

## Effect of Educational Program on Nurses' Performance Regarding Cardiotocography at Labor Units

Marwa Abd El-Azeem Abd El-Hameed<sup>1,2</sup>, Manal Abdalla Gaheen<sup>3</sup>, Fatma Ahmed Abou Romiya<sup>4</sup>, Rabaa El-Sayed Shaban<sup>5</sup>, Anaam Ebrahim El-Nagar<sup>6</sup>

<sup>1</sup>Doctorate Student at Maternal and Neonatal Health Nursing, Faculty of Nursing, Tanta University, Egypt.

<sup>2</sup>Nursing Specialist at Hosh Eissa Hospital, Beheira, Egypt.

<sup>3</sup> Professor of Maternal and Neonatal Health Nursing, Faculty of Nursing, Tanta University, Egypt.

<sup>4,5</sup>Assistant Professor of Maternal and Neonatal Health Nursing, Faculty of Nursing, Tanta University, Egypt.

<sup>6</sup>Lecturer of Maternal and Neonatal Health Nursing, Faculty of Nursing, Tanta University, Egypt.

**Corresponding author:** Marwa Abd El-Azeem Abd El-Hameed

**Email:** [PG\\_161121@nursing.tanta.edu.eg](mailto:PG_161121@nursing.tanta.edu.eg)

### Abstract

**Background:** Cardiotocography has been considered the primary tool for monitoring fetal health during antepartum and intra-partum periods. Cardiotocography detects any changes of the fetal heart rate tracings that might jeopardizes the fetal condition or posing risk of death or distress. **The aim of the study** was to evaluate effect of educational program on nurses' performance regarding cardiotocography at labor units. **Subjects and method:** A quasi-experimental research design was used to conduct this study. **Setting:** The study was carried out at labor units of obstetrics and gynecological department of Tanta Main University Hospital, El- Menshawy General Hospital and El- Mabra Hospital. **Sample:** The study comprised all 54 nurses who were employed in the aforementioned settings. **Tool (I):** Nurses' knowledge regarding cardiotocography during labor. It included Part (1): Socio-demographic characteristics of nurses and **Part (2):** Nurses' knowledge regarding cardiotocography during labor. **Tool (II):** Nurses' Practices observational checklist regarding cardiotocography. **Results:** High level of nurses' knowledge and satisfactory practices regarding cardiotocography were reported immediately and three months after program implementation in contrast to low and unsatisfactory practices before educational program implementation. **Conclusion and Recommendations:** The cardiotocography educational program had a positive effect on improving the level of knowledge and practices among the studied nurses working at labor units. Regular annual training courses and workshops should be conducted for maternity nurses regarding cardiotocography monitoring and its traces.

**Key words:** Cardiotocography, Educational Program, Nurses' Performance.

## Introduction

Labor is a wonderful, natural experience, with pleasurable event for both the woman and her family. Nevertheless, a life-threatening complication can occur causing maternal and fetal morbidity or mortality (Alhetar, Ramadan, Afifi, & Ibrahim, 2022; Gweda, Ahmed, Abozeid, Belal, & Khalifa, 2024). The health of the fetus and her mother are extensively linked with each other (Dol, et al., 2021; Ramli et al., 2023; Wahyuningsih & Linggardini, 2022).

Therefore, birth-related issues can cause catastrophic consequences for mothers, newborns, and their families, as well as lead to significant healthcare expenses. The primary causes of perinatal mortality are inadequate assessment of fetal well-being during pregnancy and care during labor by the skilled health professionals (Gweda, et al., 2024; Limbo & Denny, 2020).

Assessment of fetal well-being is one of the key aims of obstetric care and considered as a critical tool in ensuring optimal neonatal outcome from both pregnancy to labor. This assessment is designed to identify fetal at risk for in utero death or asphyxia-mediated damage which affects expeditious and safe delivery (Gweda, et al., 2024; Limbo & Denny, 2020).

Fetal heart rate (FHR) assessment is the most important indicator of fetal well-being (Hardicre, Arezina, Mc Guinness & Johnson, 2021; Ogenyi et al., 2022). The utilization of electronic fetal monitoring (EFM) can identify any abnormal variations in

the fetal heart rate within the uterus (Maraikkayar, Tamilselvi, & Beham, 2023; O' Sullivan et al., 2021; Yu, Z et al., 2024).

The two primary methods of FHR monitoring are intermittent auscultation and continuous electronic fetal monitoring (Murray, Fox, Coddington, & Scarf, 2024; Rodgers, 2020).

Continuous electronic fetal monitoring is commonly carried out via cardiotocograph (CTG) that has been considered the primary tool for monitoring fetal health during antepartum and intra-partum periods. CTG was first introduced in the 1960s and since then has been a focal aspect of the care provided to women during labor. CTG defined as an external fetal monitoring system or machine, that is used to record continuous tracing of the fetal heart rate (cardio) and the maternal uterine contractions (toco), by using transducers attached to the maternal' abdomen and fundus, respectively. Which were recorded into a graphical paper (graphy). CTG is typically performed during pregnancy in the third trimester or continuously during labor (Dular & Devi, 2021; Kahveci, Melekoglu, Evruke, & Cetin, 2018).

Therefore, the primary objective of CTG is recording both the fetal heart rate and the maternal uterine contractions simultaneously, as a method to identify the early signs of maternal and fetal deterioration, allowing a prompt intervention to reduce maternal and fetal fatalities (Abo-Hatab, Ahmed, Abozeid, Gaheen, & El-adham, 2020; Das,

**Mukherjee, Santosh, Saha, & Roy, 2020).**

The cardiotocography methods include internal or external methods. The internal method requires a catheter placed in the uterus after a specific amount of cervical dilation has taken place. While the external CTG method, a pair of sensory nodes are affixed to the maternal' abdomen. The first sensory (Tocotransducer) is placed over the uterine fundus to detect the tension of the maternal abdominal wall as an indirect measure of the intrauterine pressure. The pressure reading is transformed into an electronic signal that is recorded on graph paper as uterine contractions. On the other hand, the second sensory device, an ultrasound transducer, is positioned over the fetal back to detect the fetal heart rate and convert it into audible beeping sounds. These sounds are then recorded on a graph paper **(El-Sayed& Saadoon, 2018; Mahjabeen & Nasreen, 2022).**

The external CTG method is the most commonly carried out externally and can be used for continuous monitoring (all the time during labor) or intermittent monitoring (at set times with low-risk pregnancies) **(Bai, Lu, Liu, He, & Guo,2024; Mahjabeen & Nasreen,2022; Stone et al.,2017).**

Hence, CTG is recommended for women who have diabetes mellitus, hypertension/ preeclampsia, maternal pyrexia, antepartum hemorrhage, cardiac disease, severe anemia, hyperthyroidism, oxytocin infusion, hypertonic uterus, previous cesarean section, and chorioamnionitis. Additionally, CTG is advised for fetal

diseases as; chromosomal abnormalities, intrauterine growth restrictions, and intrauterine growth retardation. CTG is the most extensively used and generally accepted non-invasive method of fetal monitoring, with no known contraindications. Its findings are documented as CTG traces. **(Holmgren, 2020; Tamber, Hayes, Carey, Wijekoon, & Heazell, 2020).**

Cardiotocography traces generally shows two lines on a graph paper. The upper line is a record of the fetal heart rate in beats per minute. The lower line is a recording of uterine contractions. The average fetal heart rate is between 120 and 160 beats per minute (bpm) and it can vary by 5 to 25 bpm. The fetal heart rate may change as the fetus responds to conditions in the uterus. On the other hand, five contractions per ten minutes over thirty minutes is considered the upper limit of normal uterine activity **(Alhetar et al., 2022).** The identification and interpretation of uterine contractions and fetal monitoring patterns are a key job for maternity nurses **(Pereira, Lau, Modestini, Wertheim, & Chandrah-aran, 2021).**

Therefore, nurses need adequate knowledge and practices to interpret CTG traces and make critical decision- during intrapartum monitoring activities. There are four parameters that are used to evaluate CTG traces: baseline FHR, baseline variability, accelerations, and decelerations (whether present or not), and the characteristics of different types of decelerations (if present) **(James, Maduna, & Morton, 2019;**

**Pereira, Lau, Modestini, Wertheim, & Chandrabaran, 2021).**

Maternity nurses are responsible for the application and interpretation of CTG monitoring in the labor unit (**Uusiku et al., 2022**). They have a role before the CTG procedure as; preparing the necessary equipment and measuring maternal vital signs. Whereas, their role during CTG procedure placing woman on dorsal recumbent position, and perform Leopold's maneuver. Furthermore, the nurses' role after CTG procedure ensured documenting date and time of CTG, interpreting CTG traces and notifying for any complications, as well as initiating corrective measures when necessary (**Olewi, 2018; Blix et al., 2019; Ganti, Kaufman, & Madani, 2022; McKinne, James, Murray, Nelson, & Ashwill, 2021**).

Additionally, maternity nurses are crucial in the emergency measures or actions with CTG monitoring abnormalities as; repositioning the woman in a lateral position to increase uteroplacental perfusion, administering oxygen, discontinuing the oxytocin infusion, and evaluating uterine contractions and fetal heart rate patterns (**Smith et al., 2019**).

Thus, the pressure of workload on maternity nurses arises from their inadequate knowledge and practices regarding CTG monitoring procedure. They need to be equipped with the requisite knowledge, and practices for safe and effective care (**Uusiku et al., 2022**). They must be adequately trained for performing CTG procedure and interpretation of its traces properly and timely, thereby allowing early detection of the

complications, and reducing perinatal morbidity and mortality (**Alsaraireh, Yehia, & Khala, 2023; Jepsen, Blix, Cooke, Adrian, & Maude, 2022**).

