

Impact of Self-Care Guidelines on Women's Awareness and Identification of Early Signs and Symptoms of Preeclampsia

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Abstract

Background: Preeclampsia (PE) is a leading cause of maternal morbidity and mortality worldwide. Early identification of PE in the first trimester helps the introduction of early preventative measures initiated before 16 weeks of gestation in patients at high risk of PE. **Aim of the study:** to evaluate the impact of self-care guidelines on women's awareness and identification of early signs and symptoms of pre-eclampsia. **Subjects and Methods:** Quasi-experimental research design was utilized in the current study. **Setting:** This study was conducted at outpatient clinics at Minia university hospital for Maternity and Child which serves pregnant woman in Minia city. **Sample:** A purposive sample of 100 pregnant women was divided equally and alternatively into two equal groups (n= 50) for a control group who received routine care and (n= 50) for study group who received self-care guideline. **Tools:** The current data was collected by using a tool composed of three parts: part I: semi-structured interviewing questionnaire. Part Two: Observation checklist adapted from research literature to assess pregnant women for presence of early signs and symptoms of preeclampsia. Part Three: standardized self-care guideline used for identification of early signs and symptoms of preeclampsia. **Results:** The main findings of the study revealed that (44) 88% of control group has unsatisfactory level regarding knowledge score compared with (38)76% of the study group. Also, this study showed that there was high statistical significant correlation between study group regarding level of severity and total knowledge score pretest and posttest with p-value (0.010, 0.000) study group who had a good knowledge score had low level of severity and low signs and symptoms detected. **Conclusion:** educational guidelines were effective in improving pregnant women knowledge regarding early detection of signs and symptoms and decreasing the maternal and neonatal mortality and morbidity rate. **Recommendations:** This study recommended that: there is a necessity to design continuous health education program to pregnant women and their families about preeclampsia, many seminars and awareness campaigns related to pre-eclampsia should be organized for developing preeclampsia knowledge and self-care measures for prevention and control of it.

Keywords: awareness, guidelines, identification, preeclampsia, self-care.

Introduction

Preeclampsia as the presence of new-onset hypertension and proteinuria or other end-organ damage occurring after 20 weeks of gestation. PE is a multisystem syndrome that is primarily defined by the development of new-onset hypertension, persistent systolic blood pressure [SBP] of 140 mm Hg or higher or diastolic blood pressure [DBP] of 90 mm Hg or higher after 20 weeks' gestation in a woman with previously normal blood pressure (Brown et al., 2018)

Preeclampsia (PE) is a leading cause of maternal morbidity and mortality worldwide. It occurs in women with first or multiple pregnancies. It occurs in the second or third trimester, and is characterized by de-novo development of concurrent hypertension with either proteinuria or at least one severe feature (thrombocytopenia, renal insufficiency, impaired liver function, pulmonary edema, cerebral or visual symptoms) after gestational week 20 (Bergman et al., 2019).

Preeclampsia is a pregnancy-specific disorder and multi-organ dysfunction. There is growing evidence that these effects persist after pregnancy PE strikes mostly the prim-gravida after 20th to 24th weeks of gestation and frequent occurrences are often seen at term. It is determined clinically by development of hypertension and proteinuria in previously normotensive woman (Alnuaimi et al., 2020).

Complications of preeclampsia can affect both the mother and the fetus. Acutely, preeclampsia can be

complicated by eclampsia, the development of HELLP syndrome (hemolysis, elevated liver enzymes, low platelet count), hemorrhagic or ischemic stroke, liver damage and dysfunction, acute kidney injury, and acute respiratory distress syndrome (ARDS) (Rana et al., 2019).

The risk of developing pre-eclampsia appears to be greater in women who have a family history of essential hypertension, and there may be a relationship between risk of pre-eclampsia and the metabolic syndrome. The underlying basic pathology is endothelial dysfunction and vasospastic phenomenon affecting almost all the vessels, particularly those in kidney, uterus, placenta and brain. This disorder is associated with many complications such as fetal loss, preterm delivery, impotence in the neonate, early pruritus, and high rates of morbidity and mortality and is one of the five main causes of the death of pregnant mothers in developed countries (Duhig et al., 2019; Phipps et al., 2019).

