Effect of Virtual PRECDE Model Application on Pregnant Women's Knowledge and Reported Practices Regarding Preventive Behaviors of Preeclampsia

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Abstract

Background: Worldwide, preeclampsia is an increasingly leading cause of maternal and fetal morbidity and mortality. Preeclampsia prevention requires an effective, ongoing, and easily accessible educational model. **Aim:** To evaluate the effect of virtual PRECDE model application on pregnant women's Knowledge and reported practices regarding preventive behaviors of preeclampsia. **Design:** A quasi-experimental research design (pre and posttest) was used. **Settings:** The study was conducted at Antenatal Outpatient Clinics in the New Obstetrics and Gynecology Hospital, Mansoura City, Dakahlia Governorate, Egypt. **Subjects:** A purposive sample of 118 high-risk pregnant women for preeclampsia. **Tools:** Three questionnaires were utilized; A structured interviewing questionnaire, knowledge questionnaire for Predisposing, Enabling, and Reinforcing factors (PRECEDE Model) and pregnant women's reported practices of preeclampsia preventative behaviors questionnaire. **Results:** There was statistically significant increase in the total knowledge scores of predisposing, enabling, and reinforcing factors both immediately and one month later. Furthermore, one month after the intervention pregnant women exhibited satisfactory practices towards preeclampsia preventive measures compared to pre-intervention. Also, the majority of high-risk pregnant women did not develop preeclampsia following the use of PRECDE Model intervention. **Conclusion:** The current study hypotheses were accepted where the application of virtual PRECEDE model was an effective tool to improve pregnant women's knowledge and practices regarding preventive behaviors of preeclampsia. **Recommendation:** Incorporating nursing interventions guided by the PRECEDE model into routine prenatal care for the expected high risk pregnant women to prevent the occurrence of preeclampsia.

Keywords: Knowledge, PRECEDE model, Preventive behaviors of preeclampsia & Practices.

Introduction

It's important to note that after the 20th week of pregnancy, women with normal blood pressure and no history of protein in their urine may develop preeclampsia (PE), which is a pregnancy-specific disorder characterized by hypertension, proteinuria (> 300 mg/day), and edema. Therefore, it's essential to monitor blood pressure and urine protein levels regularly during pregnancy to detect any signs of preeclampsia **(Chang et al., 2023).** Worldwide, Preeclampsia leads to maternal morbidity and ranks among the top five causes of maternal and neonatal fatalities **(Abd Elgwad et al., 2021)**.

In fact, the risk factors for preeclampsia can vary from woman to woman. Those who have a previous history of hypertensive disease during pregnancy or have a maternal disease such as chronic kidney disease, autoimmune diseases, diabetes, or chronic hypertension may be at higher risk. It's important for pregnant women to discuss any potential risk factors with their healthcare provider to ensure proper monitoring and care throughout their pregnancy **(Fox et al., 2019).**

Additionally, gestational hypertension, polycystic ovarian syndrome, and existence of other infections such as urinary tract infections and helicobacter pylori increase the risk for preeclampsia. The risk for preeclampsia may be moderate with family history of preeclampsia, nulliparity, increase body mass index (BMI) of more than 35 kg/m, advanced maternal age, large interval more than ten years between pregnancies, and multiple pregnancy **(Sabry et al., 2021)**

According to **Helmy & Ibrahim, (2020)** preeclampsia has negative impact on both maternal and neonatal pregnancy outcomes. For the mother, the possibility of eclampsia, preterm delivery, placental abruption, increased rates of cesarean sections, postpartum hemorrhage, and maternal mortality. Negative outcomes for the newborns include asphyxia at birth, prematurity, intrauterine growth retardation and admission to the intensive care unit **(Alnuaimi et al., 2020).**

Finding a high-risk pregnancy requires screening for PE in order to continue preventive management and supportive care during the antenatal period **(Ayed & Ibrahim, 2021)**. Preeclampsia can be prevented by reducing the number of pregnancies in women who are high-risk for the condition, enhancing the nutritional intake of women through dietary salt

restriction, calcium and vitamin D supplementation, lifestyle modifications, and exercise to lower the risk of the condition, and lowering stress levels to enhance the mental health of mothers. In addition, taking enough rest and beginning low-dose aspirin at or before 16 weeks of pregnancy to target placental pathology are potential interventions to reduce the occurrence of preeclampsia **(Moulaei et al., 2021).**

Numerous models and preventive techniques were created to emphasize lessening the possibility of preeclampsia occurrence rather than treatment **(Poniedziałek-Czajkowska et al., 2023).** The PRECEDE model is currently regarded as one of the most significant and useful theories in the field of health promotion. PRECEDE is an acronym for predisposing, reinforcing, and enabling constructs in diagnostic and evaluative frameworks for education and the environment **(Saulle et al., 2020).** According to a systemic review conducted by **Kim et al. (2022)** there is limited studies that have confirmed the effectiveness of the PRECEDE model in the health promotion and prevention of preeclampsia. While the model provides a framework for planning and implementing health promotion programs, more research is needed.