#### **Significance of the study:**

Worldwide, the current perinatal mortality rate in 2022 is 15.084 deaths per 1000 live births, with nearly one-third occur within the first 24 hours of birth as a result of complications related to childbirth, such as birth asphyxia or lack of breathing. While in Egypt, the perinatal mortality rate in 2022 is 15.513 deaths per 1000 live births (**Mahmoud, Aboud, Emam, & Abd Elmordy, 2023; WHO report, 2021**). Therefore, the prevention of birth potential complications can be facilitated by the implementation of adequate obstetric care interventions, as CTG monitoring (**Akyıldız, Çoban, Uslu, & Taşpınar, 2021**). So, maternity nurses, who spend a significant time with the woman during labor, must possess the necessary expertise for CTG monitoring and tracings in a timely and accurate manner to ensure immediate and corrective actions, thereby reducing the number of maternal and fetal fatalities (**Mdoe et al., 2019**). Thus, educational training program equipping the maternity nurses with the necessary knowledge and skillful practices regarding CTG and its traces interpretation (**Jepsen, Blix, Cooke, Adrian, & Maude, 2022**). So this study was conducted was to evaluate effect of educational program on nurses' performance regarding CTG at labor units.

#### **Aim of the study was to**

Evaluate the effect of educational program on nurses' performance

regarding cardiotocography at labor units.

### **Operational definition**

Nurses 'performance means nurses' knowledge and practices.

### **Research Hypothesis**

Nurses' performance is expected to be improved after implementation of the educational program regarding cardiotocography at labor units.

### **Subjects and method**

**Study Design:** This study used a quasi-experimental research design. Quasi-experimental is a research design that aim to identify the impact of a particular intervention, program, or event (a treatment).

**Setting:** The research study was conducted at labor units of obstetrics and gynecological department of Tanta Main University Hospital which is affiliated to the Ministry of High Education and Scientific Research, El- Menshawy General Hospital which is affiliated to the Ministry of Health and Population and El- Mabra Hospital which is affiliated to the Health Insurance.

The labor unit of obstetrics and gynecological department at Tanta Main University Hospital consisted of 3 separate rooms ( CTG & abdominal U/S room ,waiting room & delivery room).While, the labor units of the other two hospital have 2 separate rooms (waiting room with a CTG set - delivery room).

**Subjects:** All nurses (54 nurses) who were working at labor units in the previously mentioned study settings were included in the study.

### **Tools of data collection**

Two tools were used to achieve the aim of this study:

**Tool (I): Nurses' knowledge regarding cardiotocography during labor:** The researcher developed this tool after compiling relevant recent literature reviews (Abd El-Razek, 2016; Alhetar et al., 2022; El-Sayed & Saadoon, 2018). It included the following two parts:-

**Part (1): Socio-demographic characteristics of nurses:** - This section was employed to collect nurses' basic data including their age, level of education, place of residence, years of experience, and attendance at previous CTG training programs.

**Part (2): Nurses' knowledge regarding cardiotocography during labor:-** It was developed after reviewing the recent related literatures (Abd El-Razek, 2016; Alhetar et al., 2022; El-Sayed & Saadoon,2018) The researcher used this part to assess the nurses' knowledge regarding CTG before, immediately and three months after implementation of the educational training program. It encompassed, its definition, objectives of CTG, methods of CTG, maternal and fetal indications, contraindications, advantages, disadvantages, characteristic of normal and abnormal CTG, indication times to begin and time taken to perform it, detection of the signs of intra uterine fetal distress, reading number of contractions on the monitor, performing non-stress test, clarifications of CTG traces including FHR (base line FHR, accelerations, decelerations) and uterine contractions, as well as nursing responsibilities regarding CTG.

**The scoring system for nurses' knowledge regarding CTG was categorized as follows:**

- Correct and complete answers were scored as (2).
- Correct and incomplete answers were scored as (1).
- Incorrect answers and/or don't know were scored as (0).

**The total score level of nurses' knowledge was calculated as follows:**

- **High level of knowledge**  $\geq$  80-100% (43-56).
- **Moderate level of knowledge**  $\geq$  60- $<$ 80% (32-42).
- **Low level of knowledge**  $<$  60% (0-31).

**Tool II: Nurses' practices observational checklist regarding cardiotocography:** This tool was adapted by the researcher from (Abd El-Razek, 2016; Alhetar et al.,2022; El-Sayed & Saadoon, 2018) In order to assess nurses' practices regarding CTG procedure before, immediately and three months after implementation of the educational program. It contained three main tasks:-

**A. Pre-procedure tasks as;**

Preparation of the equipment such as (CTG machine, cardiotocograph belt, gell, check paper in the machine and paper speed is net at lcm per minute, clean gloves, tissue paper, sphygmomanometer, maternal record and pen), positioning of the woman and preparation of the environment.

**B. Procedure tasks:** Included tasks of the nurse related to steps of performing CTG monitoring and care of the woman during the procedure as; Put woman in dorsal recumbent position with monitor belts under her back, expose woman's abdomen, encouraging to breathe naturally, perform Leopold's

maneuver to fetal back, assist woman again to a semi-fowler's position in bed, align and insert the tocotransducer and ultrasound transducer plug into the appropriate monitor port, apply special jell on the skin where the fundus of the uterus and fetal back palpated at woman's abdomen for a strong signal, apply tocotransducer on the maternal abdomen at uterine fundus, apply ultrasound transducer correctly where the fetal back palpated at woman's abdomen, put an elastic belt around the woman's abdomen to fix the tocotransducer and ultrasound transducer, repositioned tocotransducer and ultrasound transducer with changing woman's position, reassure woman that stopping FHR signal with changing her position not mean her fetus had a problem, assess and read CTG graph tracings as; woman uterine contractions, base line FHR, tachycardia, bradycardia, accelerations, decelerations and doctor notification for immediate action with CTG tracing results suggest mother or fetus problem.

**C. Post-procedure tasks as;** collecting of the equipment, documentation; date and time of CTG procedure & its results, inform woman about procedure findings and reassurance of the woman.

**The scoring system for nurses' practices regarding CTG was as follows**

- **Done correctly and completely** was scored as (2).
- **Done correctly but incompletely** was scored as (1).

- **Done incorrectly or not done** was scored as (0).

**The total score of nurses' practices were summed up and converted into percent score as follows:-**

- **Satisfactory practice:  $\geq 80\%$ .**
- **Unsatisfactory practice:  $< 80\%$ .**

### **Method**

The study was implemented according to the following steps:

**1.Administrative approval:** The researchers obtained an official letter from the Faculty of Nursing Tanta University, elaborating the purpose of the research study that was subsequently submitted to the relevant authorities of the chosen settings for approval to conduct the study.

### **2.Ethical and legal consideration**

- Approval of the Scientific Research Ethical Committee at Faculty of Nursing was taken code No: 159.
- After providing an explanation of the study's purpose, including the opportunity to withdraw at any time, all nurses provided informed consent.
- The researcher guaranteed that the study's nature did not result in any damage or discomfort for the entire sample.
- Privacy and confidentiality were taken into account when collecting data.

### **3.Tools development**

- The researcher reviewed recent and related literature before developing data collection tools (**Abd El-Razek, 2016; Alhetar et al., 2022; El-Sayed & Saadoon, 2018**). **Tool I** was developed and translated into Arabic language and **Tool II** was developed in English.

- The study tools were then reviewed by a panel of five obstetric and gynecological nursing experts for content and construct validity, and any necessary adjustments or modifications were made.
- The validity of the expert assessments of the nurses' knowledge questionnaire and practices observational checklist pertaining CTG was 95% and 96%, respectively.
- The reliability of the study tools was tested by using Cronbach's Alpha test. They were (0.898 and 0.897) for knowledge questionnaire and practices observational checklist respectively which indicating high reliability of the study tools.

**Pilot study:** 10% of the sample (6 nurses), who were chosen from the aforementioned settings for a pilot study in order to test and determine the tool' clarity, feasibility, and application as well as identify any issues that would impede the data collection process. Since there were no significant changes made to the study tools, the data from the pilot study were incorporated into the current study sample.

### **4. Data collection (field work)**

- The nurses' performance (knowledge and practices) regarding CTG was assessed using tools I and II before, immediately after, and three months after the program was implemented.
- The researcher attended 4 days per week at the previously settings in the morning and afternoon shifts, until the predetermined sample size and data were collected.

- Data collection was conducted up to one year and two months ranged from the beginning of February 2023 to the end April 2024.

5. Four phases were implemented during the educational program: including assessment, planning, implementation, and evaluation:

**Phase I: Assessment phase (Pre-test)**

- The maternity nurses were asked to participate in the study prior to the implementation of the educational program and after being informed of its purpose. Using **Tool (I) part one** to assess nurses, sociodemographic characteristics and **Tool (I) part two** to assess their knowledge pertaining to CTG.
- Also, **Tool (II)** observational checklist was used to assess nurses' practices regarding CTG (pre-procedure, procedure and post procedure tasks) on CTG machine at labor units.
- Before implementation of the educational program, nurses' pre-test was distributed individually for each nurse through an interview lasted 30-40 minutes to assess knowledge regarding CTG using **Tool (I)** in the researcher's presence for essential explanation. Whereas an observational checklist **Tool II** was used to assess nurses' practices regarding CTG procedure before program implementation.

**Phase II: Planning phase:-** An appropriate in-services educational program sessions regarding CTG was prepared by the researcher based on assessment phase.

**A.The educational program included two main parts:**

- **Theoretical part:** This component was developed in accordance with the educational program objectives and the assessment of nurses' knowledge prior to the commencement of the program sessions, and it was directed by pertinent literatures. (Abd El-Razek, 2016; Alhetar et al., 2022; El-Sayed & Saadoon, 2018).

