Training Program Effectiveness on Knowledge and Interpretation Skills of Fetal Cardiotocography among Undergraduate Nursing Students

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Abstract

Fetal cardiotocography is a type of electronic fetal monitoring used to evaluate the health of the foetus and find any alterations that put the fetus at risk. **Aim:** to evaluate the effect of training program on knowledge and interpretation skills of fetal cardiotocography among undergraduate nursing students **Research methods:** A quasi-experimental design was employed. **Setting:** The study was carried out at the Nursing Faculty of Minia University in Egypt. **Sample:** Two hundred and ninety-seven (297) students with odd numbers who enrolled in the second semester and studying obstetrics & gynaecology nursing course during the academic year 2021–2022 were selected by a systematic random sampling procedure from the total number of five hundred and ninety-five (595) students. **Tools:** Three tools were utilized for data collection, tool 1, socio-demographic data, tool II, knowledge about fetal cardiotocography, tool III, interpretation skills regarding cardiotocography. **Results:** Mean score of total knowledge of students was 19.41 ± 1.535 in pre-test, increased to 24.27 ± 2.263 in post-test with statistically significant differences (p-value =.0001). Additionally, the mean score of interpretation skills of fetal trace was 25.92 ± 2.81 in pertest, increased to 38.18 ± 5.52 in post-test with statistically significant differences (p-value =.0001). Also, there was a strong positive correlation between student's knowledge and their interpretation skills in post-test with statistically significant differences (p-value .003). **Conclusion:** There were statistically significant differences in knowledge and interpretation skills in pre-test and post-test which indicate a positive effect of the training program among undergraduate nursing students. **Recommendations:** Providing continuous training programs concerning fetal cardiotocography not only for nursing students but also for staff nurses in maternity hospitals which result in the improvement of the quality of maternal and new-born care.

Keywords: Fetal Cardiotocography (CTG), Interpretation Skills, Knowledge, Training Program.

Introduction

Preventable birth-related issues can cause catastrophic consequences for mothers, newborns, and their families, as well as lead to significant healthcare expenses. Cardiotocography (CTG), a commonly used method for monitoring fetal health during labor, can also pose a risk for harm in maternity care if not properly interpreted **(Kelly et al., 2021)**.

Nurses and doctors responsible for interpreting CTG tracings during the intrapartum period must possess the necessary knowledge and skills to identify any alterations that could endanger the fetus. Incorrect interpretation of CTG readings can result in delayed preventive care measures and jeopardize the well-being of the unborn child **(Hébert, 2022)**.

Cardiotocography is a method of fetal monitoring that records the fetal heart rate and uterine contractions using transducers attached to the mother's abdomen and fundus, respectively. The primary objective of fetal heart rate recording by CTG is to identify any changes that could pose a risk to the fetus. This method reduces the incidence of neonatal seizures, long-term neurological issues, and intrapartum fetal death **(Zaghir et al., 2022)**.

The Contraction Stress Test (CST) is carried out when uterine contractions are present, as opposed to the Non-Stress Test (NST), which measures the fetal heart rate response to fetal movements for at least 20 minutes. Both tests, which are based on CTG recordings, call for meticulous interpretation in compliance with global standards **(ERDOĞAN et al., 2022)**.

Fetal heart rate typically ranges between 120 and 160 beats per minute. The tracing's variability is a reassuring indication that the fetal nervous system is operating normally. Reduced variability can be brought on by acidosis, fetal hypoxemia, or specific drugs. When the fetus is dozing off, variability may momentarily decline. Variability that is absent or cannot be recognized is seen as unsettling **(Ibrahim & Arief, 2019)**.

A temporary increase in the fetal heart rate by at least 15 beats per minute over the baseline lasting for a minimum of 15 seconds is referred to as acceleration. On the other hand, when the Fetal heart rate drops below the baseline by at least 15 beats per minute and lasts for at least 15 seconds, it is called deceleration **(Silvestri, L. & Silvestri, A., 2019)**.

Fetal bradycardia, tachycardia, and heart rate all have predictable patterns. Bradycardia happens when the fetal heart rate drops below 110 beats per minute for 10 minutes or more, whereas tachycardia happens when the fetal heart rate increases beyond 160 beats per minute for 10 minutes or more (**Kamala et al., 2018**).

The identification and interpretation of fetal monitoring patterns is a key job for nurses. The baseline heart rate, baseline variability, the presence of accelerations, the presence or absence of decelerations, and the features of varied decelerations if present are the four parameters used to assess the CTG trace. The National Institute for Health and Care Excellence (NICE) suggests classifying each attribute as "reassuring," "non-reassuring," or "abnormal." There are four different categories for the CTG trace: "normal," "suspicious," "pathological," and in need of urgent intervention **(Lamé et al., 2019)**.

In the fetal cardiography unit, nurses play an essential role in fetal heart rate monitoring, which includes repositioning the patient in the lateral position to increase uteroplacental perfusion or relieve cord compression and head compression, administering oxygen as ordered, reporting findings to the healthcare provider, notifying the physician of any problems, and initiating corrective and supportive measures when necessary **(Blix et al., 2019) & (Smith et al., 2019)**.

To reduce fetal death, nurses must be qualified to interpret CTG tracings properly and promptly. A lack of knowledge can make both the nurse and the patient more anxious. Although numerous CTG educational programs are available internationally, few have been established in Egypt to provide maternity nurses with the necessary skills for CTG interpretation **(Wisner & Holschuh, 2018)**.

Significance of the study:

Each year, approximately 2.4 million newborns pass away, with nearly one-third of them dying within the first 24 hours of birth as a result of complications related to childbirth, such as birth asphyxia or a lack of breathing. Additionally, there are about 2 million stillborn births reported annually, as per the World Health Organization's report from 2021, These deaths can largely be prevented through the implementation of well-known, evidence-based interventions **(World Health Organization report, 2021).** Improving neonatal health, one of the unfinished agendas of the Millennium Development Goals, remains a high priority area in the era of the Sustainable Development Goals **(Heidkamp et al., 2021)**.

