Effect of Self-care Program Guided by PRECEDE–PROCEED Model on Maternal and Fetal Outcomes among Gestational Diabetic Women

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Abstract

Background: Gestational diabetes mellitus is a type of diabetes characterized by impaired glucose tolerance, first discovered during pregnancy and can precipitate several adverse effects for mother and fetus**. Aim:** To evaluate the effect of self-care program guided by PRECEDE–PROCEED model on maternal and fetal outcomes among gestational diabetic women. **Design:** A quasi-experimental research design was followed. **Setting:** The study was carried out at Obstetrics and Gynecology Outpatient Clinic of Benha University Hospital. **Sample:** A purposive sample included 70 gestational diabetic women divided into 2 groups, and allocation ratio was 1:1 (35 for each group). **Tools of data collection:** Four tools were used, a structured interviewing questionnaire (General characteristics and previous and current obstetrics history), health-related behaviors questionnaire, PRECEDE–PROCEED model questionnaire (knowledge, attitude, enabling and reinforcing factors) and maternal and fetal outcomes questionnaire. **Results:** A statistical significant improvement in scores of total knowledge, attitude, health-related behaviors, enabling and reinforcing factors regarding gestational diabetes for the study group compared to the control group was found after implementation of program ($p < 0.001$). Also, a statistical significant high proportion of maternal and fetal complications in the control group than in the study group was found. **Conclusion:** The implementation of self-care program guided by PRECEDE–PROCEED model had a positive impact on improving gestational diabetic women's knowledge, attitude, health-related behaviors, enabling and reinforcing factors regarding gestational diabetes and improved maternal and fetal outcomes. **Recommendations:** An educational intervention guided by PRECEDE–PROCEED should be conducted at postpartum period to help gestational diabetic women to adopt healthy lifestyles during breastfeeding.

Key words: Gestational diabetic women, Maternal and fetal outcomes, PRECEDE–PROCEED Model

Introduction

Gestational diabetes mellitus (GDM) is one of the main metabolic disorders that first occur during pregnancy and refers to rising of plasma glucose concentrations or carbohydrate intolerance that result in hyperglycemia of variable severity. GDM is considered a global health problem and one of the most popular complications that induced by pregnancy **(Elomrani et al., 2023).** Gestational diabetes mellitus can occur during pregnancy around the 24th week of pregnancy in women who don't already have diabetes. After delivery of fetus, the blood sugar levels will almost return to normal. However, nearly 50% of women with gestational diabetes may develop type 2 diabetes **(Center for Disease Control and Prevention (CDC), 2021)**

Worldwide, GDM is estimated to affect 15 % of all pregnancies with about 87.6% are in low and middle income countries. In the United States about 2% to 10% of pregnancies are affected by gestational diabetes every year, in the United Kingdom, up to 5% of women giving birth each year have gestational diabetes, about 20.9% of the prevalence rate occurs in Asia and 14% was in sub-Saharan Africa **(Boko W.D., Abera R.G.and Wolde M., 2024) (CDC, 2021).**

Risk factors for GDM encompasses obesity, multipara, maternal age of more than 25 years, previous history of diabetes mellitus during pregnancy, family history of GDM, infertility treatment, recurrent urinary tract infection, macrosomia, fetal malformation, polyhydramnios, unexplained neonatal mortality, prematurity and preeclampsia **(Grupe and Scherneck, 2023).**

The majority of women with carbohydrate intolerance may occur only during pregnancy; however, the incidence of potential adverse effects is not limited to pregnancy outcomes only but also, include short-term impacts for mother as increased risk of developing gestational hypertension, preeclampsia; preterm labor, cesarean section, perineal trauma and postpartum hemorrhage. However, long term impacts involve increased risk of the development of type 2 diabetes, cardiovascular disorders, higher risk of diabetes in subsequent pregnancies and a delayed secretion of milk **(Ghanem Y.M., El Kassar Y., Magdy M.M. , Amara M. and Amin N.G., (2024) (Tian Y., Zhang S., Huang F. and Ma L., 2021).**

In addition, gestational diabetes mellitus can cause various complications in fetus and neonate that include macrosomia, asphyxia, birth trauma, stillbirth, hypoglycemia, and polycythemia. Potential long-term adverse effects can include obesity, late onset diabetes, and cardiovascular disease in adulthood for newborns **(Assaf et al., 2024)**.