The theoretical part contains sessions about definition, objectives of CTG, methods of CTG, maternal & fetal indications, contraindications, advantages, disadvantages, characteristics of normal and abnormal CTG, appropriate time to use, signs of intrauterine fetal distress, reading contractions on monitor, performing non-stress test, clarifications of CTG traces including FHR (base line FHR, accelerations, decelerations) and uterine contractions as well as nursing responsibilities regarding CTG during labor.

- **Practical part:** This part was prepared before conducting the educational program guided by relevant literatures (Abd El-Razek, 2016; Alhetar et al., 2022; El-Sayed & Saadoon, 2018) and it included demonstrating CTG monitoring pre-procedure, procedure and post-procedure tasks during labor.

**B.Preparation of the educational program content**

- The researcher created an educational booklet based on the needs of nurses (knowledge and



practices assessment phase). The booklet was disseminated to all nurses in order to enhance their knowledge & understanding of CTG and serve as a reference.

- The program was conducted using a variety of teaching methods as; lectures, group discussions, posters, PowerPoint, demonstrations, re-demonstrations of the CTG machine in the study settings indicated earlier, as well as video scenarios presentations.

The total numbers of nurses are (54 nurses), they were divided into 18 groups. Each subgroup included 3 nurses.

### **Phase III: Implementation phase**

- The in-service educational program regarding CTG was implemented in the aforementioned study settings through the implementation of four sessions, two of which were dedicated to the theoretical content and two to the practical part.
- The program sessions were conducted in the morning and afternoon shifts four days a week.
- Each session lasted between 30 and 45 minutes, which included discussion periods. The sessions were as follow:

#### **Theoretical part**

- **The first theoretical session:** The aim of this session explained the goal (improve nurses' performance regarding CTG) and objectives of the educational program as; (methods of CTG, appropriate time to use, list CTG indications, differentiate between normal and abnormal CTG, demonstrate CTG procedure etc....). Also, the first session provided nurses with

knowledge about definition of CTG, objectives of CTG, methods of CTG, appropriate time to use, maternal and fetal indications and contraindications of CTG.

#### **- The second theoretical session**

This session provided nurses with knowledge about CTG advantages, disadvantages, characteristics of normal and abnormal CTG, intrauterine fetal distress signs, interpretations of CTG traces including FHR (base line FHR, accelerations, decelerations) & uterine contractions as well as nursing responsibilities regarding CTG.

#### **Practical part**

- **The first practical session:** The aim of this session provided the nurses with the proper and needed practical skills regarding CTG monitoring procedure:

**A. Pre-procedure tasks:** It included four preparations. **Equipment preparations** such as; (CTG machine, cardiotocograph belt, gell, clean gloves, tissue paper, paper speed is set at 1cm per minute in CTG machine, sphygmomanometer, & maternal record and pen). **Preparation and positioning of the woman** such as; (identify and greet the woman respectfully, explain the procedure, listen attentively and respond to woman's questions and concerns, empty her bladder, measure woman blood pressure and pulse rate, and inform that the procedure will last for 20 minutes). **Preparation of the environment** such as; (maintain privacy and ensure that the environment is clean

and tidy, adequate light, elevate bed to the suitable level) and **Preparation of the nurse** such as; (wash hands with an antiseptic solution, put on clean gloves, and stand at the right side of the woman's bed.

**B. Procedure steps/tasks:** included steps of CTG procedure and training nurses for; Positioning the woman in dorsal recumbent position and at the same time place monitor belts under her back, exposing the woman's abdomen and assist to relax by breathing naturally, performing Leopold's maneuver (second maneuver) to determine lie, presentation and fetal back (hold the left hand steady on one side of the uterus while palpating the opposite side of the uterus with the right hand, then hold the right hand steady while palpating the opposite side of the uterus with the left hand, the fetal back was a smooth convex surface, the fetal arms and leg were felt nodular and the fetus often move them during palpation ), assist the woman to a semi-fowler's position in bed, align and insert the toco transducer and ultrasound transducer plug into the appropriate monitor port, apply jell on the fundus of the uterus and fetal back for a strong signal, applying tocotransducer at uterine fundus and ultrasound transducer on the fetal back palpated at woman's abdomen, Put an elastic belt around the woman's abdomen to fix the tocotransducer and ultrasound transducer, repositioning tocotransducer and ultrasound

transducer) with changing woman' position during labor, inform woman stopping the fetal heart signal with position change and not think her fetus had a problem, assess and read CTG graph tracings including; uterine contractions (normal frequency 3-5 contractions in 10 min), base line FHR(110 – 160 bpm), tachycardia (baseline value above 160 bpm lasting more than 10 minutes), bradycardia (baseline value below 110 bpm lasting more than 10 minutes), acceleration (increased in FHR at least 15 bpm lasting at least 15 seconds) and deceleration: decreased FHR more than 15 bpm lasting at least 15 seconds), doctor notification regarding abnormal CTG tracing results for immediate action.

**C. Post-procedures tasks:** these included steps related to woman as; (help woman to assume comfortable position), steps related to equipment such as; (remove and clean the equipment), steps related to nurse as; (wash hands and documentation of CTG tracing results.

- **The second practical session** included nurse's demonstration and re-demonstrations for CTG procedure and how to perform Leopold's maneuver (second maneuver) to determine lie, presentation and fetal back with nurses.

How to read CTG tracing results including (uterine contractions & base line FHR, accelerations, decelerations). In addition to, training the nurses to sign on the

CTG paper (date, time of starting CTG, name of the mother, ID number).

**Phase IV: Evaluation phase (Post-test):-** This phase was designed to evaluate the effectiveness of the CTG education program.

- Nurses' knowledge was assessed individually using **Tool I part II** before, immediately and three months after implementation of the educational program.
- Nurses' practices were also assessed using **Tool II (observational checklist)**. Each nurse was observed separately during the CTG procedure in order to assess and evaluate their practices before, immediately and three months after program implementation.
- Nurses' knowledge and practices regarding CTG were compared before, immediately and three months after training program implementation.

#### **Statistical analysis:**

- The Statistical Package for the Social Sciences (SPSS) version 25 (IBM Corporation, Armonk, NY, USA) was used to code, enter, tabulate, and analyze the gathered data (**Dawson, 2001**).
- When it came to numerical data, we calculated the mean, standard deviation, and range. The Chi-square test was employed to compare two categories or more of qualitative data, which are described by frequency, percentage, or proportion of each category.
- The Z value of the Mann-Whitney test was employed to compare the

means of two groups of non-parametric data from independent samples. Kruskal-Wallis ( $\chi^2$ ) was computed to facilitate the comparison of non-parametric data with more than two means. The  $\alpha 2$  value of the Friedman test was calculated for non-parametric data in order to compare the means of three related groups (pre, immediate post, and three months post educational training program). Pearson's correlation coefficient (r) was implemented to assess the correlation between variables. The significance level was established at  $p < 0.05$  for the purpose of interpreting the results of the tests of significance.

#### **Results**

**Table (1):** Shows that more than one third of the studied nurses were aged more than 40 years old, with mean age of  $35.74 \pm 8.56$  years. While, (51.9 and 44.4%) of them had completed Nursing Technical Institute and Secondary Nursing respectively. on the other hand, more than half 57.4% of the studied nurses were from rural and nearly half of the studied nurses had >10 years of experience with non of them attend any previous training program regarding CTG.

**Table (2):** Illustrates that the total knowledge mean score of the studied nurses' regarding CTG before, immediately and three months post program sessions were ( $14.65 \pm 3.00$ ,  $48.92 \pm 2.79$  &  $45.28 \pm 2.33$ ) respectively. The score difference noticed is statistically significance before and after implementation of the educational program (**p = 0.0001\***)

**Figure (1):** Reveals that all of the studied nurses had low level of knowledge regarding CTG before educational program implementation, which increased to the vast majority (96.3%) of them had high level of knowledge immediately after program implementation. While the percentage decreased to (68.7% & 31.5%) high and moderate level of knowledge respectively, three months post educational program implementation.

**Table (3):** Demonstrates that the total practices mean score of the studied nurses regarding CTG was  $13.85 \pm 1.57$  before implementation of the educational program, which increased to  $58.65 \pm 1.94$  immediately after program sessions, while decreased to  $51.94 \pm 3.86$  three months after the educational program implementation. The score difference observed is statistically significance before post program implementation ( $p = 0.0001^*$ ).

**Figure (2):** Illustrated that Pre-procedure practices mean scores of the studied nurses regarding CTG before, immediately, and three months after implementation of the

educational program were (5.54, 23.33 and 21.24 respectively), while procedure practices mean scores were (5.02, 20.30 and 18.63 respectively), and post-procedure practices mean scores were (3.30, 15.02 and 13.44 respectively) that indicate significant nurses' practices improvement.

**Figure (3):** Portrays that all the studied nurses had unsatisfactory practices regarding CTG before implementation of the educational program, meanwhile 100% of them had satisfactory practices immediately after program implementation, and decreased to 79.6% three months after program implementation.

**Figure (4):** Clarifies that immediately after program implementation, a significance positive correlation was found between the total nurses' knowledge score and their total practices score ( $r = 0.531$ ,  $p = 0.0001^*$ ).

**Figure (5):** Shows a significance positive correlation is observed between total knowledge score and total practices score of the studied nurses three months after program implementation ( $r = 0.420$ ,  $p = 0.002^*$ ).

