscitation during pregnancy**.**

Research hypotheses:

H1: Nursing students who will be trained using virtual reality strategy will have an improved knowledge and skills than those who will be trained conventionally.

H2: Nursing students who will be trained using virtual reality strategy will exhibit higher self-confidence than those who will be trained conventionally.

H3: Nursing students who will be trained using virtual reality strategy will have better satisfaction than those who will be trained conventionally.

Operational definition:

Virtual reality training: a three-dimensional graphical representation of the natural or imaginary environment that is generated by a computer and is experienced by users through a dedicated headpiece or an array of display walls (***Siivola et al., 2024)***

Conceptual definition:

Skills: encompasses the ability to process and understand information, interpret, and use it in order to complete a task. ***(DeKeyser ,2020).***

Self-confidence is behaving in a composed manner due to your confidence in the individual's knowledge and abilities. An individual's intellectual sensitivity can be a reflection of self-confidence, which is crucial for fulfilling basic personal needs such as achievement and delight. Not only in study but also in social life, such as enthusiastic in the teaching and learning activity ***(Sabarun et al., 2024)***

Satisfaction is described how happy, fulfilled and involved a student are in their educational experience ***(Alhamad et al., 2024.)***

Subjects and method:

Research Design:

A quasi-experimental research design (two groups "control /study", ″Posttest only″) was utilized.

Study Setting:

The study was conducted at obstetric clinical skills laboratory/ faculty of nursing/ Benha University during the course of obstetrics and gynecological nursing; the first semester of the third academic year 2024/2025. The laboratory is placed in the second floor at the Faculty of Nursing and it contains all the required equipment as (hard surface, doll of CPR and ambo bag) for the obstetric and gynecological clinical procedures except virtual reality equipment.

Sampling:

Sample type and size:

20% percent of obstetric nursing students were selected by a systematic random sample to recruit (110 nursing students) who were drawn from total of (548 nursing students) (240) males and (308) females.

Sample criteria and technique:

According to list obtained from information technology (IT) unit in faculty of nursing at Benha University, the nursing students were selected every fixed interval (every five students) until reaching to the desired sample size. The starting point were picked up randomly. Those students were evenly distributed with a mix of male and female nursing students into two groups (study group "virtual reality training method"=55 students and control "conventional training method"=55 students).

Tools of data collection:

Four tools were used for data collection:

Tool I: A structured self-administered questionnaire: It was developed by researchers following a review of pertinent literature. It consisted of two components:

Part (1): **Personnel characteristics of nursing students:** it comprised of 4 items which were (age, gender, residence, pre university education and attending any training courses about CPR using virtual reality.

Part (2): Nursing students' knowledge questionnaire: It was designed by researchers after reviewing a related literature ***(Habibli et al., 2020), (Farsi et al., 2023) and (Agm et al., 2024)***. It was designed to measure nursing students' knowledge regarding virtual reality, obstetric cardiac arrest and cardiopulmonary resuscitation during pregnancy. It comprised of 3 major sections; each section consisted of questions with total of 28-multiple-choice questions. Each question has four options (one right answer, two wrong answers, and I do not know). These sections were:

A. ***General knowledge about virtual reality*** "6 question" (definition of VR, uses, types, advantages, disadvantages, applications of virtual reality in obstetric nursing education).

B. ***Knowledge regarding obstetric cardiac arrest*** "7 question" (definition obstetric cardiac arrest, causes, complications, prevention, management, indication of peri-mortem cesarean section and duration in which peri-mortem cesarean section should be performed)

C. ***Knowledge regarding cardiopulmonary resuscitation during pregnancy*** "14 questions" (definition of CPR, importance, indications, meaning of code blue, meaning of Basic Life Support in Obstetrics (BLSO), general principles of CPR, ways to open the airway, landmark or site of chest compression in pregnant women, rate of compressions to the breathing, depth of chest compression, complications, physiological changes during pregnancy affect cardiopulmonary resuscitation, drugs used during

cardiopulmonary resuscitation during pregnancy, supportive management and indications of ending of resuscitation).

Scoring algorithm:

The weighting of all knowledge questions was determined by the number of elements included in each question (multiple choice questions). A score of one was assigned to each query in the event of a correct response, while a score of zero was assigned in the event of an incorrect response or a lack of knowledge. The sum of the scores of all questions was used to determine the total score. The entire mean number of knowledges was calculated by averaging the responses to all queries. The scores can vary from 0 to 28, with a higher score suggesting a higher level of knowledge. Additionally, the cumulative knowledge score was categorized as follows:

Excellent: 80% -100% correct answer (23 – 28 degree).

- Good: 70%-<80% correct answer (20 – 22 degree).
- Acceptable: 60%-<70% correct answer (17 – 19 degree).
- Nonacceptable: <60% correct answer (≤16 degree).

Tool II: Observational checklist for cardiopulmonary resuscitation: It was constructed by the researchers based on reviewing the related literatures ***(Mohamed et al., 2018), (American Heart Association (AHA), 2020), (Falahan et al., 2024)*** and ***(Agm et al., 2024)***. It was used for assessing the nursing students' practices regarding cardiopulmonary resuscitation during pregnancy. It was consisted of 76 steps divided into 8 sections as follow:

- Pre procedure tasks (6 steps).
- Basic interventions during procedure (6 steps).
- A-B-C assessment (airway, breathing and circulation) (7 steps).
- Chest compression technique (8 steps).
- Open air and breathing technique (15 steps).
- Defibrillation technique (17 steps).
- Intubation technique (10 steps).
- Post resuscitation care (7 steps).