To improve the prognosis of GDM and minimize the risk of harmful side effects in both mother and child, early diagnosis of the disease is thought to be essential. Pregnant women should maintain optimal blood sugar levels, which are only manageable by dietary and lifestyle changes. Accordingly, pregnant women should practice self-care and have a thorough understanding of the disease. Thus, health education and training are

crucial for maintaining blood sugar control throughout time. Given that the majority of pregnant women have never had GDM before and that the condition may have a harmful impact on the fetus; it is possible that pregnant women with the disorder are unaware of any aspects of blood sugar management or the illness itself **(Park and Lee, 2020).**

Additionally, a variety of sociodemographic, physiological, psychological factors, personal beliefs and community culture affect the self-care behaviors of women with gestational diabetes. Poor self-care practices were significantly correlated with factors like advanced maternal age, a lack of family and social support, a lack of education, a lack of knowledge about diabetes, the presence of complications, unemployment, lack of access to a glucometer and non-adherence to diet and exercise. These factors may increase the risk of comorbidities for both the mother and the infant. Hence, effective and up-to-date education helps to improve clinical outcomes and woman's quality of life through changing woman's attitudes and practices which ultimately change lifestyle **(Assaf et al., 2024)**.

In addition, PRECEDE–PROCEED design is an effective health education theory created by Green and Kreuter to examine individual knowledge, attitudes, and beliefs toward desired behavioral change **(Wen M., Chen Y. and Yu J., 2024)**. Also, it can be utilized for designing, implementing, and evaluating health behavior change programs by identifying fundamentals of epidemiology, health instruction, behavioral sciences, and health organization. When-ever a problem that affect a specific population is considered, health care professionals can use this model to provide guidance for the process of creating a solution **(Garcia et al., 2019).**

Nurses ought to address the adequacy of PRECEDE-PROCEED model as an instructional method for the promotion of health and health-related issues of different social groups. Self-care program utilizing PRECEDE-PROCEED model is a supportive process in which the capacity and decision-making power of women are made and shared communication in which the needs, knowledge, attitudes and self-efficacy of women are surveyed in relation to the subjects of intrigued **(Wulandari, 2020).**

Significance of the problem

Gestational diabetes mellitus is a serious pregnancy complication that effects on the health of both mother and child, in which spontaneous hyperglycemia develops during pregnancy and is definitely expanding year by year now. Also, it shows that predominance of gestational diabetes mellitus increases by 45% due to lack of women's knowledge and self-care management **(George G., Sasikala T. and Chidambaran R., 2021)**.

In Egypt the incidence rate of diabetes has dramatically risen above the universal rates. According to the International Diabetes Federation (IDF), Egypt is one of the top 10 countries in the world for the number of diabetes patients. According to the latest IDF estimates, gestational diabetes mellitus influences

approximately 14% of pregnancies around the world which representing around 18 million births yearly **(Eltoony L.F., Ibrahem S.A., Hafez M.Z, Ali O.M., Elsewify W.A., 2021).** Self-care practice is less frequent in gestational diabetic women and could be due to lack of sufficient educational programs and lack of understanding of self-care strategy that should be provided at health centers and diabetes clinics so, continuous women education and self-management supervision should be strongly emphasized during the antepartum care visits **(Tian et al., 2021)**.

Thus, the researchers felt that this study would offer assistance to the pregnant women to upgrade their knowledge with respect to gestational diabetes mellitus and self- care practices which in turn would assist to prevent complication during pregnancy and promote maternal and fetal outcomes.