The study provides insights into the effectiveness of training programs in enhancing the understanding of CTG and its interpretation. The findings of the study can guide nursing educators in developing effective training programs that can improve the skills and knowledge of nursing students. The goal of the research is to enhance nursing students' understanding and ability to interpret fetal traces as well as to determine the effectiveness of educational programs on their knowledge and skills. This can ultimately lead to better patient outcomes, reduced complications, and improved maternal and neonatal health.

There are a few studies that try to analyze knowledge and interpretive skills among maternity nursing students as a healthcare provider regarding fetal CTG. Therefore, there is a need to expand on the information on fetal trace knowledge and interpretive abilities. So, we undertook this study among undergraduate nursing students to improve their knowledge, skills, and effective management of intrapartum CTG particularly regarding the application and interpretation of the cardiotocograph.

Aim of the study:

This study aimed to evaluate the effect of training program on knowledge and interpretation skills of fetal cardiotocography among undergraduate nursing students.

Research Hypothesis

H1. Student's total score of Knowledge will be increased after implementing the training program.

H2. Student's satisfactory level of interpretation skills will be improved after implementing the training program.

H3. There is a positive correlation between knowledge and interpretation skills among undergraduate nursing students in posttest after implementation of training program.

Subject and Methods:

Research Design:

The present study was used a quasi-experimental approach (one group pre and posttest design), which is appropriate for the nature of existing research problems. The researchers' applied a pre and posttest to investigate change in knowledge and interpretation skills of fetal cardiotocography among undergraduate nursing students. The scores were measured before and again after the training program, then the difference between pretest and posttest scores were compared.

Setting:

This study was conducted in the classrooms and laboratories of the department of Obstetrics and Gynecology Nursing, Faculty of Nursing, Minia University, Egypt. Our laboratories include three rooms used for clinical skills, and procedural training; and one simulated room (labor simulation). Furthermore, our labs are equipped with several obstetrics and gynecology manikins, and fetal cardiotocography device, which helped us a lot in training the students on interpretation skills related to CTG. In addition, students learn through a variety of educational formats, including: role play, staff demonstrations and students redemonstration, so that students can be examined following each clinical session.

Sample: Probability systematic sampling was utilized in the present study. The total number of third year's undergraduate nursing students was five hundred and ninety-five (595), who enrolled in the second semester and studying obstetrics & gynecology nursing course for the academic year 2021- 2022 at Faculty of Nursing - Minia University. The selected starting point for sampling was student number one in the student list followed by the odd numbers to the end of the students list, therefor, two hundred and ninety-seven (297) students with odd numbers were recruited to conduct this research from the previous mentioned setting (168 female students & 129 male students).

Study Tools:

Three tools were utilized in the current study to collect data. The tools were created by the researchers after reviewing related literature and tested by five expert professors in medical and nursing obstetric field to test the validity of the questionnaire before using it.

I. The 1st Tool: It is an English language structured online questionnaire (Google Form) developed by the researchers. It consisted of personal characteristics that included (age, gender, marital status, residence, previous educational certification, and telephone no).

II. The 2nd Tool: Knowledge Assessment tool (pre/posttest):

It is an English language structured online questionnaire (Google Form) developed by the researchers to assess student's knowledge about fetal cardiotocography: it included 30 theoretical MCQ to assess nursing students' knowledge about Fetal Cardiotocography like (previous training courses on fetal cardiotocography, concepts of (electronic fetal monitoring, cardiotocograph, baseline rate of the fetal heart, fetal tachycardia, fetal bradycardia, baseline variability, acceleration) methods of electronic fetal monitoring, and causes of (fetal tachycardia, deceleration, and fetal bradycardia).

Scoring system:

Calculated scores were assigned to the students' knowledge-related answers. The model key answer sheet that the researchers had previously created is used to evaluate the students' responses in accordance with the answers. Each correct response received a score of "one," while

every incorrect response received a score of "zero." The scores of the items for each area of knowledge were added up, and the total was divided by the number of items, yielding a mean score for each area. The total items of knowledge were 30 items given 30 scores. Classification system for the knowledge level was adapted and modified from previous study **(Quarshie, H., E. et al., 2022)** to be: high knowledge was defined as 80% or higher (grades 24 and above), while average knowledge was defined as 60% to 79% (18 to 23 grades), low knowledge as 40% to 59% (12 to 17 grades), and very low knowledge as 40% or less (grades below 12).

III. The Third Tool: Fetal trace interpretation skills it included Fetal Cardiotocography (pre/post) quiz pictures. The researchers created an online English language test to evaluate students' fetal trace interpretation skills. There were multiple-choice questions in it. It was made up of 7 photos of traces, and each trace contained 7 questions intended to assess the respondent's understanding of it. The seven traces described as pictures each contain questions about the type of trace, what is the baseline of the FHR, describe the variability, are there accelerations, decelerations, contractions, and are this FHR reassuring. This means that the students had requested to answer 49 questions about interpretations of traces regarding fetal cardiotocography.

Scoring system:

Each accurate response received a score of one, while each wrong response received a score of zero. The scores of the items were added up for each area of fetal trace interpretation, and the total was divided by the number of items, yielding a mean score for each region. There were 49 total items for the interpretation of the fetal trace, with 49 scores. A percentage score was created from these scores. A successful interpretation of the fetal trace was considered satisfactory if the percent score was greater than 60% (28 grades), as opposed to an unsatisfactory interpretation scoring less than 60% (28 grades).

Validity: The instruments were revised for accuracy, relevance, inclusion, understanding, applicability, and simplicity by five-person panel professors of specialists from the department of obstetrics and gynaecology nursing and medical academics.

Reliability: The Alpha Cronbach test was used to gauge how the instruments' internal consistency was maintained. The tools were determined to be dependable because the score on the knowledge test was 0.860and the fetal trace interpretation skills score was 0.89.