Early identification of PE in the first trimester helps the introduction of early preventative measures initiated before 16 weeks of gestation in patients at high risk of PE. Monitoring for PE can also be useful during the second trimester as close observation of early signs of PE enables timely treatment and delivery. Self - care guidelines are very vital to health care; it has been shown better result in patient outcomes and cost-effective care. It is also fundamental to maintenance of health, and prevention and management of chronic illnesses (Gooda et al., 2020; Riegel et al., 2017).

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Nurses having a vital role within the health care system as well as play an important role in the management of preeclampsia are to protect the maternal/fetal wellbeing and optimize a healthy outcome for both. The nurse is responsible for keeping a quiet environment, maintaining seizure precautions, having emergency medications available, and an emergency birth pack ready (Mohamady & Elkheshen, 2017).

Self-care help pregnant women and health care providers take effective measures to control and prevent gestational hypertension, and to provide endorsed solutions for improving maternal and neonatal health. It is now clear that the onset of the disease is multifactorial, and interventions for management of preeclampsia will necessarily have to address a wide range of factors through lifestyle and diet modification and multidisciplinary care (Rasouli et al., 2019).

Significance of the study

Pre-eclampsia is the greatest common hypertensive disorder of pregnancy, it is a major cause of maternal mortality and morbidity, preterm birth, intrauterine growth restriction, and perinatal death worldwide. It has been predictable that preeclampsia complicates 2-8% of pregnancies globally, and is considered to be the third cause of maternal death (Helmy & Ibrahim, 2020).

In Egypt, maternal mortality ratio is reported to be 45 per 100000 live births according to WHO. In a study conducted by (Gabal et al., 2017) prevalence of hypertensive diseases of pregnancy in Egypt (4.2%) had pregnancy induced hypertension, (3.8 %) had preeclampsia and eclampsia was (0.3%).

Antenatal care played an important role in diagnosing, curing, and preventing the hypertensive disorders of pregnancies. Frequent follow-up, assessment of blood pressure, and the search for proteinuria form the cornerstone of antenatal screening of all pregnant women for PIH and her fetus which can prevent maternal and fetal mortality and morbidity (Mekie et al., 2021).

Aim of the study:

This study aimed to evaluate the impact of self-care guidelines on women's awareness and identification of early signs and symptoms of pre-eclampsia.

Research hypotheses:

The researcher hypothesized that pregnant women will be aware of early signs and symptoms of pre-eclampsia posttest after providing self-care guideline compared with pre-test.

Subjects and methods:

Research Design: Quasi-experimental research design was utilized in the current study.

Research Setting: This study was conducted at outpatient clinics at Minia university hospital for Maternity and Child which serves pregnant woman in Minia city.

Sample: A purposive sample of 100 pregnant women was divided equally and alternatively into two equal groups (n= 50) for a control group who received routine care and (n= 50) for study group who received self-care guideline.

Inclusion Criteria: -

1. Pregnant women (second trimester) 16-20 weeks' gestation.
2. High risk groups (family history, PCO, polyhydramnios, twins, GDM, obesity)

Exclusion Criteria:

1. Past history of preeclampsia
2. Chronic hypertension.

Tools of Data Collection

Data for the study was adopted by the researcher after extensive review of literature and related studies conducted before. The current data was collected by using a tool composed of three parts: -

[Part One: "semi-structured interviewing questionnaire" which includes (4) domains:

- 1st section: Sociodemographic characteristics that consists of six items as age, education, marital status, occupation, residence and phone number.
- 2nd section: Past obstetric history.
- 3rd section: Present health history.
- 4th section: Structured knowledge assessment sheet which assess women knowledge about preeclampsia. It contained a multiple choice questions. It included twelve questions which cover all information about preeclampsia.

Scoring System:

Each correct answer in knowledge assessment sheet took (one) and the wrong answer took zero with total scores of 12, so (< 60%) considered unsatisfactory and (≥60) considered satisfactory.

Part Two: Observation checklist: it was adopted from research literature to assess pregnant women for presence of early signs and symptoms of preeclampsia as degree of edema, presence of hypertension, urine analysis for presence of sugar and or protein urea.

Scoring System:

The score for each sign ranging from (0 to 1), sign or symptom that was not present take zero, present sign takes a score one (1).