Significance of the study

Preeclampsia is the most common obstetrical complication during pregnancy and one of the three main causes of maternal morbidity and death globally, with a higher incidence in low- and middle-income countries **(Mohammed et al., 2022).** Preeclampsia affects pregnant women in developing countries between 1.8% and 16.7%. 10% of the African women experience preeclampsia, a rate significantly higher than the 2% global rate**.** An Egyptian study to ascertain the prevalence of hypertensive disorders during pregnancy found that 4.2% of pregnant women had pregnancy-induced hypertension, 3.8% had preeclampsia, and 0.3% had eclampsia **(Belay & Wudad, 2019).**

Despite presence of approved medical management for preeclampsia, complications can occur in women who aren't adhering to the prescribed medical regimen. Therefore, identification of pregnant women who are at risk for PE is very important. In this context, numerous research studies have focused on predicting, preventing, and treating PE, including efforts to identify biomarkers in plasma, implement lifestyle interventions, and develop drug prophylaxis **(Chen et al., 2024).** Additionally, the application of preventive interventions such as the PRECEDE model is crucial for enhancing women's knowledge and preventive practices and preventing the occurrence of preeclampsia, despite the limited number of studies that investigate the effect of the

PRECEEE model on the prevention of preeclampsia. Therefore, the researchers conducted the current study.

Operational definitions:
 PRECEDE
It is acronym to predisposing, reinforcing, and enabling constructs in educational diagnosis and evaluation.

Predisposing factors knowledge:
They are pregnant women's knowledge about preeclampsia such as definition, risk factors, symptoms, etc.

Enabling factors knowledge:
They are pregnant women's knowledge regarding the factors that help them change their behaviors, such as preeclampsia educational programs attendance, resources, and access to medical services, and help in the prevention of preeclampsia.

Reinforcing factors knowledge:
They are pregnant women's knowledge regarding the factors that enhance and motivate the desired behavioral changes, such as emotional support and getting assistance from family or health care providers.

Aim of the Study
The study aimed to evaluate the effect of virtual PRECDE model application on pregnant women's Knowledge and reported practices regarding Preventive behaviors of Preeclampsia

Hypotheses
In order to achieve the goal of this study, two hypotheses were tested:

Hypothesis (1): High risk pregnant women's who apply the virtual PRECEDE model have higher knowledge scores regarding preeclampsia Preventive behaviors after application than before.

 Hypothesis (2): High risk pregnant women's who apply the virtual PRECEDE model have higher satisfactory practices scores regarding preeclampsia Preventive behaviors after application than before

Subjects and Method

Research Design
A quasi-experimental design (one group pre and posttest) was used in this study. It is an empirical interventional research that does not utilize randomization in order to define the causal effects of an intervention on the target population**.**

Study Setting
The study was carried out in the New Obstetrics and Gynecology Hospital's Antenatal Outpatient Clinics in Mansoura, Dakahlia Governorate, Egypt. The clinics comprises five sections, including the ultrasonography section, antenatal examination section (which constitute of three rooms for examining normal and high-risk pregnant women),

gynecological examination section, vesicular mole section, and nursing staff room section. In addition, there is a women's waiting area and a lecture hall with sufficient seating capacity. The clinic is open every day from 9:00 a.m. to 12:00 p.m., Sunday through Wednesday. All pregnant women can receive therapeutic and diagnostic treatments from the Antenatal clinics.

Sampling

A study sample was purposive and consisted of 118 high-risk pregnant women for preeclampsia who were admitted to the previously described setting and fulfilled the following requirements;

- Aged from 18 to 40 years.
- Had a single living fetus.
- Women in first trimester of pregnancy.
- Educated and own an Android smartphone with Wi-Fi access.
- At risk for developing preeclampsia, such as preexisting hypertension, having previous or family history of preeclampsia, etc.

Exclusion criteria

Pregnant women suffering from psychiatric and chronic diseases.

Sample size calculation

The sample size required for the study is 118. This was calculated using a formula that takes into account the level of significance, power of the study, standard deviation obtained from a previous study, and the expected difference. It's important to ensure that the sample size is appropriate for the study to achieve accurate and reliable results.

Based on data from literature **(Elagamy et al., 2021)**, considering level of significance of 5%, a power of study of 80%, the sample size can be calculated using the following formula:

$$n = \frac{(Z\alpha/2 + Z\beta)^2 \times 2(SD)^2}{d^2}$$

where, SD = standard deviation obtained from previous study; $Z_{\alpha/2}$, for 5% this is 1.96; Z_β, for 80% this is 0.84 and d, for the expected difference. Therefore,

$$n = \frac{(1.96 + 0.84)^2 \times 2(0.52)^2}{(0.19)^2} = 117.4.$$

Based on the above formula, the sample size required is 118.

Tools of data collection

Three tools were used for collecting data as follows:

Tool I: A structured interviewing questionnaire: It was created by the researchers and was divided into the following two parts**: the first part** included general characteristics of the studied pregnant women as age, residence, educational level, occupation, weight, height, BMI and telephone number. **The**

second part included obstetric history such as number of gravidity, abortions and family & previous history of preeclampsia.

Tool II: Knowledge questionnaire for Predisposing, Enabling, and Reinforcing factors (PRECEDE Model): Researchers adapted it following a review of the literature **(Sabry et al., 2021)** It had the following components:

Part (1): Predisposing factors knowledge based on PRECEDE model which included six questions covering preeclampsia such as definition, risk factors, symptoms, complications, management and preventive measures.