Aim of the study

The aim of study was to evaluate the effect of self-care program guided by PRECEDE–PROCEED model on maternal and fetal outcomes among gestational diabetic women

Research hypotheses

Hypothesis (1): Pregnant women with gestational diabetes who will receive self-care program guided by PRECEDE–PROCEED model will exhibit more enhancement in predisposing factors (knowledge and attitude), reinforcing factors and enabling factors than those who will not receive it.

Hypothesis (2): Pregnant women with gestational diabetes who will receive self-care program guided by PRECEDE–PROCEED model will exhibit more engagement in health-related behaviors than those who will not receive it.

Hypothesis (3): Pregnant women with gestational diabetes who will receive self-care program guided by PRECEDE–PROCEED model will exhibit better maternal and fetal outcomes than those who will not receive it.

Subjects and Method

Research design

A quasi-experimental research design (control & study groups Pre-test/Post-test,) was utilized for the achievement of the aim of this study.

Setting

The research was carried out at the Obstetrics and Gynecology Outpatient Clinic in Benha University Hospital, Benha City, Egypt.

Sampling

Type: A purposive sample

Size: It comprised 70 gestational diabetic women who attended the previously mentioned setting for six months based on the following inclusion criteria: aged 18 to 40 years with a diagnosis of gestational diabetes, a gestational age of 20 to 24 weeks, literacy, absence of medical conditions such as hypertension and renal disease, as well as other chronic or mental health conditions that impact pregnancy and pregnant in one viable fetus. The following were the exclusion rules: pregnant patients who use drugs that interfere with the metabolism of glucose, such as oral corticosteroids, have a history of diabetes mellitus, or have participated in a comparable intervention before and reluctance to continue cooperation.

Technique

The allocation ratio was 1:1 and the sample was split equally into two groups. A control group of 35 women received standard hospital care, while the study group of 35 women received a self-care program guided by the PRECEDE–PROCEED model.

Study tools

Four tools were used to obtain data:

Tool I: A structured Interviewing Questionnaire was created by the researchers following a comprehensive literature review **(Ibrahim and Saber, 2019)**. It was written as a series of closed-ended questions in Arabic. Two parts constituted the questionnaire:

Part (1): Personal characteristics of the studied women, comprised 7 items namely, age, educational level, occupation, residence, monthly income, weight and height to calculate body mass index (BMI).

Body mass index's scoring system: -

Body mass index calculated as following:

BMI = weight (kg)/height2 (m)

BMI Categories:

- "Underweight" = "<18.5"
- "Normal weight" = "18.5–24.9"
- "Overweight" = "25–29.9"
- "Obesity" = "BMI of 30 or greater"

Part (2): Previous and current obstetric history. It comprised 5 items: relevant data about gravidity, parity, previous abortions, gestational age and number of antenatal care visits.

Tool II: Health-related behaviors questionnaire: (pre/posttest tool)

This questionnaire was designed by the researchers after reviewing the literature **(Khadivzadeh et al, 2016; Ibrahim and Saber, 2019)** to evaluate the reported self-care behaviors used by women to manage and keep their gestational diabetes under control. It included nine items, specifically (participating in regular physical activity under the supervision of a specialized doctor, obeying the diet's recommendations, monitoring of blood glucose level daily, compliance with prescribed medications, compliance with recommended antenatal visits, drinking eight to ten glasses of water a day, getting enough rest and sleep, ability to handle stress as well as counting fetal kicks each day).

Scoring system

A three-point Likert scale was used to rate the items: always (score 3), sometimes (score 2), and never (score 1). The scores that were obtained dropped between 9 and 27, where higher scores symbolized active engagement in healthy behaviors. The total score of self-reported health behaviors was classified into:

- "Satisfactory level": (≥ 60 %) total score.
- "Unsatisfactory level": (< 60%) total score.

Tool III: PRECEDE–PROCEED model questionnaire (pre-post tool)

After conducting literature review **(Ibrahim and Saber, 2019)**, the researchers created it, and the questions were created using the PRECEDE–PROCEED model's educational–ecological approach (PPM) to determine predisposing, enabling and reinforcing factors. It was divided into the following three parts:

Part (1): Predisposing factors and included 2 sections (knowledge and attitude) and adapted from **(Islam et al, 2017; Ibrahim and Saber, 2019)**.