Pilot study:

Ten percent (10 %) of the total sample of 30 students were used for the pilot study. It was conducted to evaluate the instruments' applicability and clarity, the viability of fieldwork, and any potential challenges the researcher would face that might obstruct the gathering of data. There were no changes made. The trial sample was included in the basic sample.

Ethical Consideration:

A formal written consent letter detailing the aim of the current research was acquired from the Dean of the faculty, the vice dean of research and postgraduate studies, the director of the department of woman health and obstetrics nursing and Ethical committee of the faculty. The relevance and goals of this study were discussed with the participants, and written consent from every student was also obtained. All participants were informed that the information they provided was voluntary, that they may withdraw at any moment, that data confidentiality had been achieved, and that the information would only be used for the current study.

Procedure:

The study was conducted in three phases: the assessment phase (pre-test), the actual training program (implementation phase), and the evaluation phase (post-test).

1. Assessment phase (pre-test)

The initial meeting between the researchers and the students took place during the students' free time, and it was used to quickly explain the purpose and goals of the study. They have been informed that their participation is optional and that they have the choice to stop at any moment. Almost all of them gave their written consent. Following their consent to participate in the study, a group was made on WhatsApp for easily sending a structured questionnaire through a Google Form, in order to gather information about their personal characteristics and gauge their background knowledge of fetal

cardiotocography and their skills and ability to interpret fetal traces. The questionnaire took between 30 and 40 min.

2- Implementation phase

The students were sorted into 20 groups after the pretests were collected, with the exception of the final three groups, which each had 14 students. Based on their free time and an agreed-upon date, each group of students received two educational sessions during the implementation phase. The topics of the instructional session were explained to the students at the beginning. The 1st session focused on the theoretical information related to fetal cardiotocography, such as concepts of (electronic fetal monitoring, cardiotocograph, baseline rate of the fetal heart, fetal tachycardia, fetal bradycardia, baseline variability, acceleration), methods of electronic fetal monitoring, causes of (fetal tachycardia, deceleration, and fetal bradycardia), and the 2nd session focused on fetal CTG interpretation skills with the help of power point presentation, illustrated videos and pictures for more clarification on how to interpret the fetal trace and detect any abnormalities. Each session lasted between thirty and forty minutes and featured numerous illustrations to instruct the students on how to understand and interpret the fetal CTG.

3. Evaluation phase (post-test):

Evaluation phase was conducted after one month from the implementation of educational program using the same structures questionnaire used in assessment phase, also it collected online through a Google Form via WhatsApp.

Statistical analysis

The collected data was computerized, tabulated, analyzed, and summarized by using statistical tests such as paired sample t-test and a Chi-square to test research hypotheses by using SPSS version 22. The level of significance was accepted at P value <0.05 and was considered highly significant when P-value less than or equal 0.01.

Results:

Table 1, reveals personal characteristics of participants, it demonstrates that mean age of them were $21.03 \pm .678$ years, 56.6% of them were females,97.3% were single, 82.5% of them have secondary school certification, also 81.5 %

of them were doesn't have previous training courses on Fetal cardiotocography.

Table 2, illustrates distribution of participants according to their knowledge about Fetal cardiotocography related concepts, it reveals that percentage of right responses regarding Fetal cardiotocography related definitions/concepts is increased in posttest than in pretest with statistically significant differences (p-value =.0001).

Figure 1, illustrates distribution of participants according to their responses about indication of Fetal cardiotocography, it reveals that percentage of correct answers in posttest was higher than in pretest (68.7% Vs 36.4% respectively) with statistically significant differences (p-value =.002).

Figure 2, illustrates distribution of participants according to their responses about causes of Fetal tachycardia, it reveals that percentage of correct answers in posttest was higher than in pretest (79.2% Vs 30.3% respectively) with statistically significant differences (p-value =.0001).

Figure 3, illustrates distribution of participants according to their responses about causes of Fetal bradycardia, it reveals that percentage of correct answers in posttest was higher than in pretest (63.3% Vs 22.9% respectively) with highly statistically significant differences (p-value =.001).

Figure 4, illustrates distribution of participants according to their responses about signs of non-reassuring variable decelerations that indicate hypoxemia, it reveals that percentage of correct answers in posttest was higher than in pretest (72.7% Vs 39.7% respectively) with statistically significant differences (p-value =.0001).

Figure 5, illustrates distribution of participants according to their responses about nursing care for pregnant woman who uses Fetal cardiotocography, it reveals that percentage of correct answers in posttest was higher than in pretest (74.5% Vs 18.2% respectively) with statistically significant differences (p-value =.0001).

Table 3, shows percentage distribution of participants according to their correct interpretation skills of Fetal trace in pretest and posttest, it reveals that percentage of students who correctly interpreted Fetal trace pictures was high in posttest than in pretest, also there was

statistically significant differences between mean score of interpretation skills related to each picture in pretest and posttest (p_ value = 0.0001).

Table 4: revealed that 40.4% of participants had low knowledge level about Fetal cardiotocography in pretest reduced to 18.8% of them in posttest, also frequencies of participants who had high level of knowledge about Fetal cardiotocography were higher in posttest than in pretest (21.2% vs 65.7% respectively). The mean total knowledge score of students was 19.41 ± 1.535 in pretest, increased to 24.27 ± 2.263 in posttest with statistically significant differences (p-value =.0001). Additionally, only 20.5% of students had satisfactory level of Fetal trace interpretation skills in pretest increased to 73.1% of them in posttest with statistically significant differences (p-value =.0001). Mean score of interpretation skills of Fetal trace was 25.92 ± 2.81 in pretest, increased to 38.18 ± 5.52 in posttest with statistically significant differences (p-value =.0001).

Table 5, illustrates relation between participants level of knowledge about fetal cardiotocography and their personal characteristics in pretest and posttest, it shows that there was statistically significant relation between participant's total knowledge about Fetal cardiotocography and their sex, residence and previous training courses on Fetal cardiotocography in both pretest and posttest where P-value were 0.03, 0.003 and 0.004 respectively in pretest and 0.040, 0.009 and 0.002 respectively in posttest.