Scoring algorithm:

Each step was assigned a score of (0) for not completed, (1) for incompletely completed, and (2) for completely completed. The aggregate of the scores from all steps was used to determine the total score. Each section achieved a total mean score of practices. The possible range of scores is 0 to 152, with a higher score indicating superior practices. The following was the classification of the total practices score:

- Satisfactory practices ≥75% of total score (114-152 score).
- Unsatisfactory practices < 75 % of total score (0-113 score).

Tool III: Nursing student's self-confidence questionnaire: It was adopted from ***(Mohammed and Ahmed, 2016)*** to assess nursing students' self-confidence after implanting teaching and training methods regarding CPR during pregnancy. It composed of a 7 items such as (I feel more confident about my skills, I am better able to assess pregnant woman, the training helped me to

think critically, I feel better prepared to care situation for real, I feel more confident in my decision making skills …etc.)

Scoring algorithm:

Agree (2), undecided (1), and disagree (0) were the ratings assigned to each item on a three-point Likert scale each. The total score was determined by summing the scores of all elements. There is a potential score range of 0 to 14, with a higher score indicating greater self-assurance. Total score was categorized into:

- High self-confidence: if score is (11-14).
- Moderate self-confidence: if score is (6-10 score).
- Low self-confidence: if score is (0-5 score).

Tool IV: Nursing student's satisfaction questionnaire: It was developed by ***(Borim Nejad et al., 2015)*** to evaluate factors like the extent to which one is enjoying or invested in the subject matter and the practicality of newly acquired information and abilities; the assessment consists of eleven items, such as (Teaching methodology is enjoyable. I found this approach to be sufficient in satisfying my information requirements. My profession can benefit from the knowledge and skills that I have acquired through this approach. With the implementation of this methodology, my performance was enhanced, Learning occurred more efficiently with this method …etc.)

Scoring algorithm:

We used a 3-point Likert scale for each item, (completely = 2, somewhat = 1, not at all = 0). A higher score indicated greater satisfaction on this questionnaire, which ranged from 0 to 22. The degree to which students were satisfied with the method of instruction fell into three categories:

- High satisfaction: if score is (17 - 22).
- Medium satisfaction: if score is (8–16).
- Low satisfaction: if score is (0-7).

Tools validity:

Questionnaires were reviewed for validity by a panel of three obstetrics and gynaecological nursing experts from Benha University. The experts made sure the questionnaires were clear, relevant, comprehensive, and applicable. Their feedback and suggestions necessitated some minor edits, such as restating certain sentences and removing others to avoid repetition. Once the experts were satisfied that the tests were adequately prepared, they were asked to review the revised tools once more. The instruments were deemed valid in the opinion of the specialists.

Tools reliability:

Using Cronbach's Alpha coefficient test, the researchers were able to determine that the research instruments were reliable and consistent :

Tool	Cronbach's alpha value
Tool I: Nursing students' knowledge questionnaire.	(α =0.88) .
Tool II: Observational checklist for cardiopulmonary resuscitation.	(α =0.85) .
Tool III: Nursing student's self-confidence questionnaire.	(α =0.79) .
Tool IV: Nursing student's satisfaction questionnaire.	(α =0.93).

Ethical consideration:

The following ethical considerations will be made prior to the commencement of the study: The research could not proceed without the green light from Benha University's scientific research ethical committee, the appropriate official authorization was procured from the Dean of the Benha Faculty of Nursing. In order to earn the trust and confidence of the nursing students, the researchers explained the purpose and significance of the study before administering the tools. The researchers ensured confidentiality and obtained informed consent from nursing students before they participated in the study. Nursing students were not exposed to any psychological, social, or bodily harm as a result of participating in the study. In order to protect the privacy of the students who took part in the study, we destroyed all data collection materials. Respected human rights and refrained from making any unethical remarks. Also, students were reassured that their data would only be utilized for research and would not impact their grades in any way, both now and in the future. Under no circumstances were the students obligated to continue with the study.

Pilot study:

A pilot study was conducted with six nursing students, which accounted for 10% of the total sample size. The objective of the investigation was to assess the clarity, objectivity, feasibility, and applicability of the tools, as well as to identify any potential issues that may arise during data collection. Additionally, the objectives were to identify any issues that were specific to the statements, such as the sequence of questions and their clarity. It was also useful for estimating how long data collection would take. In order to prevent sample contamination, the pilot sample was removed from the study and adjustments were made based on the results.

Field work:

After explaining the purpose of the research to the dean of the faculty of nursing at Benha University, we were able to get their written formal approval to proceed with the study. The research, which lasted for three months and began in October 2024, was finished at the end of December 2024. Researchers met with obstetric nursing students three times a week, on Saturday, Monday, and Wednesday, from 9:00 a.m. to 3:00 p.m., rotating between groups. This was done in accordance with the students' academic schedules. There were four stages to the research process: preparatory phase, interviewing and assessment phase, implementation phase and evaluation phase

Preparatory phase:

Researchers combed through relevant local and international literature during the first stage of the research process, known as the preparatory phase. In doing so, they were better able to get a feel for the scope of the study and devise strategies for gathering the necessary data. Three obstetrics and gynaecological nursing faculty members from Benha University were given the tools to evaluate them for relevance, usefulness, clarity, comprehensiveness, and applicability. Jury deliberations concluded.

Interviewing and assessment phase:

The researchers began the interview by introducing themselves to each nursing student, welcoming them to the program, explaining the purpose of the study, giving them all the information they needed to follow the interventions, and finally, getting their signed consent to participate. All nursing students were firstly assessed for personal characteristics using the structured self-administered questionnaire ***(Tool: I).*** It took about 2 minutes on average for participants to finish the survey .During the evaluation phase, the remaining tools were measured after both groups were taught the strategies. Starting with the control group initially to avoid bias, researchers began to equally divide the obstetric nursing students into a study group and a control group.