Section (A): assessment of women's knowledge and their information sources towards gestational diabetes. It involved (12 items) written as multiple-choice questions in the Arabic language about: definition of GDM, causes, risk factors, symptoms, diagnosis, treatment, complications, effect of GDM on mother, effect of GDM on the fetus, prevention of GDM during pregnancy, care of GDM during labor and care of GDM during the postpartum period. In addition to a question about women's source of information.

Knowledge's scoring system

Every knowledge variable was assigned a weight based on the items that were present in every question. Each item got a score a score of two for a completely correct response, a score of one for an incompletely correct response, and a score of zero for an incorrect or unknown response. The scores ranged from 0 to 24, with higher scores describing a greater level of knowledge among women regarding gestational diabetes. The following categories applied to the total knowledge score:

- Adequate: (≥ 60%) of total score.
- Inadequate: (< 60%) of total score.

Section (B): assessment of women's attitude towards gestational diabetes, written in an Arabic language included (11 statements) as (GDM is a very serious condition, Pregnant women with GDM require special care; a comprehensive national GDM education program is required to improve information access; and healthcare professionals require specialized training to manage GDM patients, complications of GDM can be prevented, early diagnosis is crucial for preventing complications …etc).

Scoring system

Every question had a three-point Likert scale with the possible choices (2) for "agree," (1) for "sometimes" and (0) for "disagree." By adding up the points from each question's response, the overall score for each subject was determined. The range of obtained scores was between 0 - 22, with higher scores indicating more favorable attitude of women towards gestational diabetes. The entire attitude score was partitioned into:

- "Positive attitude": (≥ 60 %) of total score.
- "Negative attitude": (< 60%) of total score.

Part (2): Enabling factors: encompassed of (6 items) about (receiving an educational program or attending workshops or seminars regarding gestational diabetes, available resources and having easy access to healthcare facilities, consulting a doctor about health issues, setting aside money for healthy and nutritious food and dietary supplements, and scheduling enough time each day for reading and exercise).

Part (3): Reinforcing factors: involved (5 items) to judge the encouragement and support of the spouse, friends, family, healthcare providers, and the larger society. Questions were about **(**supporting of husband and health care provider for the woman to adapt this stage safely and change bad health behaviors, emotional support from family and friends, receiving a reward from family members for following a healthy

lifestyle and implementing preventive behavior, praising of other people easily for achievements, encouraging of medical authorities to check on health continuously and talking with women of the same condition helps to overcome obstacles and encourage to change unhealthy habits).

Scoring system of both enabling & reinforcing factors

On a three-point Likert scale, the woman's response was ranked. "To some extent" earned a score of (1), "never" a score of (0), and "always" a score of (2). Enabling factors had a total score between 0 and 12, while reinforcing factors had a total score between 0 and 10. Two levels are further distinguished from the total score:

- Week factors: (≥ 60 %) of total score.
- Strong factors: (< 60%) of total score.

Tool IV: Maternal and fetal outcomes questionnaire (pre-post tool)

It was adopted from **(Koivusalo et al, 2016; Ibrahim and Saber, 2019)**. Maternal outcomes involved (14 items) as: polyhydramnios, pyelonephritis, vaginal infection, pre-eclampsia, abortion, mode of delivery, no maternal complications, abnormal uterine contraction, preterm labor, obstructed labor, operative interference, postpartum hemorrhage and infection. While, fetal outcomes included (6 items) as: need for ICU, jaundice, fetal macrosomia, Hypo-glycaemia, prematurity, respiratory distress and IUFD.

Validity and reliability of tools

Two experts in obstetrics and gynecology nursing and one expert in community health nursing evaluated the content validity of the data collection tools. The tools were evaluated based on the suitability of the content and the clarity of the questions. Expert advice was incorporated into the formulation of some items, resulting in minor modifications. The tools were seen as legitimate and valid by the experts.