**Table (1): Socio-demographic characteristics of the studied nurses. (n=54)**

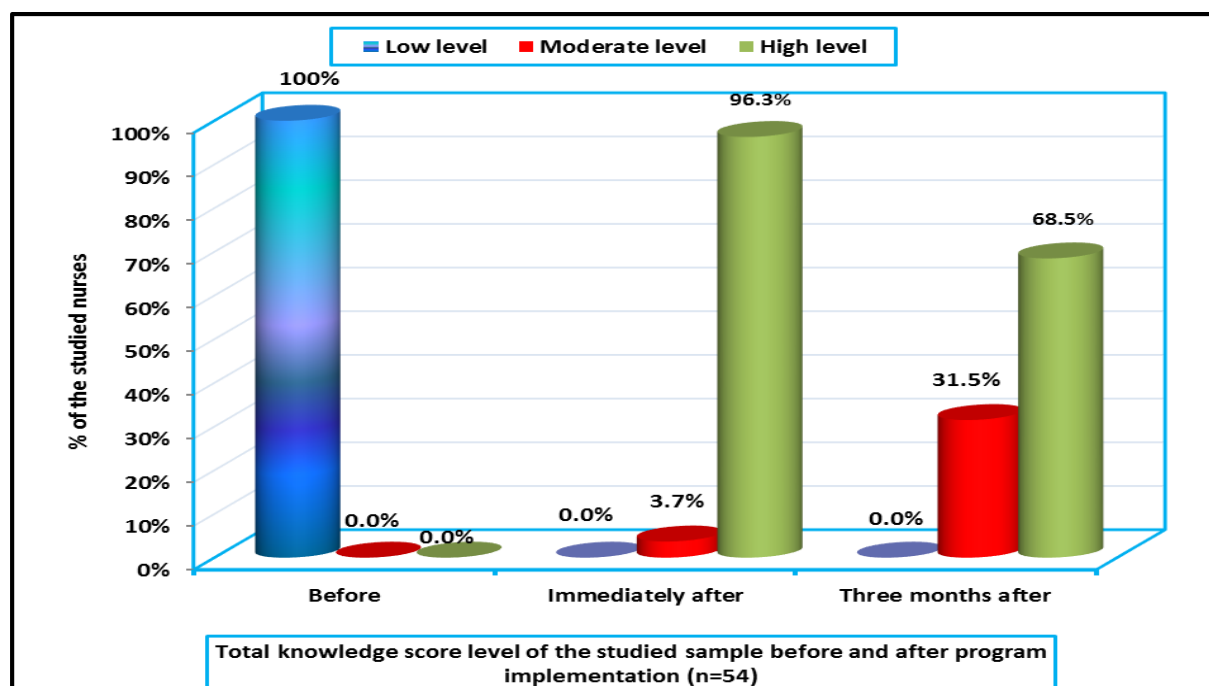
Socio-demographic characteristics	The studied nurses (n=54)	
	n	%
<b>Age (years):</b>		
< 20	0	0
20 - <31	13	24.1
31- 40	19	35.2
> 40	22	40.7
<b>Mean±SD</b>	35.74±8.56	
<b>Educational level:</b>		
Secondary Nursing	24	44.4
Nursing Technical Institute	28	51.9
Bachelor of Science in Nursing	2	3.7
<b>Residence:</b>		
Rural	31	57.4
Urban	23	42.6
<b>Years of experience:</b>		
< 5	5	9.3
5-10	23	42.6
> 10	26	48.1
<b>Mean±SD</b>	9.11±3.71	
<b>Attendance of previous training program regarding CTG:</b>		
No	54	100

**Table (2): Total knowledge mean score of the studied nurses regarding CTG at labor units before, immediately and three months after implementation of the educational program (n=54).**

Knowledge subitems regarding CTG (Each item was scored 0-2)	No. of items (Score)	Knowledge mean scores of the studied nurses regarding CTG before, immediately and three months after program implementation .			$\chi^2$ value P value
		Before	Immediately	After three months	
		Range Mean±SD	Range Mean±SD	Range Mean±SD	
<b>Definition</b>	1 (0-2)	0-2 0.91±0.49	1-2 1.57±0.50	1-2 1.57±0.50	45.018 0.0001*
<b>Appropriate time to use</b>	1 (0-2)	0-2 0.92±1.01	2 2.00±0.00	0-2 1.30±0.96	38.308 0.0001*
<b>Objectives of CTG</b>	1 (0-2)	0-2 0.54±0.50	1-2 1.68±0.47	0-2 1.67±0.51	85.819 0.0001*
<b>Methods of CTG</b>	1 (0-2)	0-2 0.54±0.77	1-2 1.78±0.42	1-2 1.65±0.48	69.898 0.0001*
<b>Indication and contraindication of CTG</b>	2 (0-4)	0-3 0.74±0.78	2-4 3.42±0.63	2-4 3.28±0.56	111.434 0.0001*
<b>Advantages and disadvantages of CTG</b>	2 (0-4)	0-2 0.74±0.62	2-4 3.37±0.65	1-4 3.42±0.63	112.668 0.0001*
<b>Performing the non-stress test</b>	2	0-2	2-4	2-4	115.757

	(0-4)	0.72±0.63	3.28±0.63	3.26±0.52	0.0001*
Characteristics of normal and abnormal CTG	8 (0-16)	0-9 5.39±1.99	9-16 13.87±1.43	8-16 13.20±1.72	110.404 0.0001*
Reading the number of contraction on the monitor	1 (0-2)	0-1 0.44±0.50	1-2 1.59±0.49	0-2 1.57±0.53	81.774 0.0001*
Detection of the signs of intrauterine fetal distress	1 (0-2)	0-2 0.35±0.48	1-2 1.70±0.46	0-2 0.61±0.53	95.185 0.0001*
Clarifications of CTG traces including FHR and uterine contractions	7 (0-14)	0-6 2.85±1.55	9-14 12.33±1.53	9-14 11.18±1.13	116.188 0.0001*
Nursing responsibilities regarding CTG	1 (0-2)	0-1 0.50±0.50	1-2 1.92±0.26	1-2 1.55±0.50	106.457 0.0001*
Total knowledge mean score	28 (0-56)	9-21 14.65±3.00	43-55 48.92±2.79	38-50 45.28±2.33	125.349 0.0001*

\*Statistically significant (P<0.05)

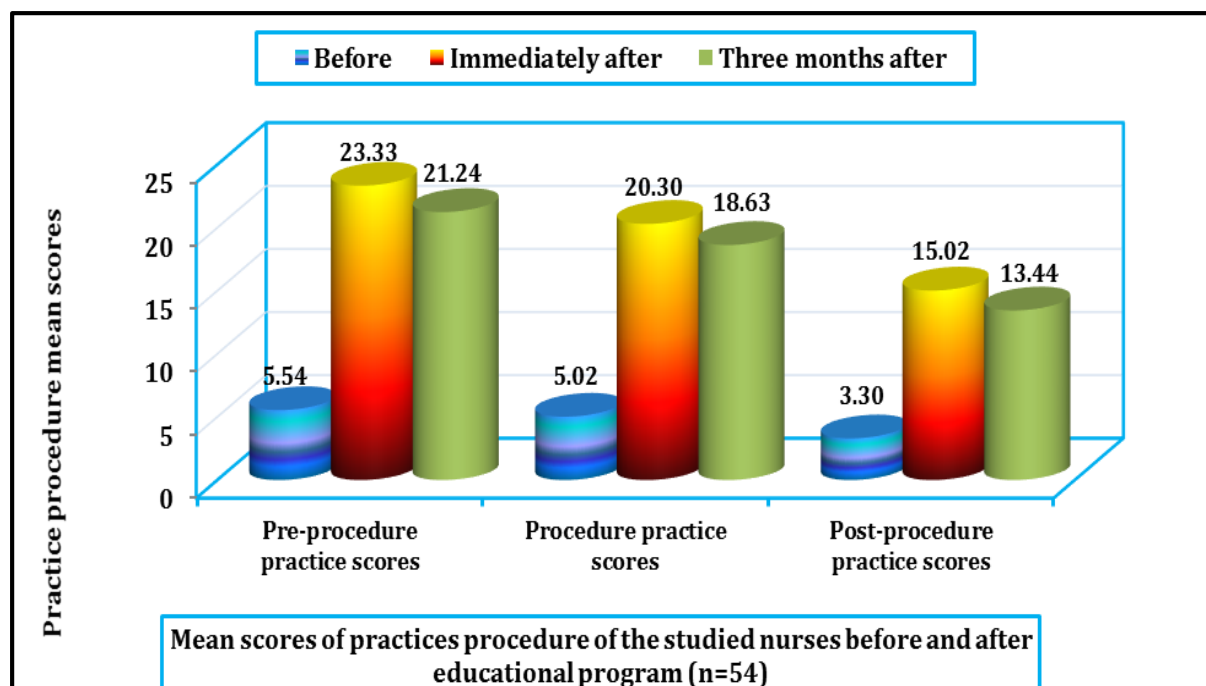


**Figure (1): Total knowledge score level of the studied sample regarding CTG at labor units before, immediately and three months after implementation of the educational program (n=54).**

