

Effect of a Simulation Intervention on Maternity Nurses' performance regarding Cardiopulmonary Resuscitation

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ABSTRACT: Background: Cardiopulmonary arrest is one of the leading causes of death outside the hospital. It threatens the lives of the mother and fetus, so cardiopulmonary resuscitation can save the woman and the fetus's life. Training a maternity nurse through simulation regarding cardiopulmonary resuscitation during pregnancy is most important for properly taking care of such emergency situations during pregnancy and saving women and fetal lives. **The purpose of** the present study was to assess the effect of a simulation intervention on maternity nurses' performance regarding cardiopulmonary resuscitation. **Method:** A quasi-experimental research design (one group pretest, posttest) was adopted. The interviewing questionnaire and maternity nurses' performance observational checklist were used throughout the study. The study was conducted at the Obstetric and Gynaecological Departments affiliated with Benha University Hospital, Health Insurance in Benha, and Quesina General Hospital. **Results:** There were highly statistically significant improvements regarding knowledge and practice after simulation intervention and during follow-up compared to pre-intervention ($P=0.000$). **Conclusion:** Simulation intervention improves knowledge and practice of maternity nurses regarding CPR. **Recommendations:** the current study showed that simulation intervention programs should be systematically applied, and continuous evaluation of nursing performance should be conducted to help improve nursing performance quality. It is also recommended that hospital managers carry out systematic planning to improve the knowledge and performance of nurses regarding CPR.

Keywords: Cardiac arrest, CPR, Simulation, Nursing performance.

Introduction

Adam et al., 2016 defined Cardiopulmonary arrest during pregnancy is a life-threatening condition and a leading cause of death. They also stated that it presents a unique clinical scenario involving two patients: the mother and the fetus. He added that the management of cardiac arrest during pregnancy is an important task for the emergency health team.

Likewise, Harris (2017) stated that sudden cardiac arrest in pregnant women is a dangerous and complex condition owing to the presence of two patients (mother and fetus) as well as the need for immediate treatment. In addition, he added that causes of cardiac arrest include trauma, pulmonary embolism, haemorrhage, hypertension, and infection.

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Additionally, he concluded that these causes could lead to death. In the same way, Michael et al. (2020) found that bleeding, heart failure, an amniotic fluid embolism, or an allergic reaction caused by the fluid around the foetus getting into the mother's bloodstream are the most common causes of maternal cardiac arrest.

WHO (World Health Organization 2017) reported that in Egypt, the maternal mortality ratio (MMR) reached 37 deaths per 100,000 live births in 2017. Meanwhile, WHO (2017) mentioned that the maternal mortality ratio decreased at a moderate rate between 1998 and 2017, falling from 70 deaths per 100,000 live births in 1998 to 37 deaths per 100,000 live births in 2017. Likewise, Viji et al. (2018) concluded that maternity nurses play a key role in the management of in-hospital cardiac arrest. Often, they are the first on the scene of an arrest, initiating CPR and summoning assistance from the "advanced life support team". Thus, Campbell et al. (2015) argued that maternity nurses should be willing and able to perform defibrillation when required. Metra et al. (2020) found that good outcomes for CPR depend on a skilled resuscitation team, prompt initiation of high-quality cardiopulmonary resuscitation and defibrillation, and organisational structures to support bedside first responders, resuscitation team members, and clinical or administrative leaders.

Damjan et al. (2012) defined simulation as the imitation of the operation of a real-world process or system over time. Also, they added that simulations require the use of models; the model represents the key characteristics or behaviours of the selected system or process, whereas the simulation represents the evolution of the model over time.

Meanwhile, Kelly et al. (2020) noted that clinical healthcare simulators are increasingly being developed and deployed to teach therapeutic and diagnostic procedures as well as medical concepts and decision-making to personnel in the health professions. They also said that simulators have been made to teach everything from drawing blood to laparoscopic surgery and care for people who have been hurt.

Significance of the study

Farida et al., 2015 defined that Cardiac arrest occurring during pregnancy is associated with a high maternal and fetal mortality rate. In the USA, a multi-center study reported that of 55 women who experienced cardiac arrest during pregnancy, including 12 who underwent perimortem caesarean delivery, only 15% (8/55) survived. Also, Myerberg et al. (2015) said that several studies on this topic have shown that obstetric care providers do not know very much about how to resuscitate pregnant women in diverse ways.

Moreover, Myerberg et al. (2015) mentioned that maternal mortality is considered a basic health indicator that reflects the adequacy of health care. Meanwhile, they added that despite numerous improvements in health care, poor pregnancy outcomes remain a major public health concern that follows us into the 21st century. So, in 2015, Neill et al. wrote about the essential steps in the management of obstetric emergencies (ESMOE), which all doctors and midwives who work in maternity units should know. As a result, special emphasis has been placed on the need for the simulation training component of ESMOE, also called obstetric 'fire drills,' to be integrated into the clinical routines of all maternity units (Neill et al., 2015). So, this study aimed to

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assess the effect of a simulation intervention on a maternity nurse's performance regarding CPR resuscitation.