Implementation phase

For the control group (traditional training method): The control group (55) students were divided into 11 sub-groups (5 students in each). These sub-groups firstly and before starting the clinical training were provided by overview about obstetric cardiac arrest and CPR during pregnancy for about half hour. After that, they trained at the obstetric clinical skills lab by the researchers through traditional clinical demonstration of CPR for pregnant; then, the students took part in the traditional re-demonstration of procedure using the available equipment and CPR mannequin. The demonstration and re-demonstration lasted for one hour and half. This took about four weeks (from the start of October 2024 to the start of November 2024, followed by two weeks for evaluation).

For study group (flipped classroom strategy group):

The researcher conducted a one-day theoretical lecture using PowerPoint presentations for all obstetric nursing students in the study group and was conducted in lecture hall obstetric and gynecological using department which is located in the third floor. The theoretical lecture time was divided into two sessions with 10 minutes break in-between:

- *Orientation session:* "lasting for one hour" The researchers explained in detail the virtual reality as a novel training strategy.
- *Another session:* "lasting for one hour" was about obstetric cardiac arrest and cardiopulmonary resuscitation during pregnancy. At end of session, the researchers distributed an illustrated handout about theoretical lecture content.

Then, the study group (55) obstetric nursing students were assigned to the obstetric nursing skills laboratory in 11 sub-groups of (5 students in each) students each. The nursing students were trained on cardiopulmonary resuscitation during pregnancy by using VR 3D glasses (The Meta Oculus Quest 2) which illustrating the steps of CPR and the technique of chest compressions that developed by the researchers through specialized engineer under their supervision.

The practical training sessions were conducted in the clinical obstetric nursing skill

laboratory and outside the hospital as a simulated cardiopulmonary event; lasting for about 3 hours. The practical training took about 30 minutes for each student to practice on CPR using VR eye glasses. This took about four weeks (from the middle of November 2024 to the middle of December 2024, followed by two weeks for evaluation).

Before training session, the researcher provided brief guidelines on how to use the VR technology, which was immediately followed by the VR-CPR training.

For each sub-group, researchers presented CPR guidelines for different scenarios along with necessary explanations. Students learnt how to use VR to their advantage when administering cardiopulmonary resuscitation (CPR) to pregnant women, considering all aspects of the scenario, including their roles and duties, the patient's condition, the resuscitation team's make-up, available resources, and any additional interventions that may be needed.

The researchers conducted CPR demonstrations and performed them on virtual reality after presenting each scenario of cardiopulmonary arrest to the students. Afterward, each student donned the VR eyeglasses and was individually instructed through the VR-CPR scenario, utilizing the same scenarios. At first, the student was a passive viewer while the scenario was repeated and each step was explained by the researcher. Then, the student act as an active CPR provider, each student carried out every step of the CPR independently and the scenario was repeated until all students perform the CPR procedure using VR.

The students subsequently practiced CPR in three-member groups at the clinical skills lab, under the supervision of a researcher. The students continued to engage in a variety of duties, such as the use of an AED, artificial respiration, and cardiac compression. In each group, each student practiced CPR steps for a duration of 10 minutes, resulting in a total of 30 minutes. A five-minute debriefing session was conducted with the researcher's assistance after the pupils had practiced in virtual reality.

Then, the researchers facilitated group discussions to conduct a comprehensive analysis of the scenario and monitored the progress of each group, providing guidance as needed. Finally, while discussing the scenario, students were asked to point out any uncertainties or ambiguities and provide reasons for their viewpoints. Afterwards, students were encouraged to openly discuss their answers right and wrong in their groups without passing judgement. Researchers and students met in virtual reality to review the CPR procedure after each session.

Note: The VR glasses had been disinfected with alcohol between students to protect them from cross any infection.

Evaluation phase:

The students from both groups were apprised of the evaluation's time. All students in both groups were evaluated for their knowledge

using the (tool: I, part 2) one week after its implementation. After that, the students of both groups were assessed for their proficiency in CPR during pregnancy (tool: II). Following this, students' satisfaction with the training strategy and their self-assurance in their cardiopulmonary resuscitation abilities (tools: II and IV).

Statistical analysis:

All of the information was double-checked before it was entered into the computer system. After we run the data through the appropriate statistical tests, we will sort it into groups and enter it into a database. Version 22.0 of the Statistical Package for the Social Sciences was utilised in the present inquiry. Quantitative data was presented using percentages, standard deviations, means and frequencies. Utilising inferential statistics, particularly the independent t-test and the chi-square test, the study's hypothesis was assessed. In order to determine how the research variables were related to one another, we calculated their correlation coefficients. A statistically significant difference was indicated by a p-value of 0.001 or less, no statistically significant difference by a p-value of 0.05 or greater, and a statistically insignificant difference by a p-value of 0.05 or less.

Results:

Table (1): Clarifies that the VR and control groups were in the same age group (21-years), with a mean age of 21.68±1.09 and 21.58±1.03 years old, respectively, with over half (54.5%) and less than two-thirds (65.5%) of the participants. Regarding gender, the VR and control groups were predominantly female, with over two-thirds and over half (69.1% and 52.7%, respectively). In addition, the rural area was the residence of over half of the VR group (50.9%) and the control group (58.2%). All (100.0%) of both groups have not attended courses on CPR using virtual reality, according to the attendance at training courses. As a result, there was no statistically significant difference in personnel characteristics between the VR and control groups ($p > 0.05$), which was indicative of group homogeneity.

Table (2): reveals that, the total mean score of knowledge is higher in the VR group compared to the control group after virtual reality implementation; 24.76±1.89 versus 16.21±3.68 respectively with highly statistically significant difference between two groups ($p \leq .0.001$).