Table 6, reveals relation between participants level of interpretation skills of Fetal trace and their personal data in pretest and posttest, it shows that there was statistically significant relation between participant's total interpretation skills level of Fetal trace and their age, residence and previous training courses on Fetal cardiotocography in both pretest and posttest where P-value were 0.05, 0.002 and 0.002 respectively in pretest and 0.04, 0.008 and 0.001 respectively in posttest.

Table 7, shows that there was no correlation between participant's knowledge about Fetal cardiotocography and their interpretation skills of Fetal trace in pretest where r_ value was .074. Furthermore, there were positive correlations between participant's knowledge about Fetal cardiotocography and their interpretation skills of Fetal trace in posttest where r_ value was .859 with statistically significant differences where p_ value was .003.

Table 1: Personal characteristics of participants (n = 297).

Personal characteristics of participants	No.	%
Age (Years)		
19	1	0.3
20	58	19.5
21	170	57.3
22	66	22.2
23	2	0.7
Mean ± SD	21.03 ± .678 years	
Sex		
Male	129	43.4
Female	168	56.6
Marital Status		
Single	289	97.3
Married	8	2.7
Residence		
Urban	125	42.1
Rural	172	57.9
Previous educational certification		
Secondary school	245	82.5
Secondary nursing school	24	8.1
Nursing institute	28	9.4
Previous training courses on Fetal cardiotocography		
Yes	55	18.5
No	242	81.5

Table (2): Distribution of participants according to their knowledge about Fetal cardiotocography related definitions/concepts (n = 297).

| Knowledge about Fetal cardiography related definitions/concepts includes: | Pre- test | | Post-test | | P-value |
| | % | | % | | |
	Correct	Incorrect	Correct	Incorrect	
Electronic Fetal Monitoring (EFM)	36.4	63.6	83.4	16.6	
Cardiotocograph	25.3	74.7	79.9	20.1	
Baseline Fetal Heart Rate	58.2	39.1	81.7	18.3	
Fetal Tachycardia	48.8	51.2	72.7	27.3	
Fetal bradycardia	29.0	71.0	74.2	25.8	0.001**
Baseline variability	32.8	67.2	76.6	23.4	
Acceleration	26.9	73.1	58.4	41.6	
Deceleration	35.4	64.6	64.6	35.4	
Early deceleration	41.5	58.5	60.6	39.4	
Late deceleration.	43.8	56.2	70.4	29.6	
Variable deceleration	21.2	78.8	63.2	36.8	
Prolonged deceleration.	36.4	63.6	61.8	38.2	
Sinusoidal pattern.	17.8	82.2	69.6	30.4	
Mean ± SD	8.31 ± 0.928		10.24 ± 0.32		

** Statistically significant at P – value ≤ .01
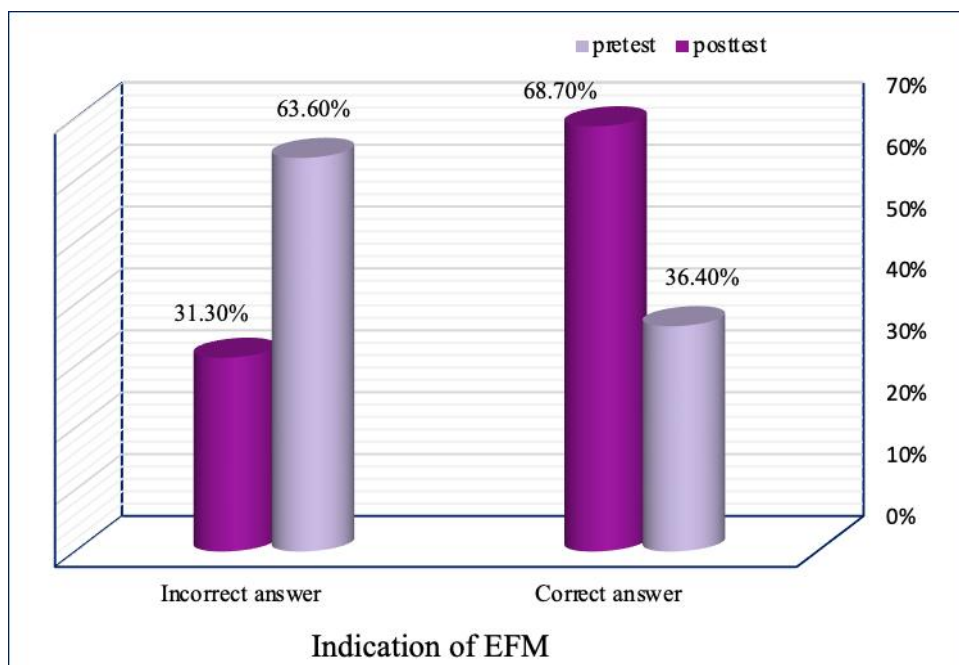
Figure 1, Distribution of participants according to their responses about indication of Fetal cardiotocography (n=297**)**
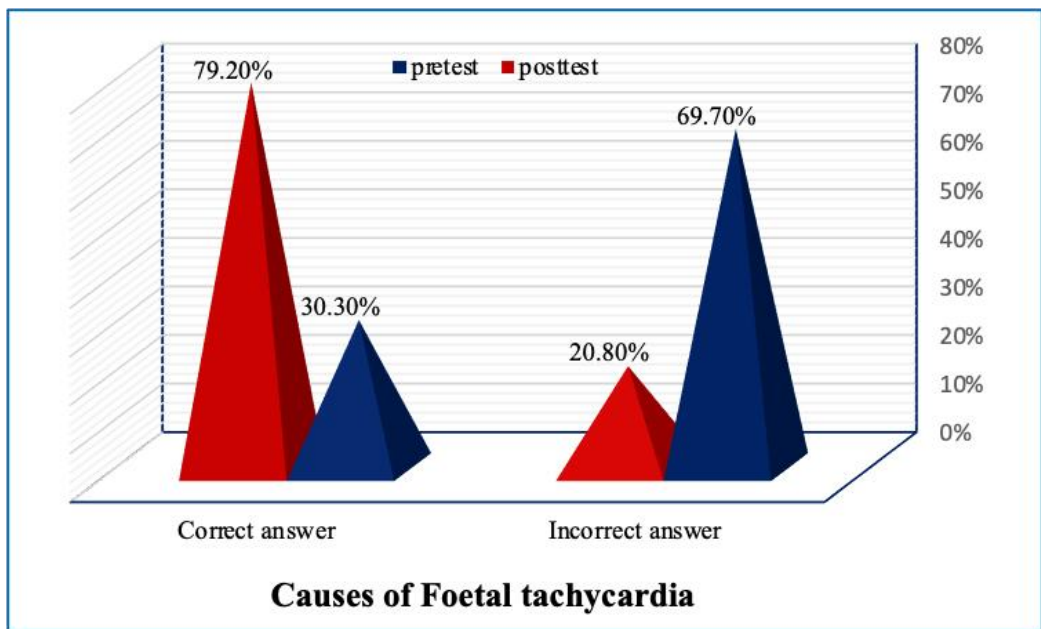
Figure 2, Distribution of participants according to their responses about causes
of Fetal tachycardia (n=297)