Purpose of the Study

The purpose of the present study was to assess the effect of a simulation intervention on maternity nurses' performance regarding cardiopulmonary resuscitation.

Research hypotheses

1. Maternity nurses who will receive a simulation intervention regarding cardiopulmonary resuscitation will obtain higher knowledge scores than those who do not.
2. Maternity nurses who will receive a simulation intervention about cardiopulmonary resuscitation will achieve higher performance levels than those who do not.

Methods

Research Design:

A quasi-experimental research design was used in this study (one group pre-test, post-test).

Research setting:

The study was conducted at the Obstetrics and Gynecological department at Quisna General Hospital in Menoufia Governorate, Benha University Hospital, and Health Insurance in Benha.

These settings were selected for the following reasons:

- 1- These settings were easy to access.
- 2- These settings were governmental.
- 3- These hospitals have several nurses with different social demographic backgrounds and experiences.

Quisna General Hospital in Menoufia governorate:

Affiliated with the Ministry of Health, it consists of five floors. The Obstetrics and Gynaecological department is situated on the second floor and

consists of three rooms: one for C.S (Caesarean Section) cases, one for postoperative cases, and one for follow-up cases.

Health Insurance Hospital:

Affiliated with the Ministry of Health, it consists of seven floors. The Obstetrics and Gynaecological department is situated on the fourth floor and consists of five rooms: two rooms for postoperative cases after C.S. and hysterectomy cases; and three rooms for follow-up cases before labor.

Benha University Hospital

Affiliated with the Ministry of Higher Education, consisted of three buildings; each building consisted of seven floors. The Obstetrics and Gynaecological department is on the sixth floor and has nine rooms, three of which are for C.S. cases, and the other nine are for follow-up cases before labor.

Sampling:

Sample type:

A convenient sample of a total of 100 maternity nurses who worked at the Obstetrics and Gynecological Department at Quisna General Hospital, Menoufia Governorate Health Insurance Hospital in Benha, and Benha University Hospital.

Calculation of sample size:

Data collection instruments:

Two instruments were used for data collection.

Instrument 1: self-administered interview questionnaire: this instrument consisted of two parts.

- **Part 1:** nurses' professional data such as age, educational level, educational qualifications, and years of experience.
- **Part 2:** Knowledge Assessment Questionnaire: It was used to assess

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maternity nurses regarding cardiac arrest during pregnancy and cardiopulmonary resuscitation.

Knowledge's scoring system:

The maternity nurses' knowledge was calculated for each item as follows:

Correct and complete answers took (2), the correct and incomplete answers took (1), and the incorrect answers took (0). The total score of knowledge was calculated as follows:

- Good knowledge > 75%
- Average knowledge of 50-75%
- Poor knowledge < 50%

Instrument 2: Maternity nurse performance observational checklist

It was adopted from Hui et al. (2011), Rodrigues et al. (2014), and Adams et al. (2016). It was concerned with assessing the maternity nurses' practice regarding cardiopulmonary resuscitation during pregnancy.

Performance scoring system:

- Each completed practice received a score of (2).
- Each one properly done received a score of (1).
- Each not-done practice received a score of (0).

The scores of items were summed up, and the total score was divided by the number of questions, giving the mean score. This score was converted into a percent score.

The total performance score was assigned as follows: satisfactory performance means >75% of the total performance score; unsatisfactory performance means less than 75% (Aziza et al., 2018).

Instrument validity

The instrument was developed by the researcher and was examined by a panel of five experts (three cardiologists and two professors of maternity nursing specialty) to determine whether the included items clearly and adequately cover the

domain of content addressed. The percentage of consensus among experts regarding the structured questionnaire was 94%, and the pre-post-test was 87%.

Instrument reliability

The test-retest was administered to the same sample of maternity nurses on two occasions and then compared the scores. The Cronbach's coefficient alpha was 879.

Pilot study:

A pilot study was implemented to test the applicability of the instruments, the feasibility of the study, and to estimate the time needed for data collection. It was performed on 10% of the total participants, which is 10 maternity nurses included in the study.

It was implemented to ascertain the simplicity, clarity, applicability, relevance, and content validity of instruments and to detect any problems peculiar to the statements, such as sequence and clarity, that might interfere with the process of data collection.