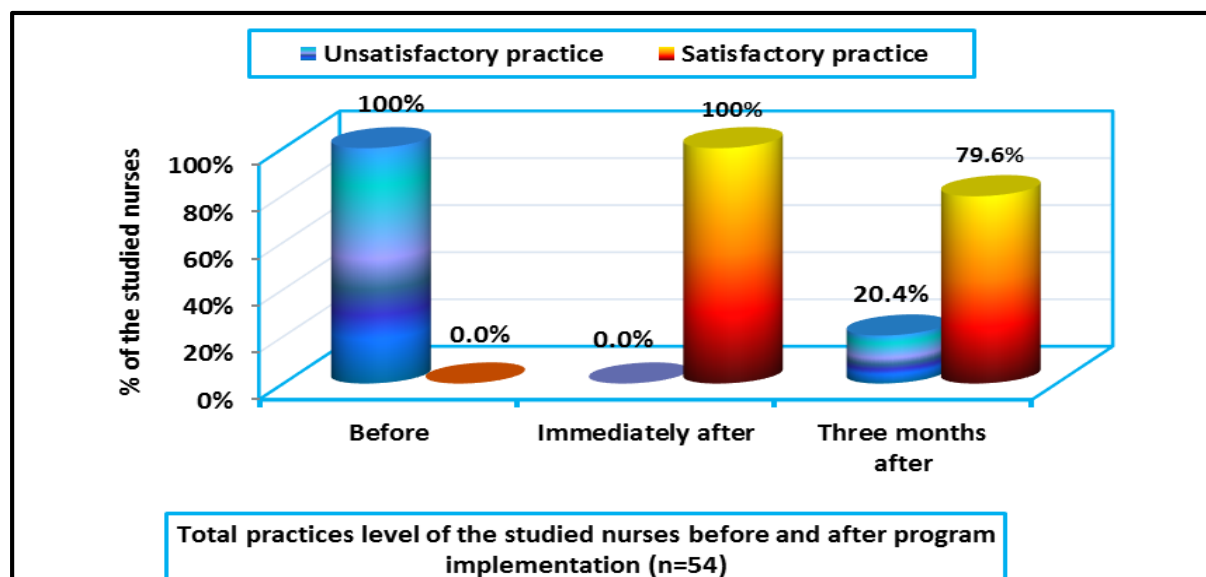
**Table (3): Total practices mean score of the studied nurses regarding CTG at labor units before, immediately and three months after implementation of the educational program (n=54).**

Practice items scores (Each item was scored 0-2)	No. of items (Score)	Total practices mean score of the studied nurses regarding CTG before, immediately and three months after program implementation.			$\chi^2$ value P value
		Before	Immediately	After three months	
		Range Mean $\pm$ SD	Range Mean $\pm$ SD	Range Mean $\pm$ SD	
<b><u>I-Pre-procedure practices score</u></b>					
- Prepare of the necessary equipment	1 (0-2)	0-1 0.46 $\pm$ 0.50	1-2 1.91 $\pm$ 0.29	1-2 1.72 $\pm$ 0.45	112.7070.0001*
- Preparation of the environment	3 (0-6)	0-3 1.41 $\pm$ 0.66	4-6 5.24 $\pm$ 0.55	3-6 4.92 $\pm$ 0.75	119.0010.0001*
- Preparation of the woman	6 (0-12)	1-4 2.37 $\pm$ 0.68	9-12 10.80 $\pm$ 0.71	8-12 9.92 $\pm$ 0.91	121.848 0.0001*
- Preparation of the nurse	3 (0-6)	0-2 1.30 $\pm$ 0.50	4-6 5.39 $\pm$ 0.53	3-6 4.70 $\pm$ 1.20	117.7760.0001*
<b>Total pre-procedure practices score</b>	<b>13 (0-26)</b>	<b>4-8 5.54<math>\pm</math>1.00</b>	<b>20-25 23.33<math>\pm</math>1.05</b>	<b>18-24 21.24<math>\pm</math>1.41</b>	<b>130.2240.0001*</b>
<b><u>II-Procedure practices score</u></b>	<b>11 (0-22)</b>	<b>2-9 5.02<math>\pm</math>1.27</b>	<b>17-22 20.30<math>\pm</math>1.06</b>	<b>14-21 18.63<math>\pm</math>2.10</b>	<b>119.868 0.0001*</b>
<b><u>III-Post-procedure practices Score</u></b>	<b>8 (0-16)</b>	<b>0-6 3.30<math>\pm</math>1.33</b>	<b>13-16 15.02<math>\pm</math>0.88</b>	<b>9-16 13.44<math>\pm</math>1.98</b>	<b>120.2740.0001*</b>
<b>Total practices mean score</b>	<b>32 (0-64)</b>	<b>11-18 13.85<math>\pm</math>1.57</b>	<b>55-62 58.65<math>\pm</math>1.94</b>	<b>42-60 51.94<math>\pm</math>3.86</b>	<b>137.44 0.0001*</b>

\*Statistically significant (P<0.05)

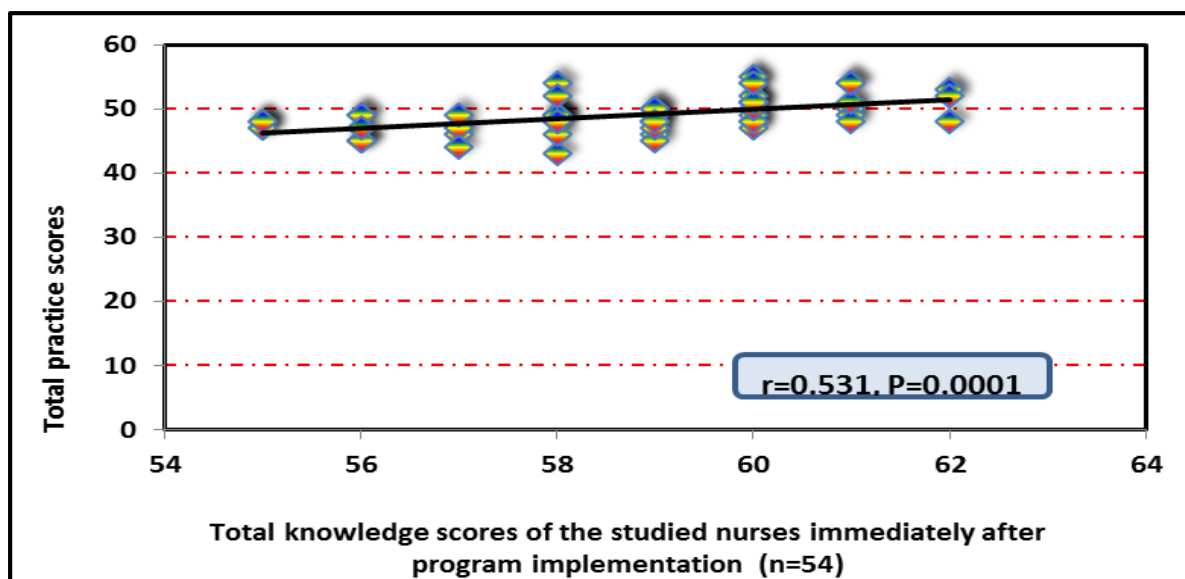


**Figure (2):** Practices procedure mean scores of the studied nurses regarding CTG at labor units before, immediately and three months after implementation of the educational program (n=54).

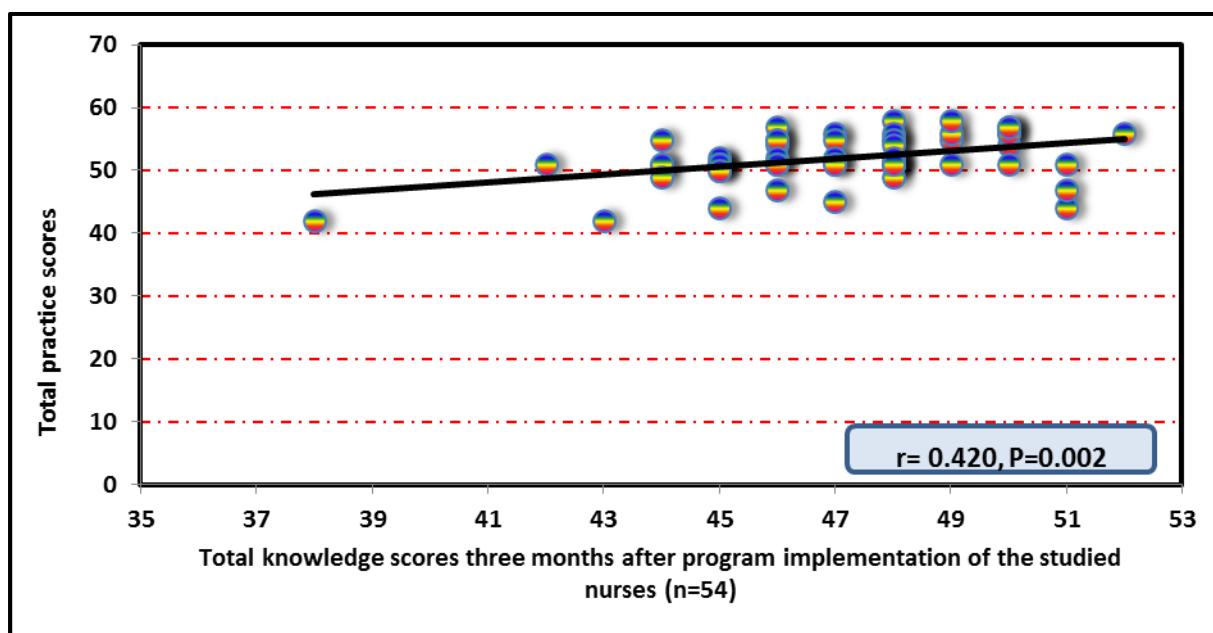


**Figure (3):** Total practices score level of the studied nurses regarding CTG at labor units before, immediately and three months after implementation of the educational program (n=54).





**Figure (4): Correlation between total knowledge scores and total practices scores of the studied nurses regarding CTG at labor units immediately after implementation of the educational program (n=54).**



**Figure (5): Correlation between total knowledge scores and total practices scores of the studied nurses regarding CTG at labor units three months after implementation of the educational program (n=54).**

## Discussion

Labor and birth are considered as one of the most memorable incidents for each woman's life. Birth-related complications could cause adverse pregnancy outcomes and significant healthcare expenses. Therefore, during pregnancy and labor, the basic goal is the well-being of the mother and the fetus. CTG is one of the most common obstetric procedures used for assessing fetal well-being, predominantly with increased risk of complications (El-Sayed & Saadoon, 2018, Ibrahim & Arief, 2019, Kelly et al., 2021).