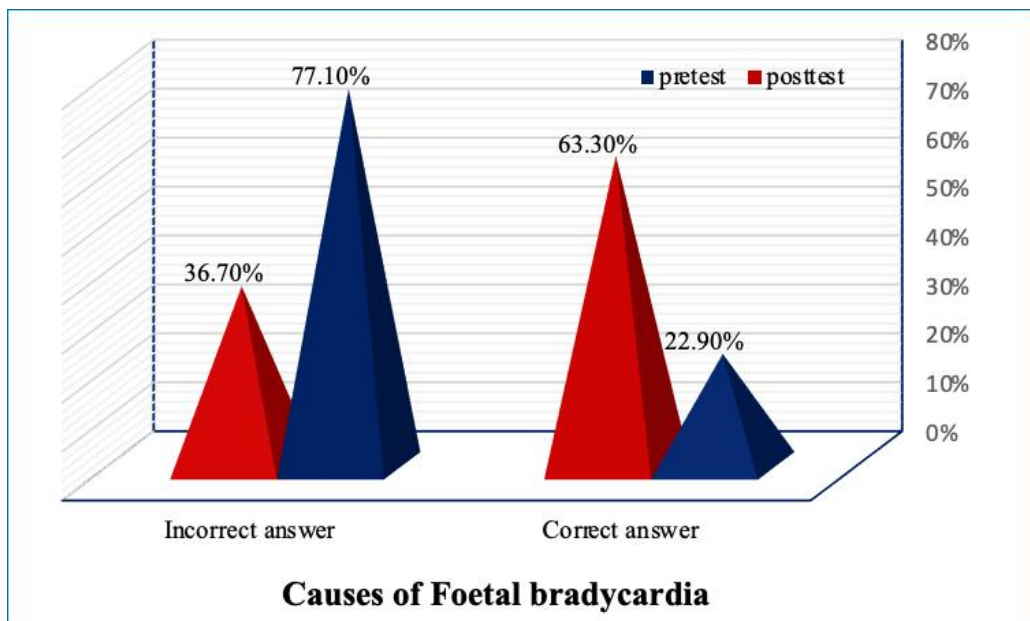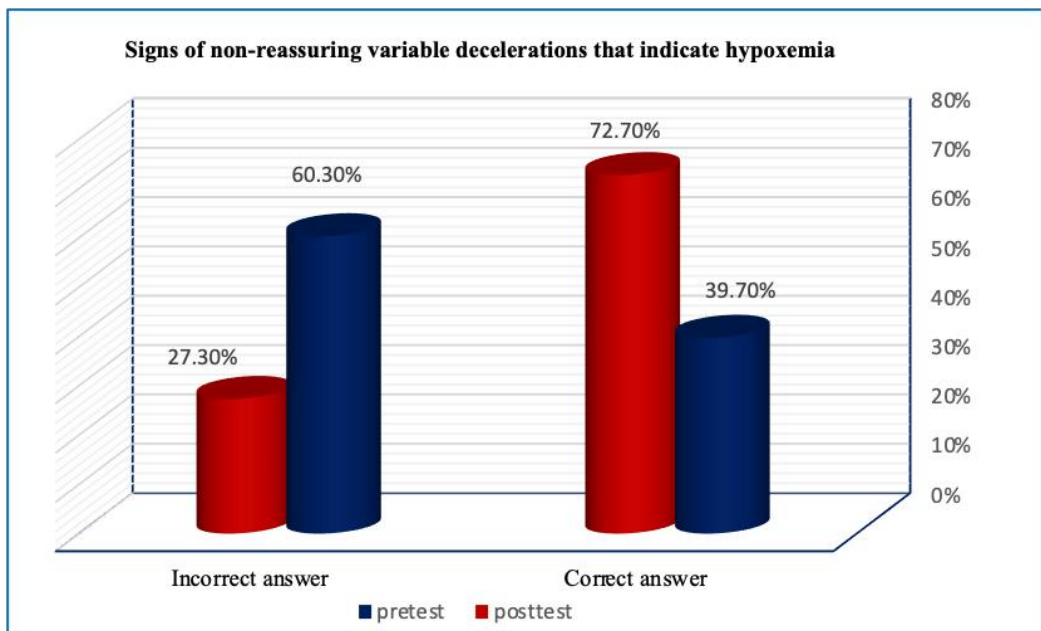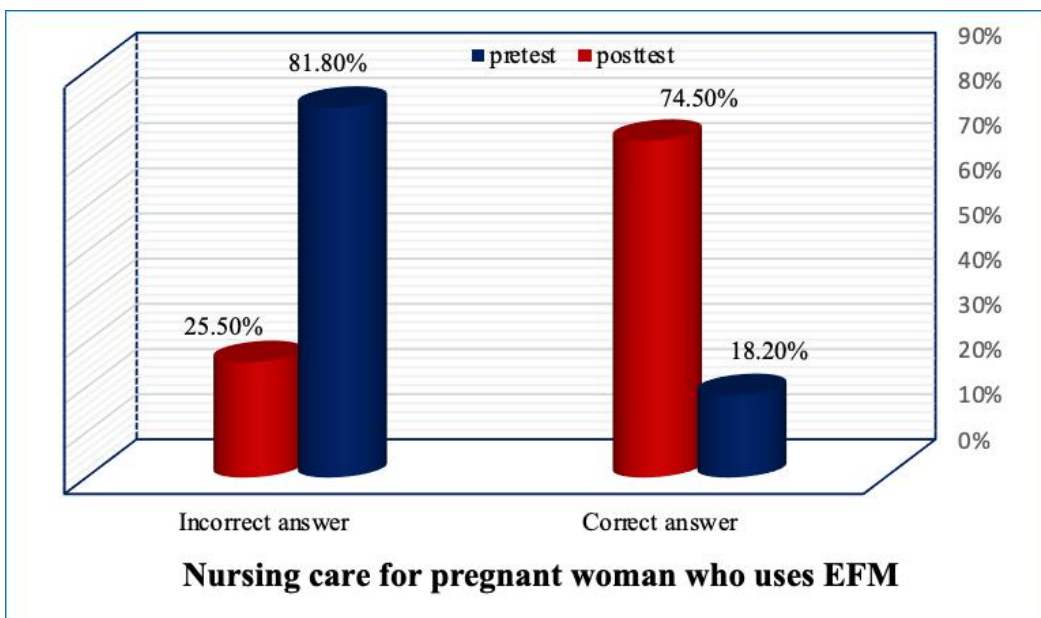**Figure 3,** Percentages of participants responses about causes of Fetal bradycardia (n=297)