Ethical considerations:

Approaches to ensuring ethics were considered in the study regarding confidentiality. The researcher introduced herself to the participants in the study sample and explain to them what the study was about. She did this to get their permission to join the study and to get their help. The approval of the study was obtained from the Ethical and Research Committee of the Faculty of Nursing, Menoufia University. Written consent for approval to participate in the study was obtained from maternity nurses after explaining the purpose of the study. They were assured of the confidentiality and anonymity of the collected data. All maternity nurses were informed that participation in the study was voluntary, and they could

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withdraw from the study whenever they decided to do so. Each participant was free to ask any question about the study details.

Procedure:

The total study participants were 100 maternity nurses taken from the above-mentioned hospitals. Official permission to do the study was given by the directors of each setting after a letter from the Dean of the Faculty of Nursing explained the study's purpose, how it would help maternity nurses, and how data would be collected. At the beginning of the study, the researcher introduced herself and explained the purpose of the study to the maternity nurses. An interview was conducted with nurses who agreed to participate in the study. Maternity nurses were informed that the information collected during the study was kept confidential and used only for statistical purposes.

The researcher began to collect data from September 2021 to March 2022 for seven months, with two sessions every week (Saturday and Monday). The researcher visited the previously mentioned settings from 9:00 a.m. to 2:00 p.m. The researcher began to collect data related to the professional characteristics, knowledge, and practice of maternity nurses concerning cardiopulmonary resuscitation. The data obtained during the assessment phase constituted the baseline data to assess the maternity nurses' knowledge, and practice concerning CPR to determine the gaps and needs of nurses through an interview that ranged from 20-30 minutes.

Based on the results obtained during the assessment phase, simulation was developed according to the needs of maternity nurses. It was constructed to satisfy maternity nurses' knowledge deficit and to evaluate their practices

concerning CPR. The simulation design was revised by experts based on the recent related literature using computers to facilitate maternity nurses' understanding of CPR techniques.

The maternity nurses were divided into 6 groups; every group contained 15-17 nurses. There were three sessions in the first session. The first session was theoretical and was about knowledge about basic life support and how to deal with a mother that has stopped breathing or has had a cardiac arrest. The other two sessions were practical about how to do chest compressions, breathing techniques, endotracheal intubation, and DC shock. A knowledge score was assessed after the implementation using the same questionnaire for pre-test and post-test. But the performance was assessed through reapplication of the model and using an observational checklist. Follow-up was 3 months after the post-test.

Instructional sessions:

Session 1: an overview of cardiac arrest and CPR.

The researcher provided the maternity nurses with a definition of cardiac arrest, cardiopulmonary resuscitation, and the causes of cardiac arrest.

A. intellectual skills:

- a- interpret the causes of cardiac arrest
- b- interpret the steps of CPR

B. General and transferable skills:

Communicate effectively with maternity nurses to learn what CPR is and what cardiac arrest is and why it happens during pregnancy.

Session outlines:

- Definition of cardiac arrest
- Causes of cardiac arrest
- Definition of CPR
- Steps of CPR

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Teaching methods

- Lecture
- Group discussion

Teaching aids

- PowerPoint presentation
- A doll model for pregnant women

Session 2: overview of the management of cardiac arrest during pregnancy and nursing role, and definition of simulation, and the importance of simulation in nursing.

Session objectives:

The researcher provided the maternity nurses with information about how to manage cases of pregnant women that have a cardiac arrest, information about the nursing roles during CPR, and information about simulation.

A. Intellectual skills:

- a- The best way to manage cardiac arrest
- b- Analyse simulation and the importance of simulation in nursing

B. Professional and practical skills:

Show how to manage a case with a cardiac arrest that is pregnant.
Show how to use simulation in nursing

Session outlines:

- Management of cardiac arrest
- Definition of simulation
- Importance of simulation in nursing

Teaching methods:

- Lecture
- Group discussion

Teaching aids:

- PowerPoint presentation
- Doll model
- Session 3- overview of CPR steps and guidelines

Session objectives:

The researcher provided the maternity nurses with information about CPR steps and guidelines.

1- Intended learning outcomes (ILOS)

A. Knowledge and understanding skills:

- explain CPR
- identify CPR steps and guidelines

B. Intellectual skills:

- interpret the management of cardiac arrest and CPR
- analyze steps and guidelines of CPR

C. Professional and practical skills:

- Demonstrate how to apply CPR on pregnant women that have cardiac arrest
- general and transferable skills:
- Communicate effectively with maternity nurses to know the management of cardiac arrest and CPR

Session outlines:

- Cardiopulmonary resuscitation procedure
- Guidelines and steps of CPR
- The nursing role during CPR
- A complication of chest compressions

Teaching method:

- Lecture
- Group discussion
- Demonstration
- Redemonstration

Teaching aids:

- Power point presentation
- Explanatory videos about CPR
- Doll model

Evaluation phase:

The purpose of this phase was to assess the effectiveness of instructional CPR

This evaluation was conducted on the study participants twice:

- The first time (pre-test): before implementation of the statistical analysis.