Figure (1): represents that, after virtual reality implementation less than two-thirds and about one-quarter (63.6% and 25.4%) of both VR and control groups had excellent level of knowledge respectively.

Table (3): reveals that, the total mean score of practices is higher in the VR group compared to the control group after virtual reality implementation; 142.78±4.72 versus 125.61±7.34 respectively with highly statistically significant difference between two groups ($p \leq .001$).

Figure (2): represents that, after virtual reality implementation the majority and more than two-thirds (85.5% and 69.1%) of both VR and control

groups had satisfactory level of practices respectively.

Table (4): denotes that there was a statistically significant difference in all self-confidence items between VR and control groups in the favor of VR group ($P \leq 0.001$).

Figure (3): represents that more than three-quarters and more than one-third (76.4% and 38.2%) of both VR and control groups had high self-confidence respectively.

Table (5): denotes that there was a statistically significant difference in all satisfaction items between VR and control groups in the favor of VR group ($P \leq 0.001$).

Figure (4): represents that less than three-quarters and more than one-third (72.7% and 36.4%) of both VR and control groups had high satisfaction regarding the implemented teaching strategy respectively.

Table (6): shows that following the implementation of VR, there was a highly significant statistical positive correlation ($P \leq 0.001$) between the total practices score and the total scores of knowledges, self-confidence and satisfaction in both the VR and control groups.

Table (1) Distribution of the studied nursing students in both groups according to their personnel characteristics (n=110).

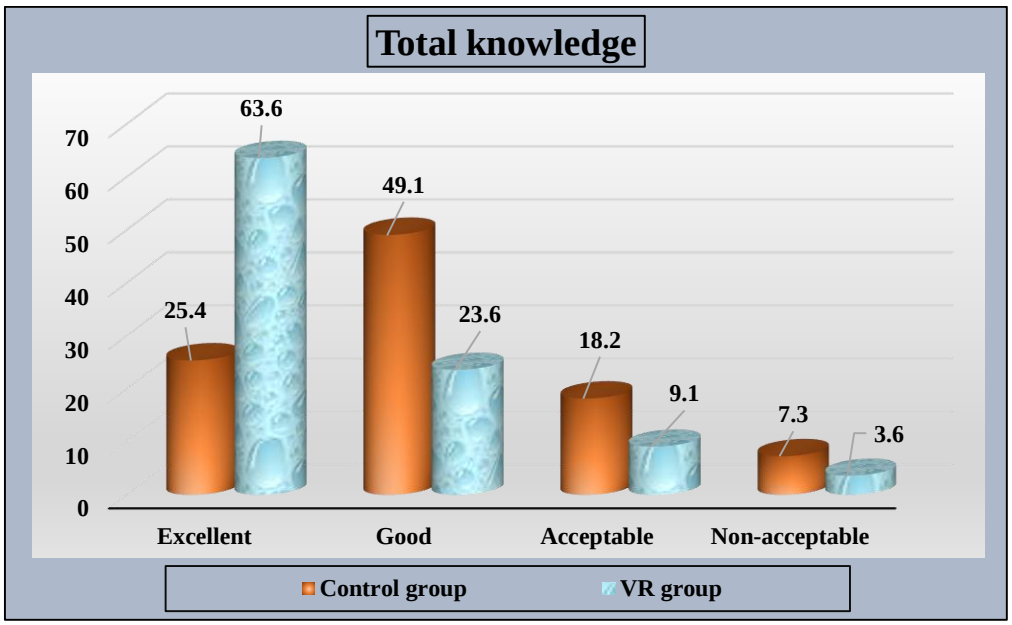
Personnel characteristics	Control group (n=55)		VR group (n=55)		FET/X^2	P value
	No	%	No	%		
Age:						
20-	6	10.9	10	18.2		
21-	36	65.5	30	54.5	**1.68**	**0.430**
>22	13	23.6	15	27.3		
Mean ± SD =	**21.58±1.03**		**21.68±1.09**		**independent t test= 4.90**	**0.625**
Gender:						
Male	26	47.3	17	30.9	**3.09**	**0.079**
Female	29	52.7	38	69.1		
Residence:						
Rural	32	58.2	28	50.9	**0.587**	**0.444**
Urban Rural	23	41.8	27	49.1		
Attending any training courses about CPR using virtual reality:						
Yes	0	0.0	0	0.0	-	-
No	55	100.0	55	100.0		

*A Statistical significant $p \leq 0.05$ **A Highly Statistical significant $p \leq 0.001$

Table (2): Mean score of knowledge regarding virtual reality, obstetric cardiac arrest and cardiopulmonary resuscitation during pregnancy and in both groups after virtual reality implementation (n=110).

Knowledge	No. of items	Possible score	Control group (n=55)	VR group (n=55)	Independent t-test	P value
			Mean ± SD	Mean ± SD		
Knowledge about virtual reality	6	0/6	1.80±1.60	4.89±1.04	11.96	0.000**
Knowledge about obstetric cardiac arrest	7	0/7	4.45±1.97	6.22±1.25	5.59	0.000**
Knowledge about cardiopulmonary resuscitation	15	0/15	9.96±3.12	13.65±1.17	8.20	0.000**
Total score	**28**	**0/28**	**16.21±3.68**	**24.76±1.89**	**15.31**	**0.000****