Figure 4, Distribution of participants according to their responses about signs of non-reassuring variable decelerations that indicate hypoxemia (n=297)

Figure 5, Distribution of participants according to their responses about nursing care for pregnant woman who uses Fetal cardiotocography (n=297)

Table 3: Percentage distribution of participants according to their correct interpretation skills of Fetal trace in pretest and posttest, (n = 297).

Pictures	Percentage (%) of correct interpretation skills							Mean ± SD	P_ value
	Q1		Q3	Q4	Q5	Q6	Q7		
Chart (1)									
Pretest	34.3	13.5	36.7	26.7	24.3	33.2	14.7	2.16 ±1.25	.0001**
Posttest	89.7	73.8	88.2	69.9	63.2	68.8	59.9	4.92± 1.26	
Chart (2)									
Pretest	19.5	20.5	17.5	27.2	29.3	36.7	31.0	2.40±1.227	.0001**
Posttest	54.9	86.4	69.5	78.9	79.5	84.6	85.4	5.1± 1.257	
Chart (3)									
Pretest	44.1	15.5	35.0	38.7	16.5	25.9	43.1	2.28 ±1.287	.0001**
Posttest	76.3	70.8	59.9	83.9	74.1	81.2	77.8	4.99± 1.301	
Chart (4)									
Pretest	32.7	40.1	39.7	43.2	29.0	24.9	48.1	3.02 ±1.332	.0001**
Posttest	69.2	88.6	89.6	76.5	68.6	77.7	88.1	6.02 ±0.998	
Chart (5)									
Pretest	41.0	16.2	36.7	19.7	25.6	18.7	42.8	2.60 ±1.294	.0001**
Posttest	83.5	64.8	63.7	59.8	66.4	75.2	91.3	5.21 ±.978	
Chart (6)									
Pretest	40.7	18.5	22.5	42.1	27.3	45.5	17.3	2.73 ± 1.289	.0001**
Posttest	89.4	77.7	67.5	88.6	82.6	77.8	72.1	4.85 ±1.046	
Chart (7)									
Pretest	17.5	36.0	26.4	29.3	39.7	18.7	41.0	3.30 ±1.704	.0001**
Posttest	59.4	66.8	76.5	85.7	80.8	77.2	69.8	5.78 ± 1.271	

Q: Question

** Statistically significant at P – value ≤ .01.

Table 4: Total level of participants knowledge about Fetal cardiotocography and interpretation of Fetal trace in pretest and posttest (n= 297)

Total score of:	Pretest		Posttest		t	P- Value
	No	%	No	%		
Knowledge level about Fetal cardiotocography.						
Very low < 40%)	22	7.4	11	3.7		
Low (40-59%)	120	40.4	56	18.8		
Average (60- 79%)	92	31.0	35	11.8	40.946	0.0001 **
High ≥ (80%)	63	21.2	195	65.7		
Mean ± SD	19.41± 1.535		24.27± 2.263			
Interpretation skills of Fetal trace						
Unsatisfactory < (60%)	236	79.5	80	26.9		
Satisfactory ≥ (60%)	61	20.5	217	73.1	13.929	0.0001**
Mean ± SD	25.92 ± 2.81		38.18 ± 5.52			

Test used: paired sample T test.   * Statistically significant at P – value ≤ .05

** Statistically significant at P – value ≤ .01

Table 5: Relation between participants level of knowledge about Fetal cardiotocography and their personal characteristics in pretest and posttest, (n = 297).