The Cronbach's alpha coefficient test was used to evaluate the reliability of the tools. The health-related behaviors questionnaire had an internal consistency of 0.87, knowledge had an internal consistency of 0.84, attitude had an internal consistency of 0.86, and enabling & reinforcing factors had an internal consistency of 0.91.

Ethical considerations

To carry out the study, formal approval from the Scientific Research Ethical Committee was secured. To earn their confidence and trust, each woman was informed about the purpose, advantages, and activities of the study. Following that, a consent form was given to each woman to sign. Every piece of information collected would be used only for research and kept completely private. The women were assured of their autonomy and safety. Every woman was told that taking part in the research was entirely voluntary and that ending at any moment would not affect the quality of care received. To protect their anonymity, the subjects were coded. After the PRECEDE–PROCEED model was implemented, an educational booklet was given to the control group.

Pilot study

Ten percent of the entire duration (three weeks) was dedicated to the pilot study, which evaluated the tools' usability, relevance, simplicity, and clarity. Furthermore, an estimation of the time needed for data collection was made in order to identify any unexpected problems arising during the procedure. Nothing was modified, and the main sample size included the women who participated in the pilot study.

Field work

The study was carried out using PPM phases after gaining official permission to be carried out from the director of Benha University Hospital. The researchers went to the aforementioned location twice a week, on Sunday and Wednesday, from 9:00 am to 12:00 pm, or until the preplanned time was up. Interviews with the women recruited for the study were conducted one-on-one; on average, a couple of women were interviewed each week. The study started to run from early September 2023 to late May 2024, a time frame of nine months.

For the study group, seven steps were involved in implementing the PPM model: "Social assessment", "Educational and ecological assessment", "Administrative and policy assessments", "Implementation, Assessment of process", "Assessment of impact and Assessment of outcomes".

Phase 1: Social assessment

During this phase, numerous data collection methods, including literature reviews, focus groups, and private counseling sessions, were used to assess the variables influencing the health of gestational diabetic women. The researcher greeted each woman and introduced herself before explaining the purpose of the study and setting up the times and frequency of counseling sessions to ensure the women followed the interventions that had been chosen. Women gave written consent to take part in the research.

In order to gather information for the pretest, the researcher interviewed the gestational diabetic women about their personal characteristics, obstetrics history (tool I), and health-related behaviors (tool II). The questionnaire took an average of thirty to forty minutes to be completed.

Phase 2: Educational and ecological assessment

The predisposing, enabling, and reinforcing factors from the PPM model were examined in this phase using tool III (as a pretest). Knowledge and attitude were selected as predisposing factors by the researcher in a primary review of the literature. Taking educational courses and having access to databases were enabling factors. Conversely, vocal encouragement and the husband's and friends' support of the family represented as reinforcing factors.

Phase 3: Administrative and policy assessments

During this phase, the researchers chose a site, created a schedule for staff activities, budget, and roles and responsibilities, and coordinated the necessary environmental and educational interventions. Interviews with the participants were used to gather these materials. The opinions of experts and the available scientific resources were used to determine the program's components as well as its

educational goals, content, messages, and concepts.

The researcher created an Arabic booklet with figures to support it, based on findings from a pre-intervention assessment of women's enabling, reinforcing, and predisposing factors as well as a review of pertinent literature. PPM was used as a guide when creating the educational self-care program. Depending on the study group, the number of sessions, their content, the various teaching modalities, and the instructional media were chosen. In order to facilitate communication in the event that a woman was unable to attend the scheduled program, women were asked for their phone number and exhaustive address.

Phase 4: Implementation

In four educational sessions (two per week), a group-based educational intervention centered on PPM construct as predisposing factors, reinforcing factors, enabling factors, and health-related behaviors was carried out with the study group. Each session lasted approximately 30 to 45 minutes in a separate room at the pre-mentioned setting and included discussion, question and answer sessions, role-playing, PowerPoint presentations, and video teaching. The new session started with a review of the feedback from the previous one, which led to a full reexamination of the addressed educational content.