Statistical analysis

Data were collected, tabulated, statistically analyzed using an IBM personal computer with Statistical Package of Social Science (SPSS) version 20 (SPSS, Inc, Chicago,

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Illinois, USA).where the following statistics was applied:

Results

The results are presented in the following parts:

- **Part one:** Socio-demographic data of the nurses in the sample
- **Part two:** Comparison between nurses' knowledge before and after simulation intervention
- **Part three:** Comparison between nurses' practice before and after simulation intervention
- **Part four:** Relationship between nurses' knowledge and practice after simulation intervention

Table (1) shows the social-demographic characteristics of the nurses in the sample. More than one-third of the sample (39%) had an age of fewer than 30 years old. Also, more than one-third of the sample either completed their secondary school or technical institute (36 % and 40 %, respectively). About one-half of the samples (45%) had more than 9 years of experience.

Table 2 shows the difference among pre-test, post-test, and follow-up knowledge of maternity nurses about simulation and its effect on CPR performance. There was a statistically significant improvement in the nurse's knowledge of all items of simulation and its effect on CPR performance ($p=0.000$ for all items). Regarding the definition of cardiopulmonary arrest, 63% of the nurses knew the correct definition in the pre-test; this percentage was increased to 96% in the post-test and to 100% in the follow-up. Regarding the most common cause of cardiopulmonary arrest during pregnancy, 32% of the nurses knew the most common cause of cardiopulmonary arrest during pregnancy in the pre-test; this percentage increased to 81% in the post-test and to 93% in the follow-up.

Regarding complications of cardiopulmonary arrest during pregnancy, 59% of the nurses knew about complications of cardiopulmonary arrest during pregnancy in the pre-test; this percentage was increased to 95% in the post-test and to 99% in the follow-up. Regarding the management of cardiopulmonary arrest during pregnancy, 56% of the nurses knew how to handle cardiopulmonary arrest during pregnancy in the pre-test; this percentage was increased to 97% in the post-test and to 100% in the follow-up. **Table 3** shows the difference among the pre-test, post-test, and follow-up of the knowledge of maternity nurses regarding cardiopulmonary resuscitation. There was a statistically significant improvement in the nurse's knowledge of all items regarding cardiopulmonary resuscitation during pregnancy ($p = 0.000$ for all items). Regarding the definition of CPR, 51% of the nurses knew the correct definition in the pre-test; this percentage was increased to 96% in the post-test and to 99% in the follow-up. Regarding the importance of CPR to pregnant women, 56% of the nurses knew the importance of CPR to pregnant women in the pre-test; this percentage was increased to 97% in the post-test and the follow-up. Only 19% correctly knew the general principles of CPR. This percentage was increased to 86% in the post-test and slightly decreased to 77% in the follow-up. More than one-half (56%) of the sample knew the indications for CPR. This percentage was increased to 97% in the post-test and to 98% in the follow-up. All the nurses in the sample correctly answered how to open the airway. This percentage was increased to 93% in the post-test and to 99% in the follow-up. Only 20% of the nurses in the sample correctly answered what

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site at which chest compressions start. This percentage was dramatically increased to 96% in the post-test and slightly dropped to 87% in the follow-up.

Table 4 shows the difference among pre-test, post-test, and follow-up of the knowledge of maternity nurses regarding simulation and its effect on their performance Related to CPR. There was a statistically significant improvement in the nurse's knowledge of all items regarding simulation and its effect on their performance related to CPR ($P = 0.000$). Regarding the definition of simulation, 40% correctly define simulation. This percentage dramatically increased to 90% in the post-test and slightly dropped to 86% in the follow-up. About two-thirds of the nurses in the sample correctly answered the importance of simulation. This percentage was increased to 98% in both the post-test and follow-up.

Figure 1 shows the difference among the pre-test, post-test, and follow-up of the categories of the total knowledge score of maternity nurses. There was a statistically significant difference

between pre-test, post-test, and follow-up of the categories of the total knowledge score of maternity nurses ($P = 0.000$). Only 14 percent of the nurses in the sample had a good pre-test knowledge, 92 % had a good post-test knowledge score while 96% had a good follow-up knowledge score.

Figure 2 shows the difference among the pre-test, post-test, and follow-up of the categories of the total practice score of maternity nurses. There was a significant difference between pre-test, post-test, and follow-up of the categories of the total practice. Only 14 % of the nurses in the sample had a good pre-test practice score, 61% had a good post-test practice score, and 37% had a good follow-up practice score.

Figure 3 shows the correlation between nurses' total knowledge and their practice score after simulation intervention. After the simulation intervention, there was a statistically significant positive correlation between the nurses' total knowledge score and their practice score after simulation intervention ($p = 0.0000$).