Scoring system:

The "complete correct" answer received a score of (2), the "partially correct" answer received a score of (1), and the "incorrect" answer received a score of (0). A higher score denotes superior understanding. The overall score for the test is between 0 and 12. The score was divided into three categories: "poor knowledge" for scores less than 50%, "fair knowledge" for scores between 50% to less than 75%, and "good knowledge" for scores greater than or equal to 75%.

Part (2): Evaluation of enabling factors knowledge based on PRECEDE model: It comprised of three questions about PE, including whether the woman knew that attending a preeclampsia educational program is necessary, the resources and access to medical services that help in preventing preeclampsia.

Part (3): Evaluation of reinforcing factors knowledge based on PRECEDE model: It compromised of two questions regarding receiving emotional support from family members and getting assistance from medical professionals in implementing preeclampsia preventative behaviors.

Scoring system for Parts (2) and (3):

Each question that received a "Yes" response was given one score, while those that received a "No" response was given zero score.

Tool III: Pregnant women's reported practices of preeclampsia preventative behaviors; the researchers created this questionnaire following reviewing of the literature **(EL Sayed et al., 2020; Elagamy et al., 2021)** and included eleven questions to assess the practices of preeclampsia preventative behaviors, such as exercising regularly, sleep enough during daytime, following the suggested diet to prevent preeclampsia, consuming supplements of calcium and vitamin D, getting enough water (8 to 10 glasses of water) each day, managing and coping with stress (Benson relaxation), checking blood pressure frequently, looking for protein in the urine by dipstick daily, checking the weight daily, taking medications as directed and having routine check-ups with the doctor.

Scoring system:
The scoring system worked out as follows: (0) for "no" and (1) for "yes." The evaluation of the questionnaire yielded a score between 0 and 11. "Satisfactory and unsatisfactory practices" were defined as follows: unsatisfactory practices < 50% and satisfactory practices ≥ 50% based on each woman's overall score. Higher overall scores imply the practice of preventative behaviors, while lower scores denote the non-practice of all preventive behaviors components.

Validity and reliability of the tools:
Three experts in the field of Woman's Health and Midwifery Nursing, Faculty of Nursing, Mansoura University evaluated the study tools for their coverage clarity, content, length, wording, format, and overall appearance. Based on their comments, the suggested modifications were taken into consideration in order to make some statements easier to be understood. The reliability of the tools was assessed through Cronbach's alpha test. It was 0.872 for the knowledge tool, and 0.903 for the practice tool which indicated high reliability of the study tools.

Pilot study
Ten percent (12 pregnant women at high risk of preeclampsia who were not included in the main study sample) participated in a pilot study to assess the feasibility of the research process, the objectivity of the study instruments, and their applicability. Pilot study's findings suggested that the instruments were understandable, and useful.

Ethical considerations
The Faculty of Nursing at Mansoura University's Research Ethics Committee granted ethical approval, reference number P. (0378). Official written approval from the director of the antenatal outpatient clinic was obtained. Women were told that taking part in the study was completely voluntary. They were also informed that they had the right to leave the study at any point. All of the women gave their informed written consent after being informed of the study's purpose. Additionally, they received assurances regarding the confidentiality, privacy, safety, and anonymity of the data gathered during the entire study.

Field Work
The data was carried out from the beginning of March 2023 to the end of July 2023 through the following four phases:

Preparatory phase
The researchers gathered the related relevant national and international literature; the study tools were prepared and verified. Then, the content of the educational sessions guided by PRECEDE model about preeclampsia were designed. Booklet was written in a simple Arabic language, covered all contents of the sessions based on the PRECEDE model, and printed out according to the sample size. Additionally, the researchers created WhatsApp group to send the content of educational sessions and the link of zoom meeting for each session.

Assessment phase
The researchers attended the Antenatal Outpatient Clinics three days per week till attained the predetermined sample size. The researchers introduced themselves to the women, checked their eligibility according to the inclusion criteria of the study, and attained their written consent to take part in it after clarification of the study's objectives. After that, the researchers obtained the contact number of the pregnant women and the researcher's contact number was given to them. Each woman was interviewed separately for twenty minutes to collect general and obstetric data using a structured interviewing questionnaire (tool I). Then, a pre-test was carried out using the PRECEDE Model questionnaire to evaluate the pregnant woman's knowledge regarding predisposing, enabling, and reinforcing factors for prevention of preeclampsia. Also, the women's reported practices regarding preeclampsia prevention were evaluated using tools III. At the end of the assessment phase the educational booklet regarding prevention of preeclampsia was given to the women to use it as a guide.

Implementation phase
The researchers added the women to the WhatsApp group. Four preeclampsia educational sessions, based on the PRECEDE model, were provided to the eligible high-risk pregnant women according to appropriate dates and times that had been set with them. Six groups, each with twenty women except the last group had eighteen women, were formed, and each group received three theoretical and one practical session. One session every week for four weeks lasted between 45 to 60 minutes. **The content of the sessions was as follows:**

The first session covered Preeclampsia definition, along with its risk factors, symptoms, complications, management, and preventive behaviors of preeclampsia. **The second session** focused on education regarding enabling factors which included resources and supportive approaches that are essential for carrying out behavior and reinforcing factors which included the methods of support as well as the significance of seeking family and medical professionals' support in conducting preventive behaviors.