Part Three: - standardized self-care guideline adopted from (Druzin et al., 2013) that is modified by the researcher: it used for identification of early signs and symptoms of preeclampsia

Scoring System:

All signs and symptom of preeclampsia were classified according to its degree into three categories: -

- Green = Normal state.
- Yellow = Increase assessment frequency
 - One sign → Notify provider
 - More than one → increase evaluation and give more attention.
- Red = severe case that need urgent evaluation in hospital
 - Any sign appears at red column → Transfer to higher acuity level

Brochure: that was provided to every woman during the educational session, this brochure will include all information about preeclampsia as

- Definition

- Causes and risk factors.
- Early signs and symptoms of preeclampsia
- Measures for how to detect it.
- Suitable food and measures that help in preventing preeclampsia.

It was in a graphic expression that helps women to understand it.

Tools validity:

The study tools were developed after reviewing the related literature. To determine content and face validity, these tools were tested by a Jury committee consists of five obstetric nursing experts. modifications were done; the questions that were not appropriate were taken out and questions which need clarification and modifications were done.

Tools Reliability

Reliability was ascertained statistically by using Alpha Cronbach test to ensure that the study tools are reliable. Reliability for knowledge assessment sheet, observation checklist, self-care guideline was (0.95, 0.84, 0.79) respectively.

Pilot Study

A pilot study was carried out on 10% (n = 10) of the total sample to test the clarity of tools and estimate the time required for fulfilling it. Based on results of the pilot study some modifications were done and the subjects were excluded from the actual sample.

Ethical Considerations:

An official permission to conduct the study was obtained from the Ethical committee in the Faculty of Nursing, Dean of Faculty of Nursing, and Manager of Minia university hospital for Maternity and Child, and agreement from Egypt Academic for Research Center and Technology to carry out this study. Women in this study were voluntary and each woman involved was informed about the purpose, procedure, benefits, and nature of the study, and that she had the right to withdraw from the study at any time without any rationale, then oral consents were obtained. Confidentiality and anonymity of each subject were ensured through coding of all data and protecting the obtained data.

Study Procedure:

Preparatory Phase:

It included reviewing of the current and relevant related literature and theoretical knowledge of the various related aspects using textbooks, articles, and periodical magazines in order to develop the data collection tools, exploring prevalence of patient at the outpatient department and incidence of complications among those patients'.

Implementation Phase:

Once official permissions were granted:

- Patients were equally enrolled in this study as control and study groups. The investigator obtained oral consent from those (study and control group) who accepted to participate in this study, for the study group, patients were informed by the investigator individually about purpose and nature of the study.
- The researcher started data collection from control group firstly who didn't receive any educational

session through (three months, three days /week) by using the first tool.

- For the study group, after filling the questionnaire, the researcher reviewed medical data and past medical history for women. With the assistance of nurses of antenatal care unit, the researcher measure BP, weight and presence of sugar or protein urea by dipstick for each patient.
- The researcher used the second tool as pre education tool to assess presence of any signs and assure that patient free from any sings of preeclampsia if the woman had any sign take one degree if not present take zero.
- Immediately after assessment phase after finishing reviewing medical, the educational session aims were explained to women.
 - (Average 7 women per session). The educational sessions covered: introduction; meaning of pre-eclampsia; risk factors and feature; complications; dietary management; importance of rest and self-care practices that women should engage in to control and manage preeclampsia as:
 - Measuring blood pressure at near pharmacy daily and record measuring with date and time.
 - Use dipstick for testing presence of sugar or protein urea and how to read it.
 - Observing foot daily for any edema.
 - Measuring weight daily or every two days and record it at near pharmacy.
 - Notifying researcher about any sign regarding preeclampsia.
 - The researcher had corrected woman's knowledge and enhances the correct practice using educational booklet.
 - During and after the teaching sessions the researcher encouraged active participation of the pregnant woman through asking questions and receiving feedback. Each woman received a copy of the educational brochure. The time taken to complete this phase was about 40-45minutes for explanation and about 10 minutes allowed for the pregnant woman for asking any question or clarification related to the session.
 - At the end of session each woman was given handout brochure in a graph way including all information about preeclampsia that was given in the session.
 - The researcher gave two sessions /day, three days per week for teaching; each session took about 30- 45 minutes.

Evaluation Phase:

- The last phase of proposed teaching program is the evaluation phase. A line of contact (by telephone) was established between the investigator and subjects of both groups for feedback, monitoring, and provision of needed consultation and help.
- the researcher used the first tool again (semi-structured interviewing questionnaire) as a post educational only for study group to assess actual level of knowledge about preeclampsia after educational session.