*A Statistical significant p ≤ 0.05 **A Highly Statistical significant p ≤ 0.001



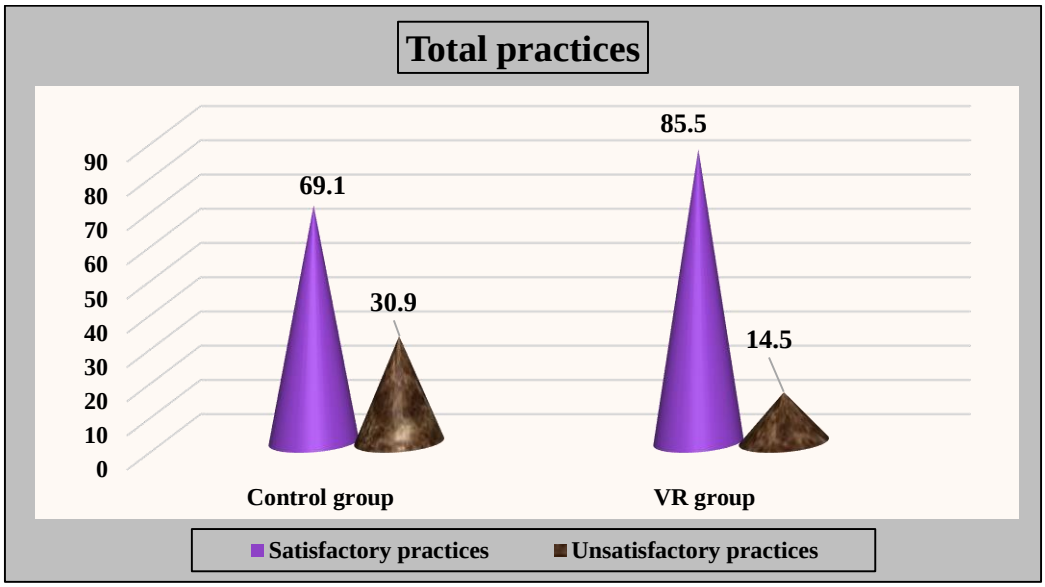
^{2}=16.23 **P- value**=0.001**X**

Figure (1): Distribution of studied nursing students in both groups regarding their total knowledge score about cardiopulmonary resuscitation during pregnancy after virtual reality implementation (n=110).

Table (3): Mean score of practices regarding cardiopulmonary resuscitation in both groups after virtual reality implementation (n=110).

Practices sections	No. of items	Possible score	Control group (n=55)	VR group (n=55)	Independent t-test	P value
			Mean ± SD	Mean ± SD		
Pre procedure tasks	6	0/12	8.73±2.28	10.98±1.26	6.38	0.000**
Basic interventions during procedure	6	0/12	9.33±1.87	11.11±1.06	6.12	0.001**
A-B-C assessment (airway, breathing and circulation)	7	0/14	11.24±1.93	12.84±1.63	4.69	0.000**
Chest compression technique	8	0/16	13.25±2.08	15.15±1.14	5.89	0.000**
Open air way and breathing technique	15	0/30	24.91±4.39	27.93±2.28	4.52	0.000**
Defibrillation technique	17	0/34	29.49±2.99	32.47±1.87	6.25	0.000**
Intubation technique	10	0/20	17.18±2.94	19.09±1.26	4.41	0.000**
Post resuscitation care	7	0/14	11.49±1.72	13.22±1.34	5.87	0.000**
Total score	**76**	**0/152**	**125.61±7.34**	**142.78±4.72**	**14.57**	**0.000****

*A Statistical significant $p \leq 0.05$ **A Highly Statistical significant $p \leq 0.001$



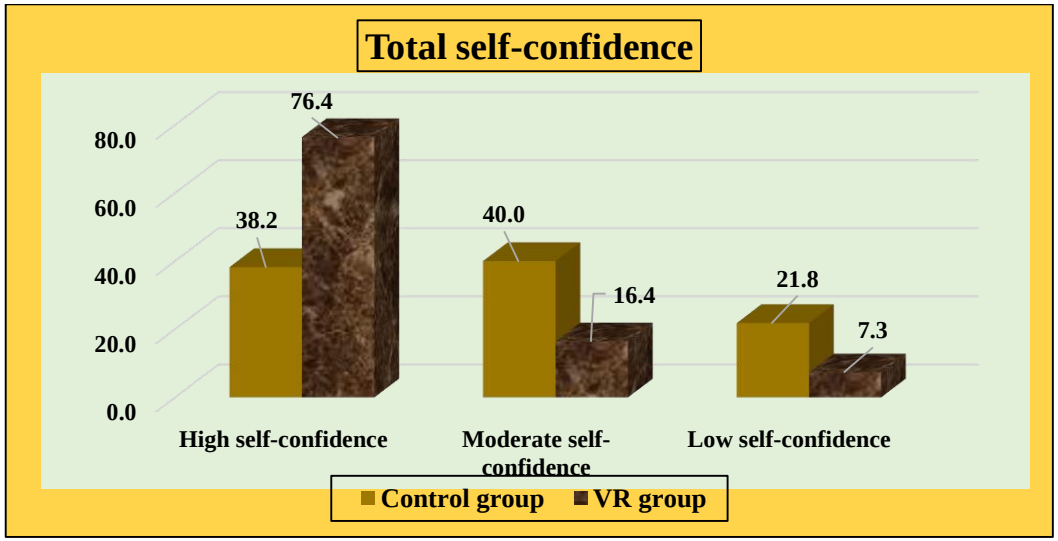
^{2}=4.9 **P- value**=0.041**X**

Figure (2): Distribution of studied nursing students in both groups according to their total practices score regarding cardiopulmonary resuscitation during pregnancy after virtual reality implementation (n=110).

Table (4): Distribution of the studied nursing students in both groups according to their self-confidence regarding cardiopulmonary resuscitation skills after virtual reality implementation (n=110).