The third session focused on pregnant women's preeclampsia preventive practices, such as educating them about the importance of getting enough sleep (8 hours or more per day), resting during the day,

maintaining a healthy diet that includes lots of protein and is low in salt and fat, and drinking enough water (8 to 10 glasses of water daily). Additionally, pregnant women's education on blood pressure self-monitoring, regular blood pressure recording, self-weighing, urine protein analysis by dipstick, adherence to the doctor's prescription, and scheduled routine check-ups. **Finally, the fourth session was the practical one,** which focused on practicing exercises during the session by opening the phone camera and imitating the researchers stretching exercises and other relaxation activities.

Several methods of education were used during the sessions, such as videos, attractive pictures, and booklets. At the end of every session, the researchers emphasized their conclusions regarding the key topics of each session. Each group of women received the same educational sessions. The researchers followed the women by phone to ensure their adherence to the preventive practices.

Evaluation phase

The main focus of the study was to evaluate the knowledge and reported practices of high risk pregnant women. Knowledge evaluation was conducted twice: first immediately after applying the PRECDE model and then again a month later, while the reported practices occurred one month after the PRECDE model application. A Google Form questionnaire was used for evaluation purposes. The secondary outcome was to determine the number of cases that developed preeclampsia. This was identified through a single question during the final interview and confirmed by revising the medical record of the participant women.

Statistical analysis

The statistical analyses were conducted using version 20.0 of SPSS for Windows (SPSS, Chicago, IL). The mean ± standard deviation (SD) were used to present continuous data that had a normal distribution. Categorical data were expressed as numbers and percentages. The chi-square test was used to compare variables related to categorical data. Additionally, the reliability (internal consistency) of the study's questionnaires was calculated. Statistical significance was set at $p < 0.05$.

Results

Table (1): General characteristics of the studied pregnant women   (n=118)

Variables	No. (n=118)	%
Age (years)		
Less than 30	103	87.3
30 - 40	15	12.7
Mean ±SD	25.1 ±3.7	
Educational Level		
Basic Education	10	8.5
Secondary Education	58	49.2
High Education	46	39.0
Post Graduate	4	3.4
Residence		
Urban	23	19.5
Rural	95	80.5
Occupation		
Housewife	102	86.4
Working	16	13.6
BMI (kg/m2)		
Underweight	6	5.1
Normal	58	49.1
Overweight	39	33.1
Obese	15	12.7
Mean ±SD	25.8 ±5.2	

Table (2): Obstetric history of the studied pregnant women (n=118)

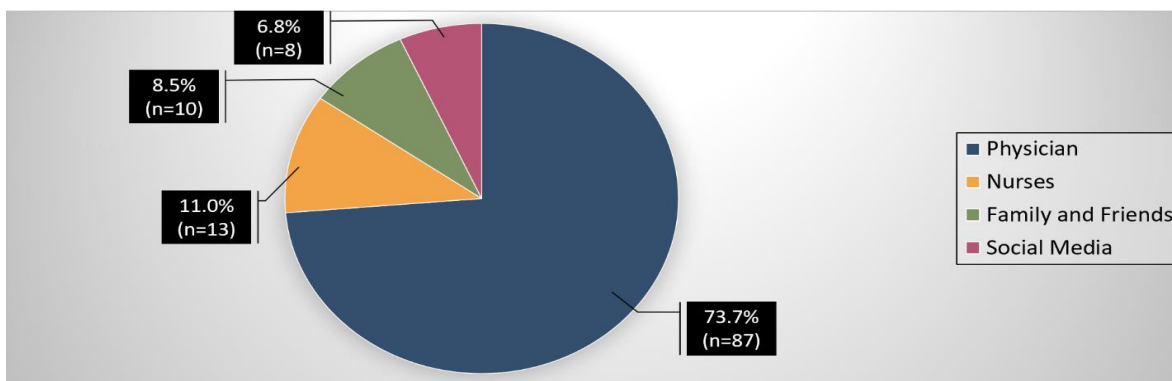| Variables	No. (n=118)	%
Gravidity		
One	43	36.4
Two or More	75	63.6
Mean ±SD	2.0 ±0.8	
Abortion		
None	110	93.2
One	8	6.8
Previous history of preeclampsia		
Yes	27	22.9
No	91	77.1
Family history of preeclampsia		
Yes	32	27.1
No	86	72.9

Figure (1): Distribution of Preeclampsia Information Sources among studied pregnant women

Table (3): The studied pregnant women's knowledge (Predisposing factors) based on PRECEDE model (n= 118)