- The researcher followed up the women every day by phone to check their compliance and to guide them, and during their antenatal appointment visits. Then after 4 weeks from the implementation phase the researcher evaluated women's knowledge and self-care practice using post-test tool.
- If any woman had any signs or symptoms of preeclampsia, the researcher used self-care guideline to clarify the degree of severity of disease and take an action for women.

Statistical analysis:

The collected data was tabulated, computerized, analyzed and summarized by using descriptive statistical tests to test research questions by using SPSS (IBM, 23). The level of significance was accepted at $P < 0.05$ and was considered highly significant when P-value less than or equal 0.01.

Results:

Table (1): distribution of studied women according to their demographic characteristics (n=100):

Demographic Characteristics	Control n (50)		Study n (50)		Sig. test	p-value
	N	%	N	%		
Age / Years						
• 20 >	15	30	13	26	t= 0.071	0.943 NS
• 20-30	22	44	25	50		
• > 30	13	26	12	24		
Mean ± SD	25.34 ± 6.515		25.43 ± 6.125			
Level of Education						
• Illiterate	10	20	10	20.0	$\chi^2=4.267$	0.234 NS
• Read & write	13	26	17	34.0		
• Intermediate education	13	26	17	34.0		
• high education	14	28	6	12.0		
Marital Status						
• Married	47	94	48	96	$\chi^2= .518$.472 NS
• Divorced	2	4	2	0		
• Widow	1	2	0	0		
Occupation						
• Employer	17	34	19	38	$\chi^2= 0.174$	0.677 NS
• Housewife	33	66	31	62		
residence						
• Rural	31	62	37	74.0	$\chi^2= 1.654$	0.198 NS
• Urban	19	38	13	26.0		

Table (1): shows that there were no statistically significant differences between study and control groups according to their demographic characteristics.

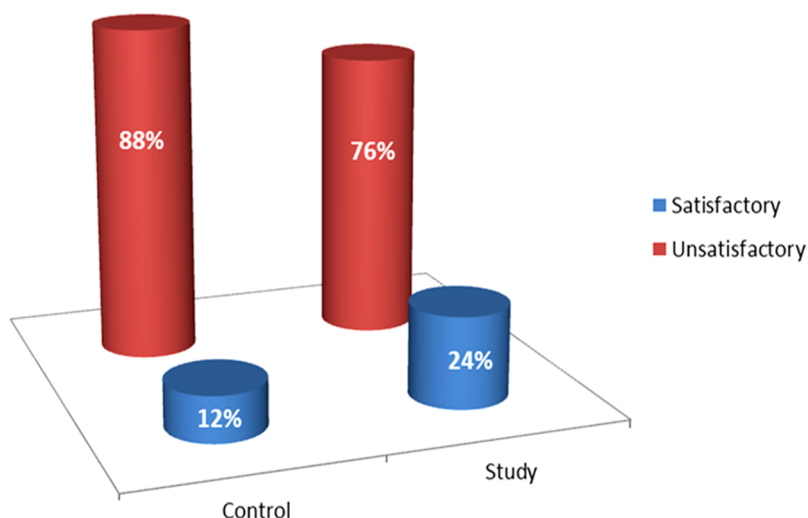


Figure (1): distribution of studied women according to total knowledge's level

Figure (1): illustrated that (44) 88% of control group has unsatisfactory level regarding knowledge score compared with (38)76% of the study group.

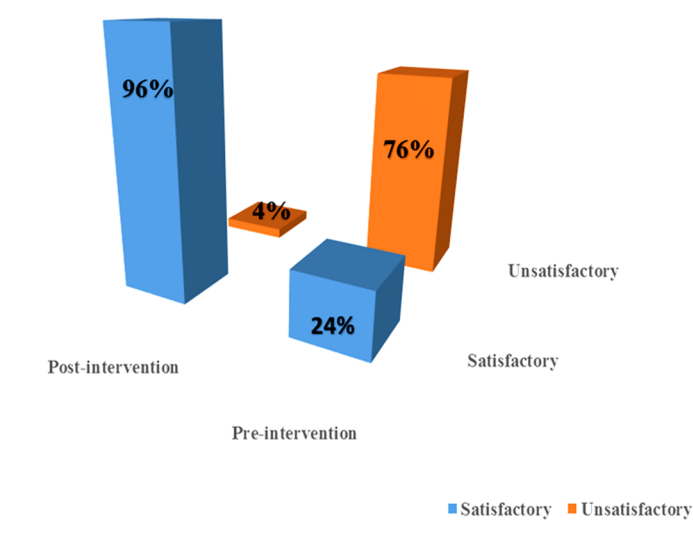


Figure (2): percentage distribution of the study group according to total knowledge's level pre and post-intervention

Figure (2): illustrates that 24% of study group has satisfactory level regarding knowledge score pre-intervention that jumped to 96% post-intervention.