Self-confidence items	Control group (n=55)						VR group (n=55)						X^2	p-value
	Agree		Undecided		Disagree		Agree		Undecided		Disagree			
	No	%	No	%	No	%	No	%	No	%	No	%		
I feel more confident about my skills	30	54.5	11	20.0	14	25.5	42	76.4	9	16.4	4	7.2	7.75	0.021*
I am better able to assess pregnant woman	28	50.9	12	21.8	15	27.3	40	72.7	13	23.6	2	3.6	12.09	0.002*
The training helped me to think critically	25	45.5	13	23.6	17	30.9	36	65.5	14	25.4	5	9.1	8.56	0.014*
I feel better prepared to care situation for real	20	36.4	15	27.2	20	36.4	34	61.8	14	25.5	7	12.7	9.92	0.007*
I feel more confident in my decision making skills	22	40.0	18	32.7	15	27.3	36	65.5	16	29.1	3	5.4	11.49	0.003*
I am more confident in determining what to tell the healthcare provider	40	72.7	11	20.0	4	7.3	50	90.9	5	9.1	0	0.0	7.36	0.025*
I feel more confident to recognize changes in my real case condition	31	56.4	12	21.8	12	21.8	45	81.8	5	9.1	5	9.1	8.34	0.015*

*A Statistical significant $p \leq 0.05$ **A Highly Statistical significant $p \leq 0.001$



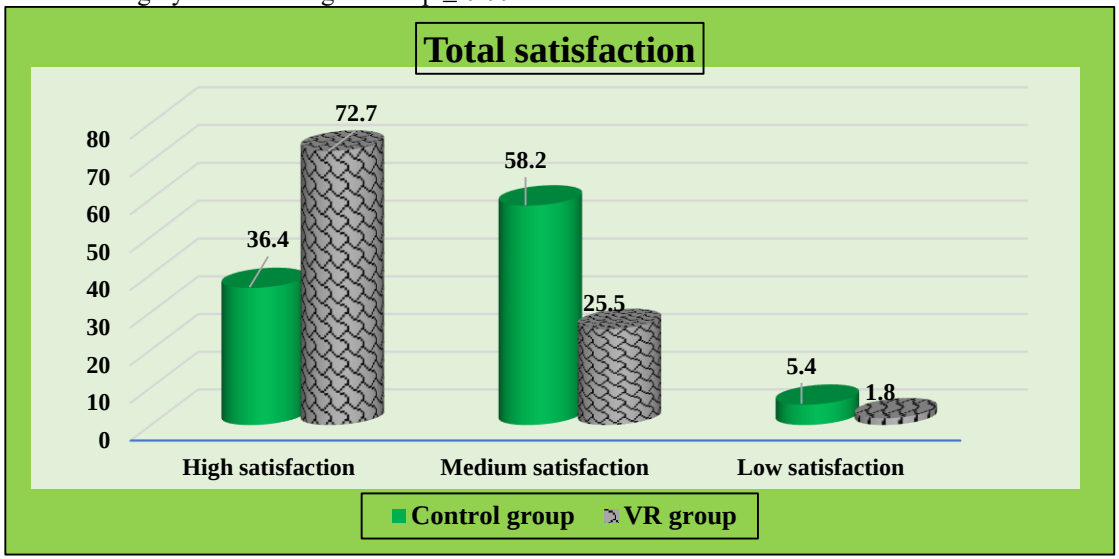
^{2} = 16.90 **P- value** = 0.000**X**

Figure (3): Distribution of studied nursing students in both groups according to their total self-confidence score regarding cardiopulmonary resuscitation skills after virtual reality implementation (n=110).

Table (5): Distribution of the studied nursing students in both groups according to their satisfaction regarding the implemented training strategy (n=110).

Satisfaction items	Control group (n=55)						VR group (n=55)						X^2	p-value
	Completely		Somewhat		Not at all		Completely		Somewhat		Not at all			
	No	%	No	%	No	%	No	%	No	%	No	%		
Teaching method is enjoyable.	20	36.4	18	32.7	17	30.9	45	81.8	10	18.2	0	0.0	28.90	0.000**
This method adequately addressed my information needs.	31	56.4	16	29.1	8	14.5	47	85.5	8	14.5	0	0.0	13.94	0.001**
The knowledge and skills acquired through this method are applicable to my profession.	38	69.1	15	27.3	2	3.6	52	94.5	2	3.6	1	1.8	12.45	0.002*
My performance improved with this method.	40	72.7	10	18.2	5	9.1	54	98.2	1	1.8	0	0.0	14.44	0.001**
Learning occurred more efficiently with this method.	35	63.6	9	16.4	11	20.0	53	96.4	2	3.6	0	0.0	19.13	0.000**
I perceive learning to be more effective with this approach.	36	65.4	9	16.4	10	18.2	53	96.4	2	3.6	0	0.0	17.70	0.000**
This method enhanced my motivation to learn.	27	49.1	20	36.4	8	14.5	45	81.8	10	18.2	0	0.0	15.83	0.000**
The subject matter more engaging with this approach.	22	40.0	20	36.4	13	23.6	40	72.7	13	23.6	2	3.6	14.77	0.001**
This method enhanced my clinical judgment.	28	50.9	17	30.9	10	18.2	42	76.4	13	23.6	0	0.0	13.33	0.001**
Overall satisfaction with this teaching method.	20	36.4	32	58.2	3	5.4	40	72.7	14	25.5	1	1.8	14.71	0.001**
Recommend implementing this method in other educational settings.	30	54.5	22	40.0	3	5.5	50	90.9	4	7.3	1	1.8	18.46	0.000**

*A Statistical significant $p \leq 0.05$ **A Highly Statistical significant $p \leq 0.001$



X^2 = 14.71 **P- value** = 0.001

Figure (4): Distribution of studied nursing students in both groups according to their total satisfaction score regarding the implemented training strategy (n=110).

Table (6): Correlation between total practices score and total (self-confidence and satisfaction) scores in in both groups after implementation (n=110).