Variables	Pre-intervention		Immediately after-intervention		After one month		Significance test	
	No.	%	No.	%	No.	%	X^2	P
Definition of preeclampsia								
Incorrect	99	83.9	6	5.1	8	6.8		
Partially Correct	12	10.2	15	12.7	23	19.5		
Completely Correct	7	5.9	97	82.2	87	73.7	230.178	<0.001**
Risk factors of preeclampsia								
Incorrect	90	76.3	4	3.4	7	5.9		
Partially Correct	24	20.3	11	9.3	18	15.3		
Completely Correct	4	3.4	103	87.3	93	78.8	235.427	<0.001**
Symptoms of preeclampsia								
Incorrect	110	93.2	6	5.1	8	6.8		
Partially Correct	6	5.1	11	9.3	17	14.4		
Completely Correct	2	1.7	101	85.6	93	78.8	269.096	<0.001**
Complications of preeclampsia								
Incorrect	15	12.7	8	6.8	10	8.5		
Partially Correct	100	84.7	6	5.1	13	11.0		
Completely Correct	3	2.5	104	88.1	95	80.5	233.435	<0.001**
Management of preeclampsia								
Incorrect	100	84.7	8	6.8	7	5.9		
Partially Correct	15	12.7	10	8.5	16	13.6		
Completely Correct	3	2.5	100	84.7	95	80.5	240.724	<0.001**
Preventive behaviors of preeclampsia								
Incorrect	100	84.7	11	9.3	12	10.2		
Partially Correct	14	11.9	13	11.0	20	16.9		
Completely Correct	4	3.4	94	79.7	86	72.9	210.109	<0.001**

**Highly Statistically Significant at P<0.001

Table (4): The studied pregnant women's knowledge (Enabling and Reinforcing factors) based on PRECEDE model (n= 118)

Variables	Pre-intervention		Immediately after-intervention		After one month Post-intervention		Significance test	
	No.	%	No.	%	No.	%	X²	P
Enabling Factors								
Attend a preeclampsia educational program	11	9.3	118	100.0	118	100.0	306.704	<0.001**
Aware of the resources for managing and preventing preeclampsia	8	6.8	107	90.7	103	87.3	224.975	<0.001**
Have an easy access to medical services	24	20.3	53	44.9	59	50.0	25.098	<0.001**
Reinforcing Factors								
Receive emotional support from family members in implementing preeclampsia preventative behaviors	21	17.8	92	78.0	86	72.9	106.756	<0.001**
Have assistance from medical professionals in implementing preeclampsia preventative behaviors	18	15.3	105	89.0	101	85.6	175.954	<0.001**

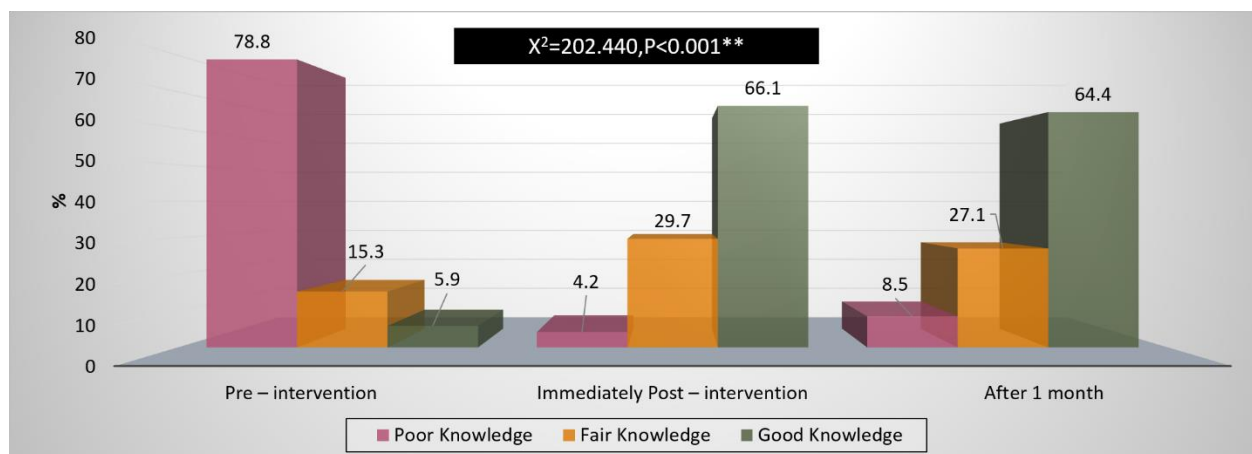***Highly Statistically Significant at P<0.001*

Figure (2): Total knowledge (predisposing, enabling and reinforcing factors) scores regarding preeclampsia preventative behaviors among the studied pregnant women

Table (5): Pregnant women's reported practices of preeclampsia preventive behaviors pre and after one month of the intervention (n= 118)