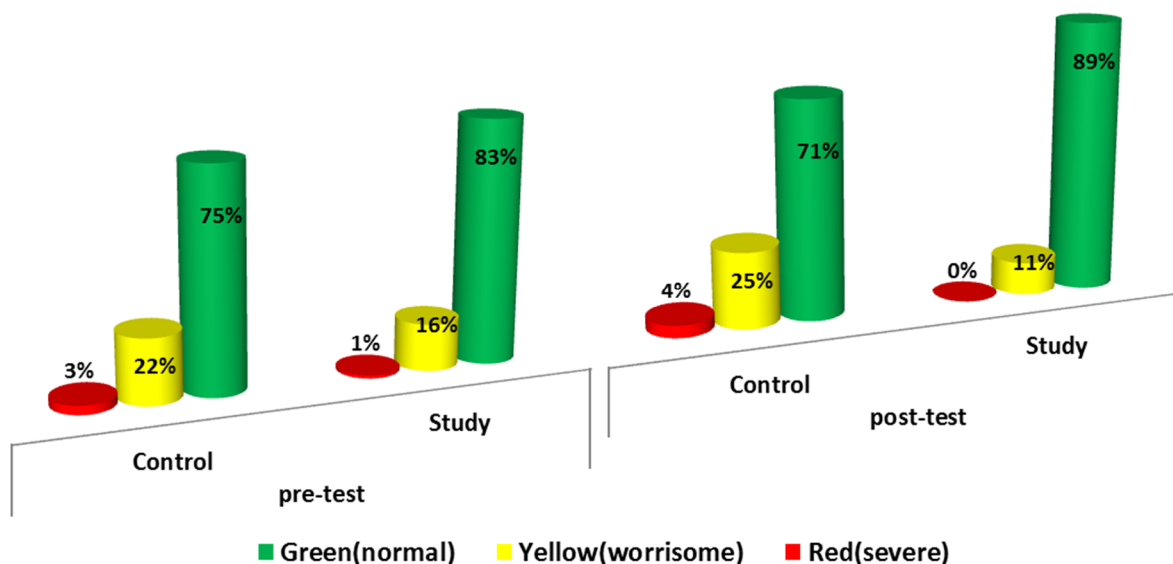


Figure (3): distribution of studied women according to level of severity

Figure (3): illustrates that about two thirds of control group constituted 75% situated in green line (normal level) pretest and 71% posttest compared with 83% of study group pretest that raised to 89% posttest. On the other hand, near to one third of control group constituted (23%) situated in yellow line (worrisome level) pretest that jumped to 25% posttest compared with 17% of study group pretest that declined to 11% posttest.

Table (2): Multiple Linear Regression Model Evaluating the Relationship between Socio-demographic data and total knowledge's score regarding preeclampsia. (n=100):

Socio demographic data	Total knowledge score			
	Control		Case	
	B	p-value	B	p-value
• Age	0.342	0.065	0.244	0.194
• Level of Education	0.297	.036*	0.981	.004 **
• marital status	0.244	0.194	-0.136	0.473
• Occupation	0.393	0.032*	0.916	.005 *
• residence	0.789	.035 *	.704	.013*

Table (2): shows that the total knowledge score increased with high level of education and the table also shows also that the working women had good knowledge due to contact with others and have many sources of information the same as revealed with residence it showed that women who resides in urban areas have a good level of knowledge rather than rural areas that documented by (p=.036, .032, .035) in control women and (p= .004, .005, .013) in case group.

Table (3): correlations between total knowledge score and level of severity according to self-care guideline among study and control groups (n=100)

Item	Level of severity							
	Pre-test				Post test			
	Control		study		Control		study	
	r	p-value	r	p-value	r	p-value	r	p-value
• Total knowledge score	-0.009	.952	-0.361	.010**	0.072	.619	-0.481	.000**

*P -value ≤ 0.05 (statistical significance) **P -value ≤ 0.01 (highly statistical significance)

Table (3): displayed that there was high statistical significant correlation between study group regarding level of severity and total knowledge score pretest and posttest with p-value (0.010, 0.000) study group who had a good knowledge score had low level of severity and low signs and symptoms detected.