Variables	Total practices score			
	Control group (n=55)		VR group (n=55)	
	r	P-value	r	P-value
Total knowledge score	0.447	0.000**	0.659	0.000**
Total self-confidence score	0.491	0.000**	0.623	0.000**
Total satisfaction score	0.555	0.000**	0. 553	0.000**

**A Highly Statistical significant $p \leq 0.001$

Discussion:

The mortality rate is remarkably high, and cardiac arrest (CA) in expectant women is a severe and life-threatening condition with an incidence of approximately 1 in 12,000 cases. Nevertheless, it is an urgent issue in the field of obstetrics and gynecology. High-quality cardiopulmonary resuscitation (CPR) and prompt intervention are the fundamental rescue measures when CA occurs ***(Lin et al, 2024)***. Virtual reality enables nursing students to fully engage with the virtual environment, which offers a more realistic teaching approach than traditional methods. This approach enhances the psychomotor skills of students, provides constructive learning with prompt feedback, and increases their confidence without posing a risk to pregnant women (***Agm et al, 2024)***.

The current study's findings showed that more than half and less than two-thirds of the cohort falling within the same age group (21-years), the average age of the VR group was 21.68±1.09 and that of the control group was 21.58±1.03, respectively. In terms of gender, more than half of the participants in the control group were female and more than two-thirds of the participants in the virtual reality group were female. Furthermore, more than 50% of both the VR and control groups lived in rural areas. No one in either group has taken a cardiopulmonary resuscitation class that used virtual reality.

This result was similar to ***(Falahan et al, 2024)*** demonstrated that the experimental and control groups exhibited no significant differences in terms of socio-demographic characteristics, which suggests homogeneity. As well as, this result was supported by ***(Peinado-Molina et al, 2023)*** revealed that the students' average age was 22.34 (SD = 6.70), that most of them were female, and that most of them lacked both basic life support (BLS) training and prior clinical experience.

The two groups' levels of knowledge regarding cardiopulmonary resuscitation and obstetric cardiac arrest were significantly different. Following the implementation of virtual reality, the total mean score of knowledge in the VR group was significantly higher at 24.76±1.89 and 16.21±3.68, respectively. After virtual reality was implemented, the following knowledge score was calculated: the control group exhibited an exceptionally high level of knowledge

(approximately 25%), whereas the VR group exhibited a score below 63%. Results from the current investigation were in agreement with ***(Abd Al Karem et al., 2022)*** showed the difference in maternity nurses' CPR knowledge between the pre-, post-, and follow-up evaluations. While she was expecting, the nurse's knowledge of cardiopulmonary resuscitation significantly increased ($p = 0.000$ for all items). The results of this study were also consistent with ***(Mohamed et al, 2018)*** showed that there was a highly significant difference ($p<0.001$) in the mean scores of knowledges about cardiac arrest during pregnancy between the phases before and after the intervention.

Else, ***(Sok et al, 2020)*** proved that the cardiopulmonary resuscitation (CPR) training program that used simulations considerably enhanced the students' CPR knowledge and skills while simultaneously reducing their stress levels. Furthermore, ***(Abd-Allah et al, 2017)*** In comparison to the control group, the study group demonstrated significantly higher mean ratings for students' knowledge of advanced CPR. Aside from***, (Requena-Mullor et al, 2021)*** noted that the total knowledge and practice of nurses regarding basic life support were statistically significantly different after the implementation of simulation-guided by intervention compared to the pretest. From the researcher's perspective, this outcome illustrated the exceptional efficacy of educational sessions in enhancing knowledge of nursing students regarding obstetric cardiac arrest, cardiopulmonary resuscitation during pregnancy and virtual reality.

The current study found that after using virtual reality, the control group's total mean score for cardiopulmonary resuscitation practices was 125.61±7.34, while the VR group's score was 142.78±4.72. This difference was found to be highly statistically significant. After implementing VR, the majority of the VR group achieved a satisfactory level of practices, while over two-thirds of the control group did the same. This result has proven the importance of applying virtual reality in enhancing nursing students' practices regarding cardiopulmonary resuscitation, especially since it simulates reality, which allows the student to enter the scenarios as if they were real, which increases the efficiency of his practical performance.

This result matched with ***(Falahan et al., 2024)*** who revealed that on assessments of teaching satisfaction ($p =0.115$) and cardiopulmonary resuscitation performance ($p =0.451$ for chest compressions and $p =0.378$ for airway management), they did not find a statistically significant difference between the experimental and control groups of nursing students. Immediate and one month after the intervention was implemented, the experimental group demonstrated significantly better cardiopulmonary resuscitation performance, including chest compressions ($p < 0.001$), airway management ($p < 0.001$), and teaching satisfaction ($p < 0.001$), in comparison to the control group. Additionally, ***(Sungur et al., 2024)*** reported that the elucidation of mixed reality CPR training has established a viable alternative to traditional CPR

training. In particular, the gratifying nature of mixed reality can be used as an incentive to increase motivation and prompt a greater number of individuals to either review or implement their prior CPR training. Moreover**, *(Hubail et al., 2022)*** The discovery was made that virtual reality (VR) instruction could impart cardiopulmonary resuscitation (CPR) skills in an engaging manner, without a loss of proficiency, in comparison to more conventional approaches. All of these findings illustrate the significant advantages and benefits of utilizing virtual reality technologies to enhance and enhance the performance of nursing students. This is a result of the technology's encouraging features and the ability to apply skills in a pleasurable manner without the dread of making an error.