Part I: Social-Demographic Characteristics of the Nurses in the Sample

Table 1: Social-demographic Characteristics of the Nurses in the Sample N=100

Variables	Number	Percent
Age		
<30	39	39
3e0-39	27	27
40-50	26	26
Abov.50y	8	8
Education		
Secondary nursing education.	36	36
Technical nursing institute	40	40
Bachelor of nursing	24	24
Years of Experience		
1-3	26	26
4-8	29	29
<9	45	45
Residence		
Urban	41	41
Rural	59	59

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Part II: Difference among Nurses' Knowledge before and after Simulation Intervention

Table 2: Difference among pre-test, post-test, and follow-up knowledge of maternity nurses about simulation and its Effect on CPR performance

Item	Pre-test		Post-test		Follow-up		Chi square	P
	No.	%	No.	%	No.	%		
Definition of cardiopulmonary arrest								
Correct	62	62	96	96	100	100	42.743	0.000
Incorrect	38	38	4	4	0	0		
The most common cause of cardiopulmonary arrest during pregnancy							98.985	0.000
Correct	32	32	81	81	93	93		
Incorrect	68	68	19	19	7	7		
Complications of cardiopulmonary arrest during pregnancy							73.769	0.000
Correct	59	59	95	95	99	99		
Incorrect	41	41	5	5	1	1		
Management of cardiopulmonary arrest during pregnancy							91.521	0.000
Correct	56	56	97	97	100	100		
Incorrect	44	44	3	3	0	0		

Table 3: Difference among Maternity Nurses' Knowledge about Cardiopulmonary Resuscitation during Pregnancy Pre-test, Post-test, and Follow-up

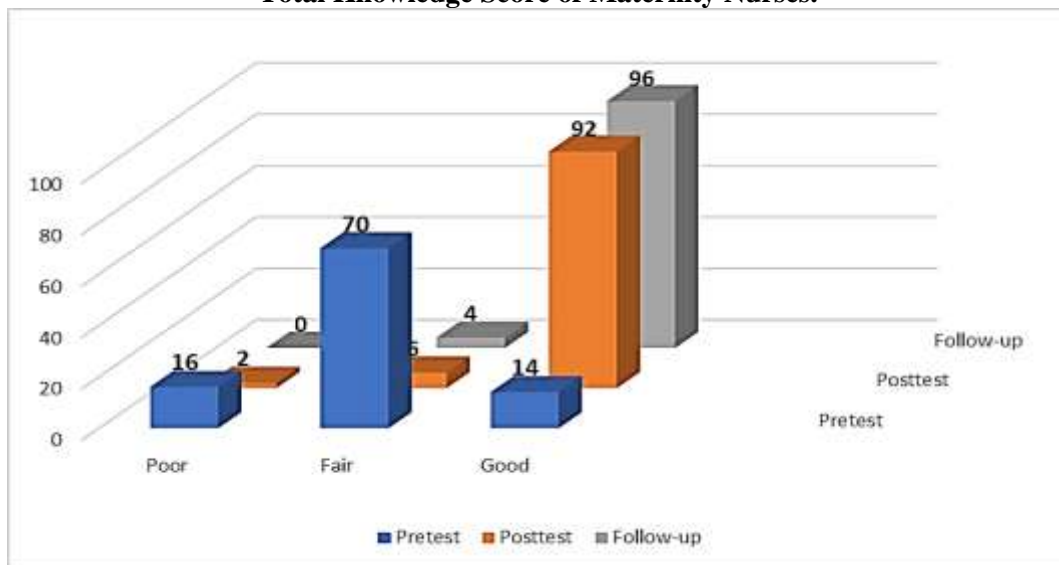
Items	Pre-test		Post-test		Follow-up		Chi-square	P
	No.	%	No.	%	No.	%		
Definition of CPR							98.184	0.000
Correct	51	51	96	96	99	99		
Incorrect	49	49	4	4	1	1		
Importance of CPR to pregnant women							77.192	0.000
Correct	58	58	97	97	97	97		
Incorrect	41	41	3	3	3	3		
General principles of CPR							106.053	0.000
Correct	19	19	86	86	72	72		
Incorrect	81	81	14	14	28	28		
Indications for CPR							82.888	0.000
Correct	56	56	97	97	98	98		
Incorrect	44	44	3	3	2	2		
Ways to open the airway							35.033	0.000
Correct	75	75	93	93	99	99		
Incorrect	25	25	7	7	1	1		
Depth of chest compression							79.996	0.000
Correct	48	48	93	93	96	96		
Incorrect	52	52	7	7	4	4		
Rate of chest compressions							123.746	0.000
Correct	35	35	92	92	95	95		
Incorrect	65	65	8	8	5	5		
Site at which chest compressions start							171.830	0.000
Correct	20	20	96	96	87	87		
Incorrect	80	80	4	4	13	13		
Complications of CPR							92.330	0.000
Correct	48	48	93	93	98	98		
Incorrect	52	52	7	7	2	2		
Drugs used during CPR during pregnancy							43.377	0.000
Correct	39	39	67	67	63	63		
Incorrect	70	70	33	33	37	37		

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Table 4: Difference among Pre-test, Post-test, and Follow-up Knowledge of Maternity Nurses about Simulation and its Effect on CPR Performance.