Discussion:

Preeclampsia is a condition unique to pregnancy, which results in significant maternal and fetal morbidity and death. Early detection of women at greater risk of preeclampsia helps avoid and treat early illness. Preeclampsia is a major maternal health issue worldwide that is responsible for maternal and neonatal severe morbidity and mortality and has substantial contributions to prematurity of the fetus and long-term cardiovascular disease (CVD) in the mother (Hegab et al., 2021).

Therefore, the current study aimed to evaluate the impact of self-care guidelines on women's awareness and identification of early signs and symptoms of pre-eclampsia

Regarding knowledge's level of preeclampsia, the present study it has been noticed that the majority of the study and control groups had unsatisfactory level of knowledge regarding preeclampsia. This may be rendered to low educational level of most of participants, decrease number of antenatal visits and follow up, restricted educational facilities in rural communities and low awareness of the main problems of pregnancy. Also, the current study finding showed that the vast majority of the study group had satisfactory level of knowledge regarding preeclampsia post-educational guideline in contrast to pre-intervention.

These results were supported by (Olaoye et al., 2019) who conducted a study entitled " Knowledge, perception and management of pre-eclampsia among health care providers in a maternity hospital" the study found that the respondents had average knowledge of pre-eclampsia. The current study finding also was supported by the study done by (Salim & Kuriakose, 2017) who conducted a study about " Knowledge of gestational hypertension and its self-care measures among prim-gravida women" and reported that, two thirds of pregnant women had poor knowledge, one quarter of the study sample had average knowledge and the lowest percentage had good knowledge regarding gestational hypertension.

The current study finding is in agreement with the study of (Jose et al., 2010) who conduct a study entitled " Assess the knowledge level regarding pre-eclampsia and its self-care measures among antenatal women attending antenatal outpatient department " the study showed that Data analysis of level of knowledge revealed majority of mothers had average knowledge.

Also, the current study is congruent with (Fondjo et al., 2019) they found that there were high prevalence of

inadequate knowledge of preeclampsia among our pregnant study population in Ghana. Furthermore, among participants with adequate knowledge, only low percentage had high knowledge of PE based on Bloom's cut-off point.

On the same line, the study done by (Eze et al., 2018) entitled " Determination, knowledge and prevalence of pregnancy-induced hypertension/eclampsia among women of childbearing age at same district Hospital in Tanzania" they found that only few women to have adequate knowledge of PE. Also (Teng & Keng, 2016) found that about two thirds of Tanzanian women had inadequate knowledge about PE.

The same as reported by (Chaudhary & Choudhary, 2016) they found that baseline knowledge of antenatal mothers regarding management of pre-eclampsia was inadequate. In pre-test it was found that few of them have not ever heard about management of pre-eclampsia and those who were having knowledge it was inadequate. After implementing teaching program, the concept of management regarding pre-eclampsia was very much clear to them as indicated by significant increase in post-test knowledge scores.

Where current study was agree with (Ouasmani et al., 2018) who found that Few of the women had any knowledge of the danger signs during pregnancy. Therefore, they did not interpret their complaints as early signs of complications, especially in cases of pre-eclampsia.

The current study was opposite to (Hussian & Al-Saffar, 2016) who stated that high percentage of the study sample had (high and moderate) knowledge regarding management and intake of food pattern) .

Regarding level of severity according to self-care guideline, the current study findings also showed that about two thirds of control group were within the green line (normal level) pretest that declined posttest. On the other hand, the highest percentage of study group located in normal level pretest that raised to majority posttest, moreover, near one third of control group) situated in yellow line (worrysome level) pretest that increased posttest compared with low percentage of study group pretest that declined posttest. According to researcher point of view this may be due to the effect of educational guidelines that help women to avoid causes of preeclampsia and early detect any sign regarding it.

In relation to the relationship between Socio-demographic data and total knowledge's score, the current study findings showed that, the total knowledge score

increased with high level of education. Finding of the current study is explained by the researcher perspectives that women that have high level of education have more information and pay a great attention to increase their knowledge about pregnancy and its complication. The study finding was supported by (Salim & Kuriakose, 2017) they found that there was significant association of knowledge regarding gestational hypertension with age and education of pregnant women.