Cardiotocography educational program raises nurses' knowledge, enhance their practices and interpretative abilities, improved management of intrapartum CTG, as well as enhance overall quality of care rendered to women throughout pregnancy and labor. While CTG programs are commonplace around the world, especially as a form of continuing nursing education, there has been little progress in Egypt in ensuring that maternity nurses have the skills necessary to perform CTG procedures and interpret the results (International Confederation of Midwives, 2017, James, Madun, & Morton, 2019, Oleiwi & Abbas, 2015, Pehrson, Sorensen, & Amer-Wählin, 2011). Consequently, the researcher undertook this study to determine the effect of educational program on nurses' performance regarding CTG at labor units. **Concerning the studied nurses' sociodemographic characteristics,** According to the present study, the mean age of the nurses was

35.74±8.56 years, and over one-third of them were over the age of 40. Although, over half of them had completed a nursing technical institute and resided in rural areas. Additionally, nearly half of the nurses observed in the study had over ten years of experience, and none of them had participated in a previous CTG training program.

Cardiotocography (CTG) is one of the most commonly used technique for fetal monitoring during labour through recording changes of the fetal heart rate and uterine contractions. One of the most important things nurses do is identify and understand patterns in fetal monitoring. Baseline heart rate, baseline variability, acceleration, deceleration, and the characteristics of different decelerations are the four parameters analyzed in CTG traces. Normal, suspicious, abnormal, and urgently needing action are some ways to classify these traces. (Holmgren, 2020, Lamé et al., 2019, Tamber, ayes, Carey, Wijekoon, & Heazell, 2020).

Thus, maternity must be knowledgeable and have practical skills to recognize any CTG traces alterations that could jeopardize the well-being of the fetus. Lack of knowledge regarding CTG and inaccurate or wrong CTG interpretation findings may cause delayed preventative care actions and endanger the fetal health as well as increases the nurses and woman' anxiety levels (Wisner & Holschuh, 2018, Parhizkar, Latiff, & Aman, 2012).

**In relation to the studied nurses' knowledge regarding CTG at labor units before, immediately and three months after implementation of the educational program,** the current study revealed that **the total knowledge mean score of the studied nurses regarding CTG** was increased from  $14.65 \pm 3.00$  before the program sessions to  $48.92 \pm 2.79$  &  $45.28 \pm 2.33$  immediately and three months after the teaching program sessions respectively with respect to the clarifications of CTG traces mean score that was raised from  $2.85 \pm 1.55$  pre-program to  $12.33 \pm 1.53$  &  $11.18 \pm 1.13$  immediately and three months post program respectively. The score difference noticed is statistically significance before and after implementation of the educational program ( $p = 0.0001^*$ ) **Accordingly, the total knowledge score level of the studied nurses regarding CTG at the present study** revealed that all of the nurses under investigation possessed low level of the pre-program knowledge regarding CTG. That figure grew to include the vast majority of nurses had high level immediately and after program implementation. Nearly two-thirds of the nurses in the study had a high level of understanding about CTG three months after the educational program was started, and over one-third had a moderate level of knowledge. These findings were statistically significant pre- and post-program implementation. These study results are similar with **Al Shamandy et al., (2023)** Where the results show that the nursing students' overall knowledge improved, going from  $19.41 \pm 1.535$  on

the pretest to  $24.27 \pm 2.263$  on the posttest. Similarly, the students' fetal trace interpretation skills improved, going from  $25.92 \pm 2.81$  on the pretest to  $38.18 \pm 5.52$  on the posttest, with a statistically significant difference. Before the program, almost half of the students had a low level of knowledge about fetal transfusions. There was a marked improvement in their posttest knowledge level one month after the session. Again the study findings are in line with **Alhetar et al., (2022)** They found that before participating in the program, most of the nurses had very little information about CTG. Having said that, most of them had a good amount of information right after the program. There was just a small decrease in the nurses' expertise after three months, so it stayed high. This indicates a significant increase in the total score of nurses' knowledge about CTG when comparing the scores **before** and after the program was implemented. Within the same framework, A study conducted by **Goldman & Naidoo, (2021)** concluded poor pre training baseline knowledge regarding CTG monitoring and interpretation with a more significant knowledge improvement post training educational sessions. **As well, Said & Ali, (2020)** proved that poor level of knowledge toward fetal CTG was documented among the majority of the nurses participants pre-program teaching sessions, which significantly improved post-teaching sessions. Additionally, **James, Madun, & Morton, (2019)** identified that more than two third of midwives had limited CTG knowledge and needed

training. On the other hand, **Lee et al., (2019)** supported the current study finding and stated that the pretest total knowledge mean score was  $81.8 \pm 6.1$  and increased to  $91.5 \pm 5.0$  posttest, with the fetal CTG interpretation skill mean score was in pretest  $75.2 \pm 10.2$  and improved to  $86.9 \pm 5.8$  significantly after the simulation course. Also, at the same line a study by **El-Sayed & Saadoon, (2018)** suggesting that there was a discernible change in the mean score of nurses' CTG knowledge and skills between the pretest, immediate posttest, and three-month posttest.

Looking at it from the researcher's point of view, the fact that the majority of the nurses in this study only attended Secondary Nursing and Nursing Technical Institute, and that none of the nurses had any background in CTG may explain why the results are consistent with those of earlier studies. But both at the one-month and three-month marks following program implementation, nurses' CTG knowledge improved noticeably. The nurses' willingness to learn about CTG and its interpretations grew after participating in the educational session, which may explain why they showed such progress despite having no background in the field. Multiple instructional strategies, such as the researcher's use of a CTG machine for explanation, booklet, group discussion, audiovisual materials, and videos, may have contributed to the knowledge progress score. While nurses' knowledge may have decreased three months after the program ended, this may be because

they were not able to keep up with the latest information, were working in an overburdened region, or simply had trouble retaining what they had learned. On the other hand, after the educational program was put into place, all CTG knowledge items generally improved. In the contrary, **Bayley et al., (2013)**, According to their report, training had minimal influence on knowledge levels, and the knowledge disparity could not be resolved by merely providing additional training. Along with it, most of the employees felt the care was of low quality.

Nearly one-third of neonatal deaths occur within the first 24 hrs of delivery as a consequence of labor-related complications such as asphyxia or dyspnea. According to **WHO estimates (2021)**, around 2 million stillbirths are recorded annually which could be prevented through the application of well-known evidence-based practices as electronic fetal monitoring. Impression of fetal well-being with continuous and persistent foetal monitoring with CTG during pregnancy and labor improves neonatal health following delivery. (**Demis et al., 2020, World Health Organization report, 2021**).

Fetal monitoring during labor detects any fetal impairment and enables appropriate intervention. However, suboptimal practices resulting from undertaking CTG is a common issue and still frequently reported in cases of successful obstetric malpractice claims. Hence, the most recommended intervention to enhance electronic fetal monitoring through CTG is educating and training of

maternity nurses. Because they are responsible for detecting and interpreting CTG patterns, alert the physician for complications and initiate corrective and supportive practices or actions when necessary (Alhetar et al., 2022, Al Shamandy et al., 2023, Lamé et al., 2019).

**In relation to the studied nurses' practices regarding CTG at labor units before, immediately and three months after implementation of the educational program**, the present study demonstrated that the total practices mean scores of the studied nurses regarding CTG was increased from  $13.85 \pm 1.57$  before CTG educational sessions to  $58.65 \pm 1.94$  and  $51.94 \pm 3.86$  immediately and three months after CTG training sessions respectively. The CTG Pre-procedure practices mean scores of the nurses studied were 5.54, 23.33, and 21.24 before the educational program was implemented; their procedure practices mean scores were 5.02, 20.30, and 18.63; and their post-procedure practices mean scores were 3.30, 15.02, and 13.44, respectively, indicating a significant improvement in the nurses' practices. There was a statistically significant change in the mean score between the pre- and post-CTG program periods. ( $p = 0.0001^*$ ).

**Thus, the total practices score level of the studied nurses regarding CTG** found that all of the nurses who were part of the trial had unsatisfactory CTG practices level before the program started. In contrast to the first and third months after program introduction, all of the nurses surveyed reported very good CTG practices, with 75% reporting

satisfactory level. Nurses' total practices scores for CTG have improved significantly, according to this analysis ( $p = 0.0001^*$ ).

These results are supported by **Mahmoud et al., (2023)** which showed that when it came to assessing the fetal well-being before the intervention, just under three quarters of the nurses studied had unsatisfactory practices, but when it came to the immediate post-intervention and follow-up phases, the majority had satisfactory practices and over three quarters had satisfactory practices. **Also, Alhetar et al., (2022)** reported that more than four fifths of the studied nurses had poor level of CTG practice prior to program start. Although the majority of nurses reported happy working conditions, there was a marked improvement in nurses' overall practices score level with respect to CTG both immediately following program implementation and at the three-month follow-up.

These results are also identical with **Kelly et al., (2021)** who, demonstrated the fetal monitoring methods, discovered a significantly significant change between the pre- and post-training periods. Meanwhile, **Said & Ali, (2020)** proved that the majority of nurses had highly satisfactory practices after the application of the supportive nursing instructions in contrast to three quarters of unsatisfactory practices before nursing application. In the same context, **Ibrahim & Arief, (2019)** was observed that over 75% of the nurses under investigation had unsatisfactory practices prior to

receiving supportive program instructions. There was a highly statistically significant difference between their pre- and post-intervention practical skills with relation to electronic fetal monitoring, however, after the program's interventions, they significantly improved.

Another study also conducted by **El-Sayed & Saadoon, (2018)**. This finding is consistent with the present study, which demonstrated that notable enhancements were observed in the pre program, immediate post-program, and three months post-program groups. In addition, the current research's findings are consistent with a study conducted by **Ramadan, Mohamed, & Salama, (2018)** who asserted that the nurses' total practices level regarding non-invasive fetal well-being measures had significantly improved in comparison to the pre- and immediate post-program implementation.