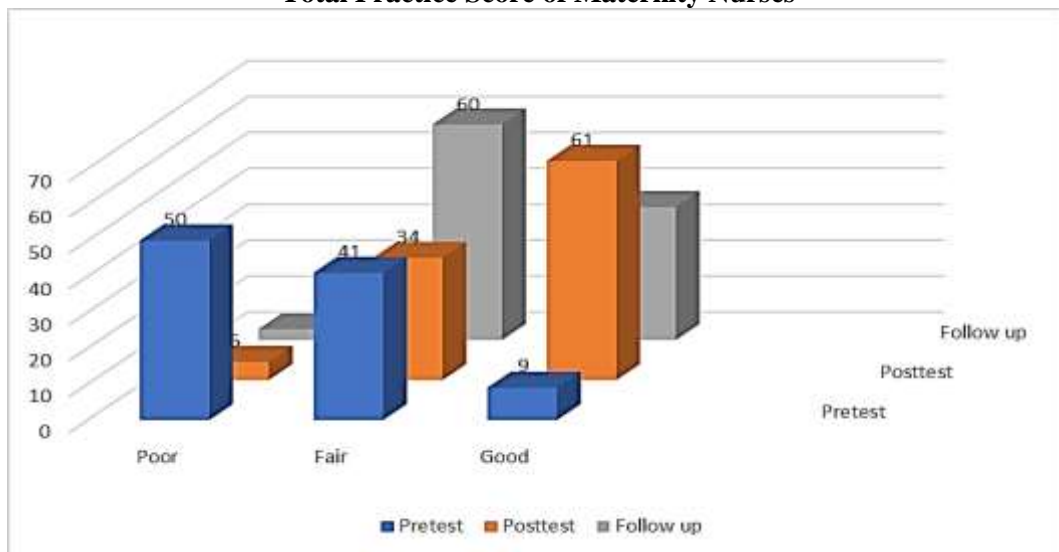
Items	Pre-test		Post-test		Follow-up		Chi square	P
	No.	%	No.	%	No.	%		
Definition of simulation								
Correct	40	40	90	90	86	86	78.689	0.000
Incorrect	60	60	10	10	14	14		
The importance of simulation in nursing								
Correct	64	64	98	98	98	98	67.017	0.000
Incorrect	36	36	2	2	2	2		

Figure 2: Difference among pre-test, post-test, and follow-up of the Categories of the Total Knowledge Score of Maternity Nurses.



Part III: Comparison between the nurses' practice before and after simulation intervention

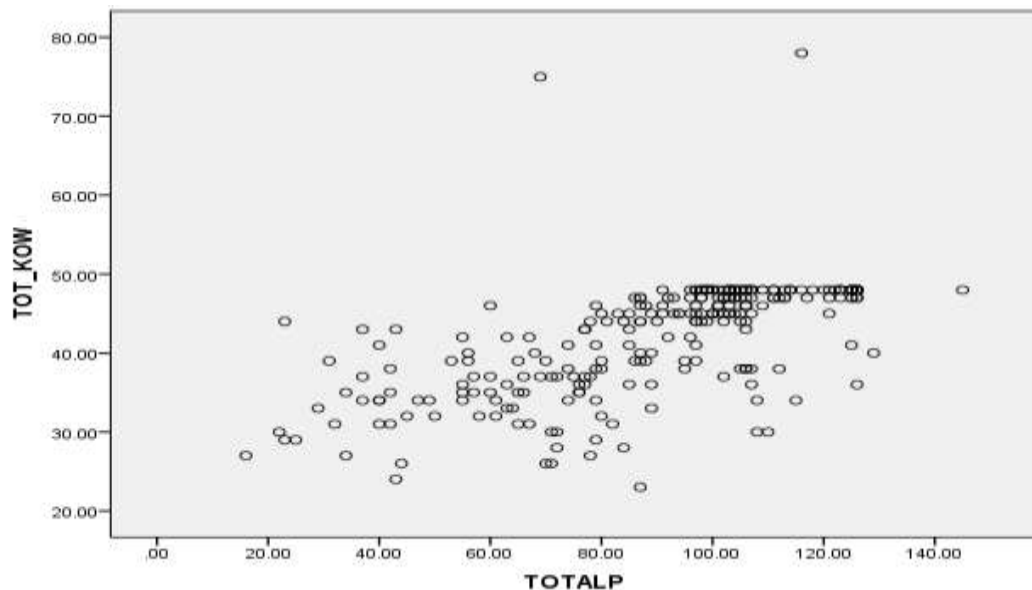
Figure 3: Difference among pre-test, post-test, and follow-up of the Categories of the Total Practice Score of Maternity Nurses