As well as, ***(Sathianathan et al., 2020)*** demonstrated a statistically significant increase in the CPR skills of expectant women among nursing personnel both before and after simulation-based instruction ($p<0.001$). Also, ***(Abd Al Karem et al., 2022)*** those maternity nurses whose total practice score in CPR categories differed significantly between the pre-, post-, and follow-up tests. Because virtual reality allows nursing students to practise in realistic settings, get immediate feedback on their performance, and, most importantly, fix their mistakes before joining the rest of the class, these outcomes are not surprising. Moreover, VR provides nursing students with the opportunity to employ procedures without any apprehension or anxiety.

The present research discovered a statistically significant difference in all self-confidence items between the VR and control groups in favour of the VR group with respect to cardiopulmonary resuscitation skills ($P \leq 0.001$). The present investigation revealed that over three-quarters and over one-third of the VR and control groups, respectively, had high self-confidence scores in terms of total self-confidence. These results can be explained by the clear role played by the inspiring virtual reality technology in increasing students' confidence in themselves while performing cardiopulmonary resuscitation, especially since it is a skill that deals with critical situations and cannot be trained in real situations because there is no room for error with it during training.

Our research result was supported by (***Wood et al., 2022)*** who showed that confidence was noted to generally increase through the use of VR. In the same vein, (***Vogel et al., 2024)*** noticed that the use of augmented reality simulation influences the evaluation of one's own professional expertise, self-assurance, and competency in handling real-life emergencies, like cardiopulmonary resuscitation. It supports students' subject knowledge, builds their confidence, and improves their practical skills and procedural knowledge in complex situations. The researchers' vision that the future is the simulation of real reality using modern technologies, such as virtual reality, is confirmed by the aforementioned results on the role of virtual reality in enhancing students' self-confidence. This vision has a tremendous impact on the improvement of nursing students'

performance and the development of the nursing profession.

The results of our research demonstrated a statistically significant difference in all satisfaction items between the VR and control groups in favour of the VR group with respect to satisfaction with the implemented training strategy. Regarding the total satisfaction score, the results indicated that the implemented teaching strategy was met with high satisfaction by less than three-quarters and more than one-third of the VR and control groups, respectively.

This result agreed with ***(Falahan et al., 2024)*** showed that the levels of satisfaction among nursing students before the intervention, there was no discernible difference between the groups (p = 0.115). On the other hand, there were noticeable differences between the two groups both before and after the intervention (p 0.001). From the beginning of the intervention until one month later, there was a significant increase ($p < 0.001$) in the average teaching satisfaction scores of the nursing students in the experimental group. There were no statistically significant changes in the control group (p=0.175), on the other hand. In the same context, ***(Yu & Duan, 2024)*** reported that VR technologies enhance motivation and satisfaction while reducing anxiety levels when compared to traditional learning methods. Additionally, ***(Ota et al., 2024)*** found that virtual reality technology significantly improved both satisfaction (SMD = 1.19, 95% CI: 0.09 to 2.30) and skills (SMD = 1.00, 95% CI: 0.46 to 1.54). Immersive VR had a significant positive impact on the participants' abilities (N = 302, SMD = 1.60, 95%CI: 0.70 to 2.50) and satisfaction (N = 406; SMD = 1.63, 95%CI: 0.04 to 3.22). These outcomes demonstrated the critical function of virtual reality in improving CPR, as well as in motivation, performance, and satisfaction. Of course, with all these results that have been reached regarding the satisfaction of participants in various researches with the use of virtual reality technology as a new method of practical training, especially among nursing students, it can be emphasized that it should be used and applied in all practical fields to improve performance at all levels.

This study clarified that there was a positive correlation between total practices score and total scores of knowledges, self-confidence, and satisfaction following implementation in both the control and virtual reality (VR) groups. The correlation between the total practices scores and the sum of the self-confidence and satisfaction scores was of particular interest to us. The results of this study were consistent with ***(Abd Al Karem et al., 2022)*** found a positive correlation (p = 0.0000) between the nurses' total knowledge score and their practice score after the VR simulation intervention. Likewise, ***(Abd-Allah et al, 2017)*** simplified that there was positive correlation between students' total knowledge and practice scores in both groups. Besides, ***(Park & Han, 2022)*** discovered a positive correlation between cardiopulmonary resuscitation (CPR) knowledge and CPR performance (r=.22, p=.01), suggesting that nursing students' CPR performance improved as their CPR knowledge increased. According to

the findings, there is a direct relationship increasing knowledge and the noticeable improvement in performance, and vice versa; this is borne out by increased self-assurance and contentment with the approach used during practical training. Because of this, it's critical to consider all relevant factors, both theoretical and practical.

Conclusion:

Based on the results of the present research, it was concluded that; virtual reality as a training strategy had a clear effect on improving obstetric nursing students' knowledge, skills, self-confidence and satisfaction regarding cardiopulmonary resuscitation during pregnancy; whereas vast majority of nursing students in VR group had better knowledge, skills, self-confidence and satisfaction after VR implementation compared to control group. Moreover, there was a highly significant statistical positive correlation between total practices score and total scores of (knowledge, self-confidence and satisfaction) in both VR and control groups after implementation. Therefore, the research aim was achieved and study hypotheses were supported.

Recommendations:

In the light of the current research findings, the following recommendations were suggested:

- It is recommended that future research endeavors capitalize on the implications of employing VR within the educational landscape, contributing to the advancement of educational and training methodologies.
- Integrating virtual reality in obstetrics and gynecological nursing clinical courses to reinforce their practices and skills in clinical settings.
- Adoption of VR in postgraduate education to create more engaging, effective and personalized learning environments
- It is advisable to conduct additional research to comprehensively elucidate the impact of the VR training method on nursing students' teaching satisfaction and performance.

Further researches:

- Further research is needed to assess the long-term **effects of VR on students' engagement and learning.**
- **Systematic training courses based on VR to improve m**aternity nurses' knowledge and performance regarding CPR during pregnancy.

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