The fact that the current study's findings are consistent with those of earlier research suggests that the nurses surveyed had limited understanding of CTG prior to the educational program's introduction, and that many of them mistakenly thought that only doctors could perform the invasive procedure. Furthermore, the unsatisfactory quality of nursing practices prior to the program was caused by a lack of in-service teaching programs, particularly for newly appointed nurses, and a lack of system supervision and assessment of nursing practices in relation to fetal monitoring with CTG. Meanwhile,

the educational training program for CTG, which included motivating demonstrations and re-demonstrations of the CTG procedure and traces interpretation using the CTG device at the study settings mentioned, may have contributed to the significant improvement in the studied nurses' satisfactory practices regarding CTG immediately and three months after program implementation.

Furthermore, the nurses gained knowledge of the CTG procedure nursing function following the implementation of the instructional program. The goal of education is to improve people's ways of thinking and doing through imparting new information and modifying existing practices. The nurses' work overload and lack of continuing in-service training and education likely contributed to a somewhat reduced but still significant decrease in their satisfactory practices scores three months after the program implementation.

**Finally, relating to the correlation between the studied nurses' total knowledge scores and their total practices scores regarding CTG at labor units before and after implementation of the educational program.** The present study's results show that the nurses' total knowledge score and total practices score were significantly correlated with each other both immediately and three months after the training program was started. A study by **Alhetar et al., (2022)** found a highly positive correlation between nurses' CTG knowledge and practices prior to and following program implementation.

**Said and Ali, (2020)**, also detected a statistically significant correlation among maternity nurses' total scores knowledge and practices before and after nursing supportive instructions. As well as, a significant positive improvement of nurses' practices in relation to nurses' knowledge in pre and post program was identified by **Lamé et al., (2019)**. **Other studies as; Ramadan, Mohamed, & Salama, (2018), Thellesen et al., (2017)**, also showed that there were very positive connections between the overall knowledge scores of the nurses who participated in the study and their total practices scores after the program in respect to CTG. **Additionally, El-Sayed & Saadoon, (2018)** highlights, following program execution, a favorable association between the knowledge and practices scores of the nursing interns. This might be because of the profound effect of the CTG training program, which increased nurses' understanding of CTG and led to better CTG practices across the board. CTG is the most frequently employed instrument for the purpose of monitoring the well-being of both the mother and the fetus during pregnancy and labor. The primary responsibilities of maternity nurses are to evaluate expectant women and provide support during childbirth. They should possess a comprehensive understanding of the assessment and identification of fetal heart rate and uterine contraction patterns, be able to report any unsettling patterns to an obstetrician, and initiate supportive measures as needed. It is imperative that all maternity nurses receive CTG

education and training to guarantee that they possess the necessary knowledge, proficient practices, and competence to operate the device and provide high-quality care in a safe and timely manner (**Alhetar et al., Alsaraireh, Yehia, & Khalaf, 2023, World Health Organization, 2022**). After the educational program on CTG was implemented, the research hypothesis was met. Nurses' performance on CTG in labor units improved significantly both immediately and three months later compared to before the program was implemented.

### **In conclusion**

The main finding concluded that the cardiotocography educational program had a positive effect on improving the level of knowledge and practices among the studied nurses working at labor units. Thus, the research aim was achieved and hypothesis was supported.

### **Recommendations**

Based on the findings of the current study, the following recommendations are suggested

#### **Recommendations for hospital administration:**

- Cardiotocography monitoring and its traces should be covered in yearly workshops and training courses for maternity nurses.
- Resuming and reactivating the maternity head nurses' responsibility in supervising, directing and assessing nurses' performance before, during and after CTG procedure and establish plan for improvement.

#### **Recommendations for nurses:**

- Training programs regarding cardiotocography based on recent evidence based practices especially for newly employed maternity nurses.
- Written Arabic instructional booklet about CTG procedure and its traces interpretation should be available for all maternity nurses.

### Recommendations for further research studies:

- A study to determine the effectiveness of using cardiotocography on maternal and neonatal outcomes.
- Reapplication of the study on larger sample for generalization of the findings.

### References

- Abd -El-Razek, A. (2016).** Impact of educational programs about methods of assessment of fetal wellbeing during pregnancy among staff nurses. *Open Journal of Obstetrics and Gynecology*, 6(8), 473-481. Doi: 10.4236/ojog.2016. 68063.
- Abo-Hatab, T., Ahmed, M., Abozeid, E., Gaheen, M., and El-adham, A. (2020).** Effect of various maternal positions on labor pain and fetal heart rate during the first stage of labor. *Journal of Nursing and Health Science*, 9(4),41-59.Doi:10.9790/1959-0904064156.
- Akyıldız, D., Çoban, A., Uslu, F. G., & Taşpınar, A. (2021).** Effects of obstetric interventions during labor on birth process and newborn health. *Florence Nightingale Journal of Nursing*, 29(1), 9. Doi: 10.5152/FNJN.2021.19093.
- Al Shamandy, S., Abd El-Hafez, A., Abd Elrahim, A., Abuzaid, O., & Abdelnaem, S. (2023).** Training program effectiveness on knowledge and interpretation skills of fetal cardiotocography among undergraduate nursing students. *Egyptian Journal of Health Care*, 14(2), 501-516. Doi: 10.21608/ejhc.2023.299216
- Alhetar, S. Z., Ramadan, S. A., Afifi, H. A., & Ibrahim, S. A. (2022).** Effect of educational program on knowledge and practices of maternity nurses regarding cardiotocography. *Journal of Nursing Science-Benha University*,3(1),706-723. Doi:10.21608/JNSBU.2022.21529.
- Bai, J., Lu, Y., Liu, H., He, F., & Guo, X. (2024).** New technologies improve maternal and newborn safety. *Frontiers in Medical Technology*,6(1),1-5. Doi. 10.3389/fmedt.2024.1372358
- Bayley,O., Colbourn,T., Nambiar, B., Costello, A., Kachale, F., Meguid, T., & Mwansambo, C. (2013).** Knowledge and perceptions of quality of obstetric and newborn care of local health providers: a cross-sectional study in three districts in Malawi. *Malawi medical journal*, 25(4), 105-108. Retrieved from <https://pubmed.ncbi.nlm.nih.gov/2492639>.
- Blix, E., Maude, R., Hals, E., Kisa, S., Karlsen, E., Nohr E. (2019).** intermittent auscultation fetal monitoring during labor: a



- systematic scoping review to identify methods, effects, and accuracy. *PLoS ONE*. Retrieved from <https://doi.org/10.1371/journal.pone.0219519> available at 19-2-2024.
- Das, S., Mukherjee, H., Santosh, K. C., Saha, C. K., & Roy, K. (2020).** Periodic change detection in fetal heart rate using cardiotocograph. In 33<sup>rd</sup> International Symposium on Computer-Based Medical Systems: 104-109. Doi:10.1109/CBM49503.2020.00027.
- Demis, A., Getie, A., Wondmienen, A., Bimerew, M., Alemnew, B., & Gedefaw, G. (2020).** Women's satisfaction with existing labour and delivery services in Ethiopia: a systematic review and meta-analysis. *British Medical Journal open*, 10(7), 1-12. Doi:10.1136/bmjopen-2019-036552.
- Dular, S., & Devi, M. (2021).** Effectiveness of Self-Instructional Module on Knowledge Regarding Non Stress Test (NST) among staff nurses working at recognized hospitals in Gurugram. *European Journal of Molecular and Clinical Medicine*, 7(11), 6214-6219. <https://www.researchgate.net/publication/351049311>.
- El-Sayed, H. E., & Saadoon, O. M. (2018).** Effect of educational sessions about cardiotocography on nurses knowledge and skills at labor and high-Risk units. *International Organization of Scientific Research Journal*, 7(3), 8-16. Doi:10.9790/1959-07030508 16.
- Goldman, B., & Naidoo, T. (2021).** Formal training in cardiotocograph interpretation of healthcare practitioner improves interpretation: *A prospective descriptive analytical study in a resource constrained setting. International Journal of Gynecology & Obstetrics*, 153(3), 527-532. Doi: 10.1002/ijgo.13513.
- Gweda, H. A., Ahmed, M. H., Abozeid, E. H., Belal, G. A., & Khalifa, F. M. (2024).** Effect of educational guidelines regarding assessment of fetal well-being during pregnancy on nurses' performance. *Tanta Scientific Nursing Journal*, 33(2), 264-286. Doi:10.21608/TSNJ.2024.35123
- Holmgren, C. (2020).** Interpretation of fetal heart rate monitoring in the clinical context. *Clinical Obstetrics and Gynecology*, 63(3), 625-634. Doi:10.1097/GRF.0000000000000554. <https://www.who.int/news-room/factsheets/detail/newborns-reducing-mortality>, Available at 16-5-2023.
- Ibrahim, W. H., & Arief, A. F. (2019).** Effect of Electronic Fetal Monitoring Educational Program on Knowledge and Interpretations of Internship Nursing Students. *International Journal of Novel Research in Healthcare and Nursing*, 6(1), 384-395. Available at: [www.noveltyjournals.com](http://www.noveltyjournals.com).
- International Confederation of Midwives. (2017).** Core document: International definition