Personal characteristics of participants	Pretest				Posttest			
	Very low (n = 22)	Low (n = 120)	Average (n= 92)	High (n = 63)	Very low (n = 11)	Low (n = 56)	Average (n= 35)	High (n = 195)
Age/year								
19	1	0	0	0	0	0	0	1
20	6	27	11	14	3	9	4	42
21	13	64	57	36	6	32	22	110
22	3	29	22	12	2	15	9	40
23	0	0	2	0	0	0	0	2
X 2 (P – value)	22.797 (.089) NS				6.234 (.976) NS			
Sex								
Male	15	48	42	24	6	24	11	88
Female	7	72	50	39	5	32	24	107
X 2 (P – value)	**8.175 (.03) ***				**10.891(.040)***			
Residencey								
Urban	11	45	35	34	6	22	14	83
Rural	11	75	57	29	5	34	21	112
X 2 (P – value)	**13.576 (.003) ** **				**12.968 (.009) ****			
Marital Status								
Single	0	116	90	61	10	54	34	191
Married	22	4	2	2	1	2	1	4
X 2 (P – value)	.947 (.814) NS				2.193 (.533) NS			
Previous educational certification								
Secondary school	20	100	72	53	9	42	27	167
Secondary nursing school	1	6	11	6	1	6	4	13
Nursing institute	1	14	9	4	1	8	4	15
X 2 (P – value)	5.881(.437) NS				4.375 (.626) NS			
Previous training courses on Fetal cardiotocography								
Yes	1	24	23	7	1	10	8	36
No	21	96	69	56	10	46	27	159
X 2 (P – value)	**17.874(.004) ****				**14.798(.002) ****			

NS= Not statistically significance   * Statistically significant at P – value $\leq$ .05

** Statistically significant at P – value $\leq$ .01.

Table 6: Relation between participants level of interpretation skills of Fetal trace and their personal characteristics in pretest and posttest, (n = 297).

Personal characteristics of participants	Pretest				Posttest			
	Unsatisfactory (n = 236)		Satisfactory (n = 61)		Unsatisfactory (n = 80)		Satisfactory (n = 217)	
	No.	%	No.	%	No.	%	No.	%
Age/year								
19	1	0.4	0	0	1	1.3	0	0
20	46	19.5	12	19.7	18	22.5	40	18.4
21	132	55.9	38	62.3	43	53.8	127	58.5
22	56	23.7	10	16.4	17	21.3	49	22.6
23	1	.4	1	1.6	1	1.3	1	0.5
X^2 (P – value)	7.021 (.05) *				6.109(.04) *			
Sex								
Male	102	43.2	27	44.3	36	45.0	93	42.9
Female	134	56.8	34	55.7	44	55.0	124	57.1
X^2 (P – value)	3.459 (.630) NS				4.685 (.455) NS			
Residence								
Urban	95	40.3	30	49.2	34	42.5	91	41.9
Rural	141	59.7	31	50.8	46	57.5	126	58.1
X^2 (P – value)	11.584 (.002)* *				10.930 (.008) **			
Marital Status								
Single	229	97.0	60	98.4	77	96.3	212	97.7
Married	7	3.0	1	1.6	3	3.8	5	2.3
X^2 (P – value)	1.326 (.569) NS				1.466 (.495) NS			
Previous educational certification								
Secondary school	198	83.9	47	77.0	69	86.3	176	81.1
Secondary nursing school	18	7.6	6	9.8	4	5.0	20	9.2
Nursing institute	20	8.5	8	13.1	7	8.8	21	9.7
X^2 (P – value)	9.675 (.004) **				1.527 (.466) NS			
Previous training courses on FETAL CARDIOTOCOGRAPHY								
Yes	40	16.9	15	24.6	14	17.5	41	18.9
No	196	83.1	46	75.4	66	82.5	176	81.1
X^2 (P – value)	11.876 (.002) **				13.0758(.001) **			

Test used: Chi-square   NS= Not statistically significance
* Statistically significant at P – value ≤ .05   ** Statistically significant at P – value ≤ .01.

Table 7: Correlation between participant's knowledge about Fetal cardiotocography and their interpretation skills of Fetal trace in pretest and posttest, (n = 297).

Variables	Pretest		Posttest	
	Knowledge	Interpretation skills	Knowledge	Interpretation skills
Knowledge about Fetal cardiotocography				
r. value	1	.074	1	.859
P. value	-	.206 NS	-	.003**
Interpretation skills of Fetal trace				
r. value	.074	1	.859	1
P. value	.206 NS	-	.003**	-

** Correlation is significant at the 0.01 level (2- tailed).   * Correlation is significant at the 0.05 level (2- tailed).   NS: not statistically significant.

Discussion

The maternity nurses introduce a serious role in monitoring and early detection of fetus who is at a high-risk during follow - up period and labor, therefore an educational interference on maternity nurses' execution about non-invasive measures of fetal wellbeing such as fetal cardiotocography (CTG) and its interpretation should be carried out **(Zaghir et al., 2022).** Therefore, the current study aimed to evaluate the effect of training program on knowledge and interpretation skills of fetal cardiotocography among undergraduate nursing students (male and female) who were studying obstetrics & gynecology nursing course in the third year at the Faculty of Nursing - Minia University- Egypt.

As regards the personal characteristics of the studied sample, the present study findings showed that more than half of them were female, from rural areas, and living at home during their studying years. However, more than two thirds of them did not have previous training courses on CTG interpretation, and most of the studied sample were single. The results were supported by **Ibrahim & Arief (2019)** who studied the effect of educational program of Fetal monitoring on the knowledge and interpretations of internship nursing students and reported that more than half of students lived in their homes in rural areas, and the most were single. On the other hand, **Meunier et al., (2015)** who performed a national assessment on teaching residents fetal cardiotocography reported that less than three quarters of the sample lived in urban area, dissimilar appeared because of variable sites of both studies.

Regarding the age, the current research results demonstrated that the range of age was from 19-23 years which is the corresponding age of studying in the university but that was less than other studies conducted by **Abd El-Razek (2016)** who investigated the effect of training programs on assessing methods of Fetal viability during pregnancy in-between nurses and reported that more than one - third were 20 – 30 years. Also, **Oleiwi & Abbas (2015)** did their study in maternity hospitals in city of Baghdad to evaluate the effectiveness of cardiotocography education program on nurse-

midwife's knowledge, reported that the most of nurses- midwives age ranged between 25-29 years old which is more than our study.