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**Part III: Correlation between nurses' knowledge and practice after simulation
intervention**

**Figure 4: Correlation between Nurses' Total Knowledge and Practice Score after
Simulation Intervention**



r

= 0.662

P = 0.000

Discussion

The findings of the current study successfully tested the research hypotheses. The findings are discussed in the following order: 1- Social demographic data of the nurses 2- Findings related to the nurses' knowledge before and after simulation intervention 3- Findings related to nurses' practice before and after simulation intervention 4- Relationship between nurses' knowledge and practice after simulation intervention.

Social-demographic characteristics

The current study showed that more than one-third of the sample had an average age of fewer than thirty years old; more than one-third of them had either completed their secondary school or technical institute, and about one-half of them had more than nine years of experience.

These findings were compatible with those of Samar Toubasi et al. (2015) who conducted their study about the impact of simulation training on

Jordanian nurses' performance of basic life support skills. The study was conducted in Jordanan, and it said that thirty registered nurses with an average of six points and one year of clinical experience took part in it.

The previous findings were also in agreement with Mohamed et al. (2018), who studied "Maternity Nurses' Performance Regarding Cardiopulmonary Resuscitation During Pregnancy: Simulation-Based Intervention" study in Egypt, and showed that the studied nurses' age ranged from twenty to fifty years, and about one-half of the studied maternity nurses had an age group ranged from twenty to twenty-five years, with years of experience ranging from five to nine with a mean of ten point five, and more than one-half of them had a secondary nursing education.

In addition, the findings of the current study showed that most of the nurses in the samples had previous CPR training

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as general as students or after graduation, while a few did not have previous CPR training. On the other hand, most of the study sample did not have previous training for pregnant women. In line with this finding, Nagashema et al. (2015) in a study to investigate nurses' knowledge and experience in cardiopulmonary resuscitation stated that most of the nurses were extremely interested in CPR, and most of them had received education and training in CPR as students or after graduation. Also, Mohamed et al. (2018) said that most nurses had not taken any classes on CPR during pregnancy before.

From the researcher's point of view, nurses are usually the primary witnesses to in-hospital sudden cardiac arrests. Training of maternity nurses has an impact on the efficiency and outcome of cardiopulmonary resuscitation (CPR) during pregnancy. Most maternity-study nurses didn't have any previous training regarding CPR during pregnancy, so most of them were willing to attend the training program.

Findings related to nurse's knowledge before and after simulation intervention

Concerning the knowledge of maternity nurses regarding simulation, definition, and causes of cardiopulmonary arrest during pregnancy at pre-test, post-test, and follow-up and its effect on their performance related to CPR. The current study revealed that there was a statistically significant improvement in the nurse's knowledge of all items of simulation and its effect on their performance related to CPR. Regarding the definition of cardiopulmonary arrest, about two-thirds of the nurses knew the correct definition in the pre-test. This percentage was increased to most of

them in the post-test and to all of them in the follow-up.

Regarding the most common cause of cardiopulmonary arrest during pregnancy, about one-third of the nurses knew the most common cause in the pretest. This percentage was increased to a majority in the post-test and to most of them in the follow-up. Regarding complications of cardiopulmonary arrest during pregnancy, more than one-half of the nurses knew the complications in the pre-test. This percentage was increased to most of them in the post-test and to all of them in the follow-up. Regarding the management of cardiopulmonary arrest during pregnancy, more than one-half of the nurses knew the correct management in the pre-test. This percentage was increased to most of them in the post-test and to all of them in the follow-up.

Concerning categories of the total knowledge score among maternity nurses at pre-test, post-test, and follow-up. There was a statistically significant difference between the pre-test, post-test, and follow-up regarding the categories of the total knowledge score of maternity nurses. Only a few percent of the nurses in the sample had a good knowledge score regarding cardiopulmonary arrest during pregnancy in the pre-test, compared to most of them having a good knowledge score in the post-test, while all had a good knowledge score in the follow-up.

The researcher's point of view, lower knowledge scores before simulation intervention, may be due to lack of implementation of educational training programs regarding cardiopulmonary resuscitation for pregnant women at the studied setting. Also, improvement in knowledge scores after intervention demonstrated the effectiveness of

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simulation intervention on the knowledge of maternity nurses.

These findings agree with Mohamed et al. (2018) who stated that the majority of the studied maternity nurses had an inadequate level of knowledge regarding all knowledge items concerning CPR during pregnancy at the pre-intervention phase, but there was a significant improvement in total knowledge scores immediately post-intervention. These findings are also agreed with Abd-Allah et al. (2017) in Egypt, who investigated the effect of educational programs on cardiopulmonary resuscitation on nursing students' performance. They mentioned that educational programs positively improved knowledge of the studied nursing students.