| Variables	Pre-intervention		After 1 month		Significance test	
	No.	%	No.	%	X²	P
Engaging in regular exercise daily as walking	12	10.2	91	77.1	107.517	<0.001**
Consuming recommended diet	9	7.6	95	80.5	127.146	<0.001**
Consuming calcium and vitamin D supplementation during pregnancy	72	61.0	104	88.1	22.885	<0.001**
Drinking enough water (8 - 10 glasses of water daily)	21	17.8	110	93.2	135.904	<0.001**
Taking rest and adequate sleep (for 8 hours or more per day)	98	83.1	113	95.8	10.066	0.002*
Managing and coping with stress (Benson relaxation)	95	80.5	116	98.3	19.730	<0.001**
Measuring blood pressure frequently	9	7.6	106	89.8	159.578	<0.001**
Checking urine for protein by dipstick daily	9	7.6	106	89.8	159.578	<0.001**
Checking and recording weight daily	11	9.3	108	91.5	159.486	<0.001**
Following the prescribed medication regimen	94	79.7	113	95.8	14.192	<0.001**
Having regular follow up with the physician	22	18.6	89	75.4	76.353	<0.001**
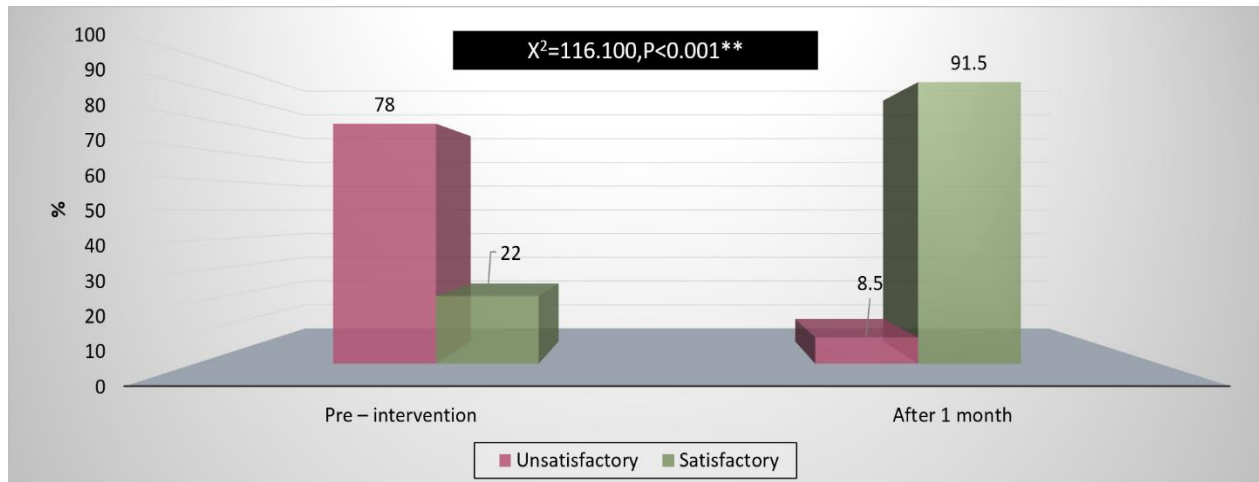
Figure (3): Total practice scores regarding preeclampsia preventive behaviors among the studied pregnant women
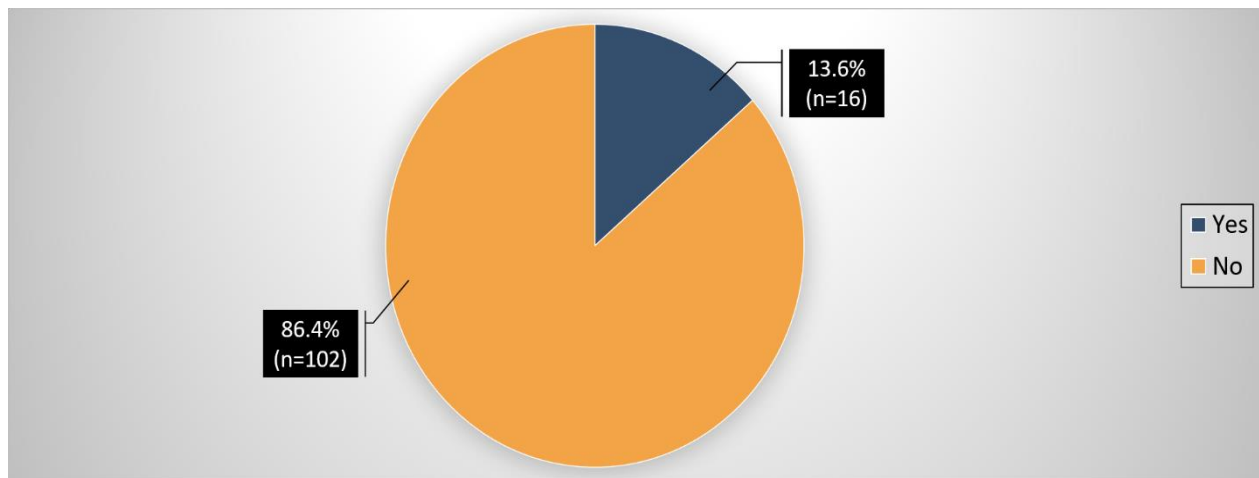