Concerning the level of education, the present finding reported more than three quarters of the studied sample had secondary school and the rest had secondary nursing school and nursing institute, this in agree with **Ibrahim & Arief (2019)** however, this disagrees with **Zaghir et al., (2022)** who found that more than half of nurses had a technical nursing institute in a study on forty maternity nurses at the Cardiotocography room of the Obstetrics and Gynecological department at the Hospital of Benha University. This difference may be attributed to the difference in the participants of data collection.

These results also illustrated that there was a highly statistically significant rise in the posttest than in pretest responses regarding fetal cardiotocography related definitions, this coincides with **Daglar et al., (2020)** who carried out a study on the midwifery senior's students and found significant difference between the pre and post CTG course scores

In the same line, the study of **Lee et al., (2019)** reported that high-fidelity simulation courses are beneficial in ameliorative both the knowledge and interpretation of fetal heart rate tracings for obstetric nurses with significant differences between pre and posttest. Also, agree with the study of **El-Sayed & Saadoon (2018)** concluded that there was statistically significant advance between the pretest and immediate posttest in the knowledge and skills of nurses regarding cardiotocograph. Many studies support these results as **Oleiwi & Abbas (2015)** and **Ramadan et al., (2018).**

Concerning the pretest level of knowledge among participants, the results showed that near half of participants had a low knowledge level about Fetal cardiotocography and more than three quarter of students had unsatisfactory level of CTG interpretation skills these results agree with **Goldman & Naidoo (2021)** investigated the effect of structured training on the skills of CTG interpretations in 218 healthcare workers in obstetric care units and concluded that less than half of them had poor pre training knowledge. Moreover, **Said & Ali (2020)** concluded that poor knowledge

was documented in the majority of nurses and more than three quarters had unsatisfactory pursuit toward nursing care during fetal cardiotocography before implementation of the helping nursing prescripts.

In addition, **James et al., (2019)** conducted a study in labor wards in public hospitals of KwaZulu-Natal to test midwives' knowledge and skills of cardiotocography interpretation and concluded that more than two third of them had limited cardiotocographic knowledge and in need for training.

However, the posttest level of knowledge among participants in this study was increased near two thirds and consequently, the satisfactory level of CTG interpretation skills was increased near to three quarters significantly in participants. This agrees with **Said & Ali (2020)** who reported that after the application of the helping nursing instruction, nearly two third were of good knowledge and the majority of nurses had highly satisfactory practices. Furthermore, the present results were in accordance with **Abd El-Razek (2016)** who reported that nurses were of increased knowledge after the interference.

In this study, the mean of total knowledge score of students was 19.41± 1.535, in pretest, increased to 24.27± 2.263 in posttest, and the mean score of interpretation skills of Fetal trace was 25.92 ± 2.81 in pretest, increased to 38.18 ± 5.52 in posttest with statistically significant differences. This result is supported by **Lee et al., (2019)** who revealed that the pretest total knowledge mean was 81.8 ± 6.1 and increased 91.5 ± 5.0 in posttest, on other hand the interpretation skills of Fetal cardiotocography in pretest 75.2 ± 10.2 and improved 86.9 ± 5.8 significantly after the simulation course. Also, in agreement with **El-Sayed & Saadoon (2018)** who revealed that statistically significant difference was found in-between the pretest, immediate and after three months posttest means of the knowledge and skills of nurses regarding cardiotocograph.

These study results showed that there was a high positive correlation between student's knowledge about Fetal cardiotocography and their interpretation skills of Fetal trace in posttest which agrees with **El-Sayed &** **Saadoon (2018)** whose results showed a high significant positive association between the level of knowledge and skills of nurses concerning the posttest CTG. These results also go in line with **Sowmya et al., (2013)** who reported the same results.

Concerning the relation between participants' knowledge level and personal data in pretest and posttest, these results showed that there was a statistically significant relation between participants' total knowledge about Fetal cardiotocography with their sex, residence, and previous training courses on Fetal cardiotocography in both pretest and posttest. These results are supported by **Anberg et al., (2014)** who did a cross-sectional study to locate the level of knowledge on the interpretation of CTG amongst midwifery nurses working at labor & delivery units in Malaysian hospitals and reported a significant relation between age, education level and knowledge on CTG interpretation, but this did not coincide with **Zaghir, et al., (2022)** whose results had a significant difference in nurses' total practice score and their age and level of education only**,** in the same direction, **Sowmya et al., (2013)** reported that there was no significant association between the demographic data with the level of knowledge and its interpretations in-between nurses in both pretest and posttest this may be attributed to the low number of participants in their study (only 30 nurses).

Conclusions:

Based on the previous results, it concluded that our study is unique in its focus on investigating the interpretation skills of fetal cardiotocography among undergraduate nursing students in a variety of obstetric situations. Moreover, the present results accomplish that there has been an increase level of student's total score of knowledge and there is also an improvement in student's satisfactory level of interpretation skills after implementing the training program related to fetal cardiotocography. Furthermore, the results showed highly statistically significant differences in knowledge and interpretation skills of Fetal cardiotocography between nursing students in pretest and posttest which reflect a positive effect of our training program

on the knowledge and interpretation skills of Fetal CTG among undergraduate nursing students.

Recommendations:

Based on the present results, the following recommendations were drawn:

It is recommended that providing continuous training programs for fetal cardiotocography is very important not only for nursing students but also for staff nurses in maternity hospitals, which result in the improvement of the quality of maternal and new-born care. Furthermore, our study recommends further research to assess the staff nurse knowledge and skills about fetal cardiography to evaluate the knowledge of the nurses about the other non-invasive methods of fetal wellbeing assessment. In addition, a guide information paper should be printed and handed out to the nurses that clarifying information about the CTG interpretation.

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