In addition, these findings were in line with Yoonshin et al. (2020), who conducted their studies about the effects of a simulation-based CPR training program on knowledge, performance, and stress in clinical nurses in Seoul, South Korea. Their findings showed that the simulation-based CPR training program significantly improved clinical nurses' CPR knowledge and skills and made them less stressed.

Findings related to nurses' practice before and after simulation intervention.

Regarding the comparison between pre-test, post-test, and follow-up of the categories of the total practice score of maternity nurses, there was a statistically significant difference between the pre-test, post-test, and follow-up of the categories of the total practice score of maternity nurses. Only a few percent of the nurses in the sample had a good practice score in the pre-test, while two-thirds of them had a good knowledge score in the post-test. The researcher's point of view, this lower nursing skill related to CPR

during pregnancy at pre-test might be due to the lack of emphasis on the nursing curriculum about CPR of pregnant women to the nursing student or insufficient CPR training program.

This result agreed with Sathianathan et al. (2018) in their study about "Effectiveness of Simulation-Based Teaching on Knowledge and Skill Regarding Cardiopulmonary Resuscitation of Pregnant Women among Nursing Personnel" in India and stated that the distribution of pre-test skill scores was lower than test skill scores.

A similar study conducted by Mohamed et al. (2018) found that most maternity nurses had unsatisfactory practise regarding the implementation of CPR during pregnancy during the pre-program phase, which was significantly increased immediately after the intervention.

Also, the previous findings were in line with Marie et al. (2021), who investigated "Effects of a Clinical Simulation Course about Basic Life Support on Undergraduate Nursing Students' Learning" and observed statistically significant differences in the total score on the pretest and after completing the BLS clinical simulation course. After taking the BLS clinical simulation course, the nursing students' average scores went up in a big way.

According to the findings of Onan et al. (2017) the review of simulation-enhanced, team-based cardiopulmonary resuscitation training for undergraduate students in Ankara, Turkey, the students who had prior knowledge of BLS obtained higher scores in both the pre-test and post-test. However, the increase in the mean score after completing the BLS clinical simulation course was significant in both men and women, like the findings of a previous study that measured the effect of a simulation-based

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educational intervention. The difference in the overall mean scores of the responses before and after the intervention was statistically significant.

Relationship between nurses' knowledge and practice after simulation intervention

The present study illustrated that there was a statistically significant positive relationship between nurses' total knowledge scores and nurses' total practice scores after simulation intervention. As the total knowledge scores increased, the total practice scores also increased. Based on the correlation between the total knowledge and practise scores of the maternity nurses who were studied, this may have something to do with the nurses' previous training, which improves their skills.

The previous results agreed with Mohamed et al. (2018), who showed that there were no statistically significant relations between nurses' practice and educational qualifications pre-intervention while there was a statistically significant difference at post-intervention. Also, regarding the relation between the total practice score and previous training, there was a highly statistically significant difference at post-intervention.

The current study aimed to evaluate the effectiveness of simulation in improving nursing knowledge and performance regarding CPR for pregnant women. The purpose was met by the findings of the current study, which showed that after the intervention, the study group scored higher knowledge, positive attitudes, and highly satisfactory practises than they did before the intervention.

Conclusion

Maternity nurses' performance had improved after simulation intervention as well.

Maternity nurses who received a simulation intervention regarding cardiopulmonary resuscitation obtained higher knowledge scores than those who did not. Only less than one fourth of the nurses in the sample received a good knowledge score on the pretest; more than three fourth received a good knowledge score on the post-test, and almost all of them received a good knowledge score on the follow-up. These findings succeeded in testing the first research hypothesis.

Maternity nurses who received a simulation intervention regarding cardiopulmonary resuscitation achieved a higher performance level than those who did not. Only less than one fourth of the nurses in the sample received a good practise score on the pretest; more than half received a good practice score on the posttest, and less than half received a good practise score on the follow-up. These findings succeeded in testing the second research hypothesis. This means that the current study findings succeeded in testing the study hypotheses.

Recommendations

Based on the current study findings, the following can be recommended:

- ❖ Simulation-based training regarding cardiopulmonary resuscitation should be provided for all obstetrics healthcare providers.
- ❖ Systematic training courses are an excellent choice to improve nursing knowledge and performance regarding CPR during pregnancy.

Further research

- ❖ Further research is needed to assess the long-term effects of simulation-based teaching.
- ❖ Several studies can be done to find out the nursing staff's level of satisfaction, attitude, critical thinking, ability to make decisions,

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and self-confidence when it comes to CPR simulation during pregnancy.

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