- **First session:** The researchers wanted to give a general overview of gestational diabetes, covering its definition, causes, risk factors, symptoms, diagnosis, treatment, complications, effects on the mother and the fetus, prevention of gestational diabetes during pregnancy, care for the disease during labor, and postpartum care.
- **Second session:** the women were instructed by the researchers to adopt health-related behaviors aimed at controlling and managing gestational diabetes. These behaviors included daily blood glucose monitoring, adhering to the recommended diet, drinking eight to ten glasses of water, and counting the number of fetal kicks each day.
- **Third session:** the researchers talked about managing one's diet, the significance of getting adequate sleep, preserving the quality of one's sleep, and engaging in regular physical activity while being monitored by a medical professional. In addition, the significance of taking prescription drugs as directed.
- **Fourth session:** the researchers discussed the significance of adhering to recommended prenatal visits, managing stress, improving reinforcing and enabling factors, and strategies for overcoming stress related to gestational diabetes. Additionally, the notion of improved maternal and fetal outcomes in gestational diabetic women was clarified, as was the relationship between adherence to healthy behaviors, factors that reinforce and facilitate these positive outcomes. When this session came to an end, the women under study received educational booklets.

Phase 5: Assessment of process

Process evaluation is done while the program is being implemented and is used to assess how the program was being run. At this stage, progress

toward the learning goals was monitored. Process evaluation in this study encompasses assessing the program's personnel, procedures, resources, and activities.

Phase 6: Assessment of impact

Using the same format of tools (pretest) (tool II and III) that were used prior to program implementation for both groups, the impact evaluation for this phase involved assessing changes two months after the application of the educational self-care program. The women's enabling, reinforcing, and predisposing factors as well as their health-related behaviors were assessed as program indicators using the (posttest) format of tools. Participants received text messages and phone calls in follow-up. At the conclusion of the program, the booklet was given to the participants in the control group.

Phase 7: Assessment of outcomes

During this phase, the program's educational self-care impact on maternal and fetal outcomes (tool IV) was evaluated throughout antenatal follow-up, labor, and postnatal period. After application of the educational self-care program, both group (control &study) were evaluated for their maternal and fetal outcomes.

For the control group, received standard hospital care, including medical diagnosis and treatment, along with a quick health education session regarding taking prescribed drugs. In order to prevent bias, the evaluation began with the control group using tools II, III, and IV.

Data analysis

Software known as the Statistical Package for Social Science (SPSS version 25) was used to analyze the data. The frequency, percentage, mean, and standard deviation of descriptive statistics were employed. Additionally, inferential statistics were applied (for quantitative variables, the independent t-test; for qualitative variables, the chi-square or Fisher's exact test). Pearson's correlation coefficient test was also utilized. A p-value of less than 0.05 indicated a statistically significant difference, and a p-value of less than 0.001 indicated a highly statistically significant difference.

Results

Table (1) displays that; The study group mean age was 28.63 ± 1.78 years, while the control group mean age was 29.41 ± 1.93 years. While 51.4% of the control group and 48.6% of the study group, respectively, had a secondary education. In terms of occupation, housewives made up 56.1% of the control group and 68.5% of the study group. In terms of residency, the study and control groups were found to be in rural areas in 71.4 % and 80.0% of cases, respectively. The percentage of study and control groups with insufficient monthly income was 74.3% and 68.6%, respectively. Regarding demographic characteristics, there was no statistically significant difference between the two groups ($p > 0.05$). Thus, there was homogeneity between two groups.

Table (2) represents the study and control groups had mean weights of 79.80±12.94 kg and 77.66±12.07 kg, respectively, and mean heights of 161.46±4.11 cm and 161.60±3.89 cm, respectively. Furthermore, the study and control groups' mean body mass indices were found to be 31.64±5.04

kg/m2 and 29.80±4.98 kg/m2, respectively. These results indicate that the two study groups were homogeneous in terms of weight and both were overweight.