The same as conducted by (Chaudhary & Choudhary, 2016) who conducted a study entitled " A study to assess the effectiveness of Planned Teaching Program (PTP) on the knowledge regarding management of pre-eclampsia among antenatal mothers attending antenatal clinic in selected hospitals of Faridkot, Punjab" the found that findings depicted that the posttest knowledge scores of the study subjects and selected Socio-demographic variables (education) was found to be statistically insignificant ($p>0.05$).

The current study was opposite to (Sharma et al., 2017) they found that, There was no statistical significant association found between mean pre-test knowledge score of antenatal mothers with PIH and their demographic variables. Hence, it can be interpreted that selected sociodemographic variable did not have any influence on pre-test knowledge of antenatal mothers with PIH.

The current study also displayed that the total knowledge score increased between the working women rather than non-working women that was explained by the researcher that working women have more contact and get more experiences from others. The study findings is consistent with (Chaudhary & Choudhary, 2016) who reported that their study findings showed that knowledge scores of the study subjects were statistically significantly associated with their education and occupation only.

Additionally, (Gaikwad & Kumbhar, 2019) conducted a study entitled " a study to assess the knowledge regarding self-care management among the pregnant mother with pih attending selected maternity opd 's of tertiary hospitals in sangli, miraj and kupwad corporation area" they stated that there was significant association between age in years, education, occupation and gestational age in weeks with knowledge score .

The current study was opposite to (Al Ebrahimi et al., 2019) who conducted a study entitled " Knowledge about pregnancy induced hypertension among pregnant women attending gynecology and obstetrics teaching hospital in Kerbala" the found that there was no significant association between the educational level and the Knowledge score also, there was no significant association between the economic status, occupation and residential area with knowledge score.

On the same line, (Hussian & Al-Saffar, 2016) reported that there was weak relationships with no significant differences at $p>0.05$ between different socio demographic characteristics variables, body mass index and knowledge of self-care management for pregnant women related to pregnancy induced hypertension.

It also noticed that women who reside in urban areas have a good level of knowledge rather than rural areas because urban women have many ways of educational facilities. This finding supported by (Alnuaimi et al., 2020) who conducted a study entitled " The effects of an educational program about preeclampsia on women's awareness: a randomized control trial" they found that women in rural areas have low level of knowledge.

This finding is opposite to (Salim & Kuriakose, 2017) they reported that no significant association of knowledge regarding gestational hypertension with place of residence, socio economic status, occupation or source of health information.

Related to correlations between total knowledge score of control & study group and level of severity, the study revealed that there was high statistical significant correlation between study group regarding level of severity and total knowledge score pre-test and post-test. This finding is explained by the researcher perspectives that: poor knowledge makes pregnant women at great risk for preeclampsia so it was showed by highly significant association between level of knowledge and level of severity.

The current study finding was similar to (Al Ebrahimi et al., 2019) who found that knowledge score of the pregnant participants is significantly associated with severity of disease. On the same line, (Salim & Kuriakose, 2017) reported in their study that the knowledge of gestational hypertension and its self-care measures is not up to the mark. This may be responsible for the increase in incidence of severe cases and increase in associated morbidity and mortality.

To conclude, the present study was grounded on the research hypothesis which confirmed that, pregnant women are aware of early signs and symptoms of pre-eclampsia posttest after providing self-care guideline compared with pre-test and this reflected on the presence of signs and symptoms of preeclampsia that declined post intervention.

Conclusion:

In light of the current study results and research hypothesis, it can be concluded that educational guidelines were effective in improving pregnant women knowledge regarding early detection of signs and symptoms and decreasing the maternal and neonatal mortality and morbidity rate.

There was significant association between study and control group pre and post-test regarding level of severity and presence of signs and symptoms of preeclampsia that reflect the impact of the current study.

Recommendations:

In the light of the present findings, the researcher recommended the following:

1. There is a necessity to design continuous health education program to pregnant women and their families about preeclampsia so that they can help in providing continuous support.
2. Many seminars and awareness campaigns related to pre-eclampsia should be organized for developing preeclampsia knowledge and self-care measures for prevention and control of it.
3. Further research should focus on replication of the study on a large representative probability sample is highly recommended in different hospitals and health care agencies at minia governorate to achieve more generalization of the results.

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