- of the midwife. International Confederation of Midwives.
- James, S., Maduna, N. E., & Morton, D. G. (2019).** Knowledge levels of midwives regarding the interpretation of cardiotocographs at labour units in KwaZulu-Natal public hospitals. *Curationis*, 42(1), 1-7. Doi.org/10.4102/curationis.v42i1.2007.
- Jepsen, I., Blix, E., Cooke, H., Adrian, S. W., & Maude, R. (2022).** The overuse of intrapartum cardiotocography (CTG) for low-risk women: An actor-network theory analysis of data from focus groups. *Women and Birth*, 35(6), 593-601. Doi.org/10.1016/j.wombi.2022.01.003
- Kahveci, B., Melekoglu, R., Evruke, C., Cetin C. (2018).** The effect of advanced maternal age on perinatal outcomes in nulliparous singleton pregnancies. *BioMed Central pregnancy and childbirth Journal*, 18(1), 343. Doi: 10.1186/s12884-018-1984-x
- Kelly, S., Redmond, P., King, S., Oliver-Williams, C., Lamé, G., Liberati, E., & Burt, J. (2021).** Training in the use of intrapartum electronic fetal monitoring with cardiotocography: systematic review and meta-analysis. *An International Journal of Obstetrics & Gynaecology*, 128(9), 1408-1419. Doi: 10.1111/1471-0528.16619.
- Lamé, G., Liberati, E., Burt, J., Draycott, T., Winter, C., Ward, J., & Dixon-Woods, M. (2019).** Improving the practice of intrapartum electronic fetal heart rate monitoring with cardiotocography for safer childbirth: protocol for a qualitative study. *BMJ open*, 9(6), 1-7. Doi:10.1136/bmjopen-2019030271.
- Lee, H. L., Liu, P. C., Hsieh, M. C., Chao, A. S., Chiu, Y. W., & Weng, Y. H. (2019).** Comparison of high-fidelity simulation and lecture to improve the management of fetal heart rate monitoring. *The Journal of Continuing Education in Nursing*, 50(12), 557-562. Doi:10.3928/0022-0124-20191115-07.
- Limbo, R., & Denney-Koelsch, E. M. (2020).** Education in perinatal palliative care for nurses, physicians, and other health professionals. *Perinatal palliative care: a Clinical guide*, 381-403. Doi:10.1007/978-3-030-34751-217.
- Mahjabeen, N., & Nasreen, S. Z. (2022).** Analysis of normal and abnormal admission CTG and its association with perinatal outcomes. *Scholars International Journal of Obstetrics and Gynecology*, 5(2), 32-6. Doi:10.36348/sijog.2022.v05i02.002.
- Mahmoud, E. H., Hassanin, S. A., Emam, A. M., & Abd Elmordy, Z. R. (2023).** Effect of instructional package on maternity nurses' knowledge and practices regarding assessment of fetal well-being. *Benha Journal of Applied Sciences*, 8(4), 167-178. Doi:10.21608/bjas.2023.191715.1053

- Maraikkayar, S. S., Tamilselvi, R., & Beham, M. P. (2023).** A Novel Biophysical profile database for fetal stress measurement in high-risk pregnancies. *Biomedical and Pharmacology Journal*, 16(4), 2192204. Doi: <https://dx.doi.org/10.13005/bpj/2796>.
- Mckinney, E. S., James, S. R., Murray, S. S., Nelson, K., & Ashwill, J. (2021).** Maternal-child nursing-e-book. Elsevier Health Sciences.
- Mdoe, P. F., Ersdal, H. L., Mduma, E. R., Perlman, J. M., Moshiri, R., Wangwe, P. T., & Kidanto, H. (2018).** Intermittent fetal heart rate monitoring using a fetoscope or hand held Doppler in rural Tanzania: a randomized controlled trial. *BMC pregnancy and childbirth*, 18(1), 1-8. Doi: 10.1186/s12884-018-1746-9.
- Murray, S., Fox, D. J., Coddington, R. L., & Scarf, V. L. (2024).** How does the use of continuous electronic fetal monitoring influence women's experiences of labour? A systematic integrative review of the literature from high income countries. *Women and Birth*, 37(4), 1-10. Doi: <https://doi.org/10.1016/j.wombi.2024.101619>
- Ogenyi, P., Chiegwu, H. U., England, A., Akanegbu, U. E., Ogbonna, O. S., Abubakar, A., & Dauda, M. (2022).** Appraisal of trimester-specific fetal heart rate and its role in gestational age prediction. *Radiography*, 28(4), 926-932. Doi: [org/10.1016/j.radi.2022.06.015](https://doi.org/10.1016/j.radi.2022.06.015)
- Olewi S. S., & Abbas. I. M. (2015).** The effectiveness of an education program concerning cardiotocography on nurse-midwife's knowledge in Maternity Hospitals in Baghdad City. *IOSR Journal of Nursing and Health Science*, 4(5), 33-42. Doi: 10.9790/1959-04543342
- Olewi S.S. (2018).** Effectiveness of an education program concerning cardiotocography on nurses-midwives practice in maternity hospitals at Baghdad city. *Iraqi National Journal of Nursing Specialties*, 31(1), 24-34. Retrieved from <https://www.injns.uobaghdad.edu.iq/index.php/INJNS/article/download/289/277>.
- Parhizkar, S., Latiff, L. A., & Aman, N. B. (2012).** Midwifery Nurses' Skill to Interpret Cardiotocogram: A Cross Sectional Study. *International journal of healthscience and research*. 2(6), 28-34. Retrieved from <https://www.researchgate.net/publication/300289026>.
- Pehrson, C., Sorensen, J. L., & Amer-Wählin, I. (2011).** Evaluation and impact of cardiotocography training programmes: a systematic review. *BJOG: An International Journal of Obstetrics & Gynaecology*, 118(8), 926-935. Doi: 10.1111/j.14710528.2011.03021.x.
- Pereira, S., Lau, K., Modestini, C., Wertheim, D., and Chandrachan, E. (2022).** Absence of fetal heart rate cycling on the intrapartum cardiotocograph (CTG) is

- associated with intrapartum pyrexia and lower Apgar scores. *The Journal of Maternal-Fetal & Neonatal Medicine*, 35(25), 7980-7985. Doi: 10.1080/14767058.2021.1940130
- Ramadan, S. A., Mohamed, A. I., & Salama, A. M. (2018).** Maternity nurses' performance regarding non-invasive fetal wellbeing measures: Educational intervention. *Journal of Nursing and Health Science*, 7(1), 2320. Doi: 10.9790/1959-0701060819
- Ramli, I., Posadino, A. M., Giordo, R., Fenu, G., Fardoun, M., Itratni, R., & Pintus, G. (2023).** Effect of resveratrol on pregnancy, prenatal complications and pregnancy-associated structure alterations. *Antioxidants*, 12(2), 341. Doi: org/10.3390/antiox1202034.
- Rodgers, C., C. (2020).** Continuous electronic fetal monitoring during prolonged labor may be a risk factor for having a child diagnosed with autism spectrum disorder. *Medical Hypotheses*, 145,(1), 1-6. Doi: org/10.1016/j.mehy.2020.110339
- Said, A. R., & Ali, H. A. (2020).** Effect of supportive nursing instructions for maternity nurses regarding electronic fetal monitoring. *International Journal of Nursing Science*, 10(1), 1-11. Doi: 10.5923/j.nursing.20201001.0.
- Smith, V., Begley, C., Newell, J., Higgins, S., Murphy, D. J., White, M. J., & Devane, D. (2019).** Admission cardiotocography versus intermittent auscultation of the fetal heart in low-risk pregnancy during evaluation for possible labor admission— multicentre randomised trial. *An International Journal of Obstetrics & Gynaecology*, 126(1), 114-121. Doi: 10.1111/1471-0528.15448.
- Stone, P. R., Burgess, W., McIntyre, J. P., Gunn, A. J., Lear, C. A., Bennet, L., & Maternal Sleep In Pregnancy Research Group, The University of Auckland. (2017).** Effect of maternal position on fetal behavioral state and heart rate variability in healthy late gestation pregnancy. *The Journal of physiology*, 595(4), 1213-1221. Doi: 10.1113/JP273201.
- Tamber, K. K., Hayes, D. J., Carey, S. J., Wijekoon, J. H., & Heazell, A. E. (2020).** A systematic scoping review to identify the design and assess the performance of devices for antenatal continuous fetal monitoring. *Public Library of Science PloS one*, 15(12), 1-31. Doi: 10.1371/journal.pone.0242983.
- Thellesen, L., Bergholt, T., Hedegaard, M., Colov, N. P., Christensen, K. B., Andersen, K. S., & Sorensen, J. L. (2017).** Development of a written assessment for a national interprofessional cardiotocography education program. *BMC Medical Education*, 17(1), 1-9. Doi: 10.1186/s12909-017-0915-2.

- Uusiku, L., James, S., Sonti, I., & Tuhadeleni, O. (2021).** Midwives' perceptions regarding the use of the cardiotocograph machine as an intrapartum monitoring tool in namibia: a qualitative research study. *Global Journal of Health Science*, 14(1), 16. Doi: 10.5539/gjhs.v14n1p16.
- Wahyuningsih, D., & Linggardini, K. (2022).** Correlation between maternal knowledge about danger sign and antenatal care visit compliance in the health care center. *Proceedings Series on Health & Medical Sciences*, 3(1), 28-31. Retrieved from. [https://doi.org/ 10.30595/pshms.v3i.615](https://doi.org/10.30595/pshms.v3i.615)
- Wisner, K., & Holschuh, C. (2018).** Fetal heart rate auscultation. *Nursing for Women's Health*, 22(6), 32. Retrieved from. [https://doi.org/ 10.1016/j.nwh.2018.10.001](https://doi.org/10.1016/j.nwh.2018.10.001)
- World Health Organization. (2021).** Improving Survival and Well-being. Retrieved from. <https://www.who.int/news-room/factsheets/detail/newbornsreducing-mortality>, Available at 16-5-2023.
- Yu, Z., Hu, Y., Lu, Y., Li, L., Ge, H., & Fu, X. (2024).** Reliable fetal heart rate signal generation using. *International Joint Conference on Neural Networks*, 1-8. Doi: 10.1109/ICNN60899.2024.10650729