Figure (1) displays that Information was obtained from friends and relatives by 77.1% and 65.7% of the study and control groups, respectively, and from doctors and nurses by 31.4% and 34.3% of the study and control groups, respectively.

Table (3) clarifies that, Primigravida and nulliparous participants made up 74.3% and 68.6% of the study and control groups, respectively. Furthermore, no abortion was done in 94.2% and 97.1% of the study and control groups, respectively. The study group and control groups visited antenatal clinics three times, with 51.4% and 54.3% of them having visited during the current pregnancy. The study and control groups had mean gestational ages of 22.46 ± 0.82 and 22.17 ± 1.25 weeks, respectively.

Table (4) shows that, prior to applying for the program; there was no statistically significant difference between the two groups' mean scores on the total knowledge and attitude tests ($p>0.05$). But following program implementation, the study group's overall knowledge and attitude mean scores were statistically significantly higher than those of the control group ($p <0.001$). The study group's knowledge mean score increased from 13.17 ± 1.65 pre-program to 22.86 ± 1.14 post-program, and its attitude mean score increased from 11.88 ± 1.13 pre-program to 20.02 ± 1.46 post-program.

Table (5) reveals that, prior to the program's implementation; there was no statistically significant difference in any of the health-related behaviors related to gestational diabetes between the study and control groups ($p>0.05$). But after the program was implemented, there was a statistically significant improvement seen in the study group as compared to the control group ($p \leq 0.001$ and $p \leq 0.05$).

Figure (2) displays that, even before to the program's implementation, 31.4% and 34.3% of the study and control groups, respectively, had a satisfactory level of health-related behaviors. Following the program's implementation, the study group 74.3% exhibited a satisfactory level of health-related behaviors, in contrast to the control group 37.1%.

Table (6) clarifies that, prior to the program's implementation, there was no statistically significant difference between the study and control groups for any of the enabling factors related to gestational diabetes ($P > 0.05$). Nonetheless, following program implementation, a highly statistically significant improvement was seen in the study group when compared to the control group ($p \leq 0.001$).

Figure (3) displays that, before the program was put into place, 22.9% and 28.6%, respectively of the study and control groups had strong enabling factors. Subsequent to the program's implementation, the study group 80.0% exhibited strong enabling factors, while the control group 31.4% did not.

Table (7) clarifies that, prior to program implementation, there was no statistically significant difference between the control and study groups

for any of the items related to reinforcing factors about gestational diabetes (P > 0.05). Nonetheless, following program implementation, a highly statistically significant improvement was seen in the study group when compared to the control group ($p < 0.001$).

Figure (4) displays that, prior to the program's implementation, 28.6% and 25.7% of the study and control groups, respectively, had strong reinforcing factors. In contrast to the control group, which had 28.6% strong reinforcing factors after the program was implemented, the study group had 68.6% of them.

Table (8-A) reveals that, with the exception of infection and abortion, the control group experienced higher statistically significant proportions of complications than the study group. Additionally, the study group had a higher rate of normal delivery while the control group had a higher rate of CS ($p \leq 0.05$).

Table (8-B) clears that, with the exception of IUFD, the rates of fetal health issues (need for an intensive care unit, jaundice, macrosomia, hypoglycemia, prematurity, and respiratory distress) were significantly higher in the control group than in the study group ($p \leq 0.05$).

Table (9) clarifies that, before and after the program was implemented, there was a highly significant positive correlation ($P \leq 0.001$) between the total knowledge score and the total attitude of both the study and control groups. Furthermore, before and after the PPM program was implemented, there was a highly statistically significant positive correlation ($P \leq 0.001$) between the study and control groups' total knowledge score and total health-related behaviors.

Table (1): Distribution of the studied women (control and study groups) according to general characteristics (n= 70).