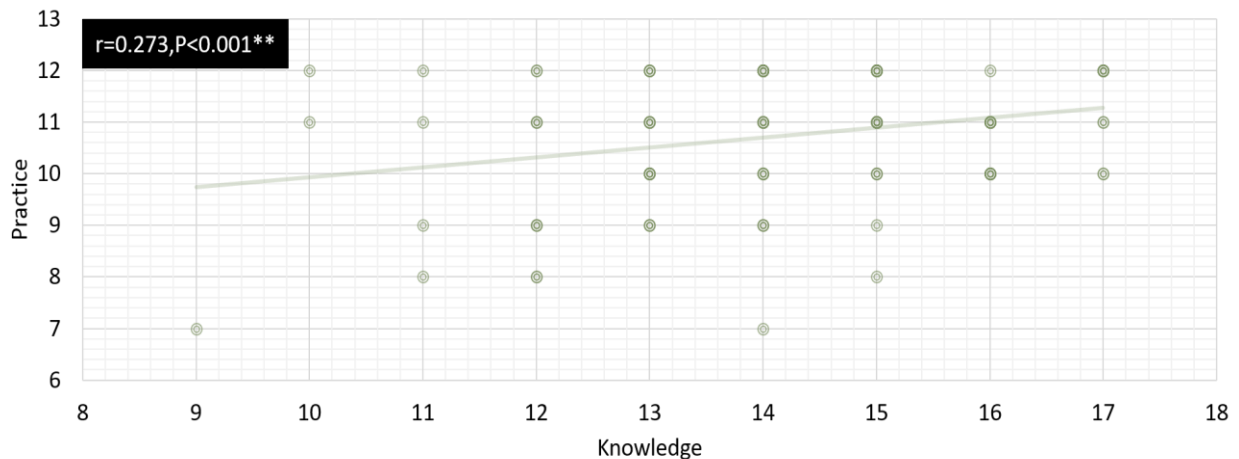**Figure (4): Occurrence of preeclampsia among the studied pregnant women after PRECEDE model application**

Figure (5): Correlation between total knowledge and total practice scores of the studied pregnant women one month post-intervention

Table (1): Presents that 87.3% of the studied pregnant women were less than 30 years old, with a mean age of 25.1 ±3.7. Regarding education, 49.2% of them were secondary educated. Concerning residences, 80.5% were rural residences. In addition, 86.4% and 49.1%, respectively, of the studied women were housewives and had a normal BMI.

Table (2): Demonstrates that 63.6% of the studied pregnant women had more than one pregnancy. 22.9% & 27.1%, respectively of the studied pregnant women had previous and family history of preeclampsia.

Figure (1): Shows that 73.7% of pregnant women get their information about preeclampsia from their physicians, while a small percentage of them get their information from nurses (11.0%), family and friends (8.5%), and social media (6.8%).

Table (3): Denotes that there were highly statistically significant improvements in all items of pregnant women's knowledge (predisposing factors) immediately and after one month post-intervention. The most points enhanced immediately after intervention were risk factors and complications of preeclampsia (87.3% and 88.1%, respectively). The score of all predisposing factors slightly declined after one month compared to the immediate posttest; however, the levels were still significantly higher than pre-intervention.

Table (4): Shows that, both immediately after the intervention and one month later, pregnant women's knowledge of the enabling and reinforcing factors for the prevention of preeclampsia improved in a highly statistically significant way across all items.

Figure (2): Presents that 78.8% of the studied pregnant women had poor knowledge regarding preeclampsia pre-intervention, whereas 66.1% and 64.4%, respectively, of them had good knowledge immediately and one month post-intervention. There was a highly statistically significant increase (p<0.001) in the total knowledge score post-intervention.

Table (5): Shows that there was a highly statistically significant improvement in all items of preeclampsia preventive practices post-intervention (p <0.001) compared to pre-intervention, where the highest percentages (98.3%, 95.8%, 95.8%, and 93.2%, respectively) were observed with managing and coping with stress, taking rest and adequate sleep, following the prescribed medication regimen, and drinking enough water daily (8–10 glasses of water).

Figure (3): Explains that, one month after the intervention, the number of pregnant women who had unsatisfactory practices for preventing preeclampsia decreased to 8.5% from 78% prior to the intervention. However, one month following the intervention, 91.5% of the pregnant women had satisfactory preeclampsia prevention behaviors, compared to only 22% prior to the intervention.

Figure (4): Clarifies that, after application of the PRECDE Model intervention on high-risk pregnant women for preeclampsia, only 13.6% of women develop preeclampsia.

Figure (5): Demonstrates that, over the course of the educational intervention phases, there was a statistically significant positive correlation between the high-risk pregnant women's reported practice scores and their overall knowledge scores.

Discussion

The present study was conducted to evaluate the effect of virtual PRECDE model application on pregnant women's Knowledge and reported practices regarding preventive behaviors of preeclampsia. This aim was achieved through the present study findings which revealed that, there was a statistical significant increase in both; total knowledge score and total score of preeclampsia preventive practices post PRECEDE model application than before.

The present study's findings showed that the virtual PRECEDE model application was a useful tool for raising pregnant women's knowledge scores on all preeclampsia prevention-related items both immediately and one month later. Thus, the first study hypothesis was confirmed "High risk pregnant women's who apply the virtual PRECEDE model have higher knowledge scores regarding preeclampsia preventive behaviors after application than before"

The results of the current study are in line with a study carried out at Tanta and Sohag University Hospitals by **Elagamy et al. (2021)** to assess the effect of nursing intervention directed by the PRECEDE model on high-risk pregnant women's knowledge and adherence to preeclampsia preventive measures. The study found that both immediately and one month after the adoption of a nursing intervention, the mean knowledge, enabling, and reinforcing factors score about preeclampsia increased with statistical significance. Similarly, a quasi-experimental study conducted by **Teltumbde et al. (2021)** to assess "the effectiveness of a planned teaching program on pregnant women's knowledge regarding preeclampsia" found an improvement in the mean knowledge score post-the teaching program compared to before.

In congruence with the present study findings, **Helmy & Ibrahim (2020),** who carried out a quasi-experimental study on 60 expectant mothers at Beni-Suef University Hospital, observed statistically significant improvement in all knowledge items related to the prevention of preeclampsia after implementing the health promotion intervention and one month later. The researchers attributed their

findings to the way the model-based educational sessions helped expectant mothers become more knowledgeable about preventing preeclampsia.

Regarding the **practices** of the studied high-risk women for preeclampsia, the current study findings revealed that the virtual PRECEDE model application was an effective tool to improve all items of preeclampsia preventive practices post-intervention compared to pre-intervention, where the highest percentages were observed with managing and coping with stress, taking rest and adequate sleep, following the prescribed medication regimen, and drinking enough water daily (8–10 glasses of water). Thus, the second study hypothesis was supported "High risk pregnant women's who apply the virtual PRECEDE model have higher satisfactory practices scores regarding preeclampsia preventive behaviors after application than before"

This result is consistent with the findings of **Ibrahim & ElSayed's (2022)** study "Effect of Self-Care Practices Sessions on Pre-eclamptic Women's Pregnancy and Labor Outcomes," which showed a highly statistically significant improvement in all post-intervention pre-eclampsia self-care practice items, with resting and getting at least eight hours of sleep being associated with the highest two percentages. Furthermore, **Ali et al. (2021)** reported a statistically significant improvement in preeclampsia self-care and lifestyle practices at Port Said Maternity Hospital after the program.

In addition, all pre-eclampsia self-care practices items showed statistically significant improvement from pre-intervention scores to post-intervention scores and 4-week follow-up, according to the study by **Afefy & Kamel (2019).** The highest two percentages were noted for getting enough sleep (eight hours or more), drinking enough water and taking prescribed medications. These results are consistent with those of the present study. The mothers' strong attachment to their children and their fear of unfavorable pregnancy outcomes, which motivated them to adhere to the advised preventive actions, are likely responsible for the harmony between the results of the current study and the other studies.

Furthermore, the present study findings revealed that the total practice scores improved one month post-virtual PRECEDE model application, with statistically significant differences between pre- and post-intervention. Congruent to the present study finding, **EL Sayed et al. (2020),** who conducted a quasi-experimental research design at the Obstetrics and Gynecology Outpatient Clinic of Benha University Hospital on 70 preeclampsia pregnant women, concluded that adopting a continuous care strategy improved the health behaviors associated with preeclampsia.

Similarly, a controlled randomized trial, carried out by **Jacob et al. (2022)** to assess pregnant women's knowledge, attitudes, and practices regarding gestational hypertensive syndrome at a public maternity hospital in Fortaleza-CE, Brazil. The study found that following an educational intervention, the pregnant women enrolled in the intervention group demonstrated greater adequacy in relation to preeclampsia preventive behaviors compared to those in the control group. These study findings may be attributed to the effectiveness of the educational sessions based on preventive model in improving the studied pregnant women's knowledge regarding the prevention of preeclampsia which reflected on their practices.

The results of the current study showed that the majority of high-risk pregnant women did not develop preeclampsia following the use of PRECDE Model intervention. This can be attributed to PRECDE Model's beneficial effects on stopping harmful behaviors and assisting women in adhering to the preventive practices. Comparably, **Mohammed et al. (2022)** found that, following the application of the preeclampsia bundle of care intervention around three-quarters of the intervention group's did not experience PE. Additionally, a study conducted by **Rasouli et al. (2019)** on the "effect of self-care before and during pregnancy for prevention and control of preeclampsia in high-risk women" reported that self-care education, screening, counseling, and health promotion were useful in preventing preeclampsia in high-risk women.

The findings of the present study showed that there was a statistically significant correlation between the pregnant women's preeclampsia preventive behavior practices and their knowledge scores during the intervention phases. These results were consistent with a study conducted by **Elagamy et al. (2021)** who found a statistically significant correlation between the pregnant women's knowledge scores and their preeclampsia preventative behavior practices scores throughout the intervention phases. The researchers attributed their findings to the fact that providing women with sufficient information about preeclampsia contributes to improving their preventive practices.

Finally, the results of the current study have enhanced high-risk pregnant women's knowledge and reported practices about preeclampsia preventive behaviors, supporting the study's aim and hypotheses. This is demonstrated by the favorable outcomes and successful use of PRECEDE model.

Conclusion

The investigated hypotheses that the virtual PRECEDE model application was a useful tool for enhancing pregnant women's knowledge and reported practices about preeclampsia preventive behaviors were accepted in light of the study's current findings. The results of the current study showed that pregnant women's knowledge improved significantly in all items and the overall score both immediately and one month later compared to pre-intervention. All items and the overall score of preeclampsia preventive practices showed a highly statistically significant improvement after the intervention compared to the pre-intervention period. The highest percentages were noted for stress management and coping, getting enough rest and sleep, adhering to the recommended medication schedule, and drinking enough water every day. Furthermore, the majority of high-risk expectant mothers who apply the PRECDE did not develop preeclampsia.

Recommendations

- Incorporating nursing interventions guided by the PRECEDE model into routine prenatal care for the expected high risk pregnant women to prevent the occurrence of preeclampsia.
- Examine the effect of implementing PRECEDE model on pregnancy and labor outcomes for other pregnancy-related complications is recommended as a further research.

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