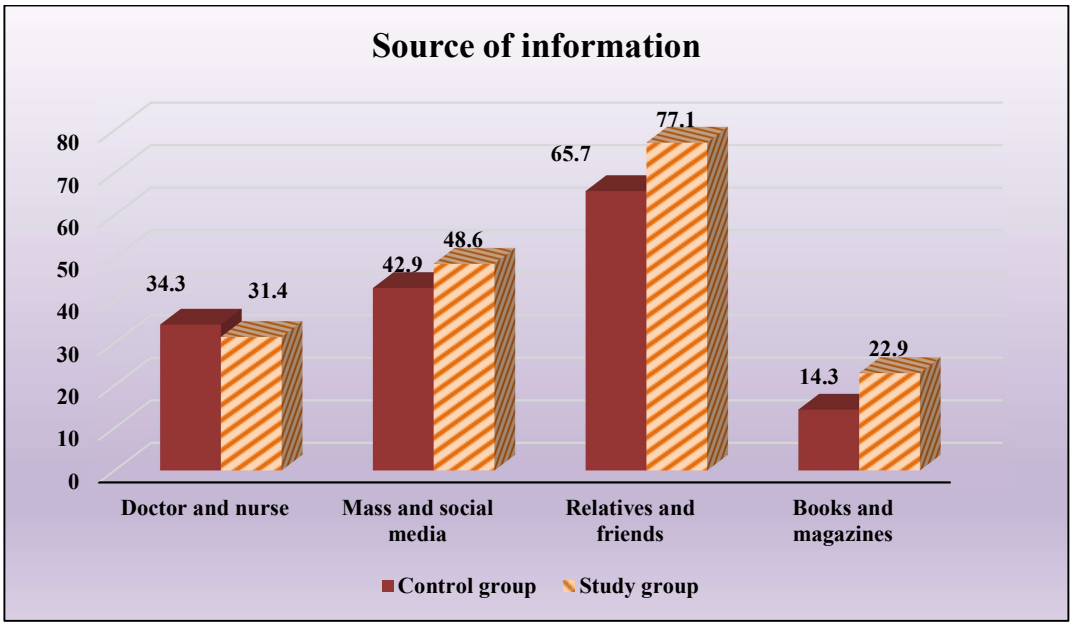
General characteristics	Control group n= 35		Study group n=35		X2/ FET p-value
	No	%	No	%	
Age (years)					
< 30	16	45.7	12	34.3	0.952 >0.05
≥ 30	19	54.3	23	65.7	
Mean ± SD	29.41 ± 1.93		28.63 ± 1.78		t=1.738 >0.05
Residence					
Urban	7	20.0	10	28.6	0.699
Rural	28	80.0	25	71.4	>0.05
Educational level					
Basic education	3	8.6	5	14.3	1.597$^{\epsilon}$
Secondary education	18	51.4	17	48.6	>0.05
University education	14	40.0	13	37.1	
Occupation					
Working	15	42.9	11	31.5	0.979
Housewife	20	57.1	24	68.5	>0.05
Monthly income					
Enough	11	31.4	9	25.7	0.299
Not enough	24	68.6	26	74.3	>0.05

*A statistical significant difference (P ≤ 0.005) **A high statistical significant difference (P ≤ 0.001) Test t= independent t test $^{\epsilon}$ Fisher Exact Test

Table (2): Mean score of anthropometric measurements of control and study groups (n=70)

Parameters	Control group n=35	Study group n=35	Independent t test	P value
	Mean ±SD	Mean ±SD		
Weight in kg	77.66±12.07	79.80±12.94	-0.716	>0.05
Height in cm	161.60±3.89	161.46±4.11	.149	>0.05
BMI	29.80±4.98	31.64±5.04	-0.693	>0.05

*A statistical significant difference (P ≤ 0.005) **A high statistical significant difference (P ≤ 0.001) Test t= independent t test



*Results are not mutually exclusive

Figure (1): Percentage distribution of the studied women (control and study groups) according to their source of information regarding gestational diabetes (n=70).

Table (3): Distribution of the studied women (control and study groups) according to their previous and current obstetrical history (n= 70)

Obstetrical history	Control group n= 35		Study group n=35		X2 p-value
	No	%	No	%	
No. of gravida					
Primigravida	24	68.6	26	74.3	2.79$^{\epsilon}$ >0.05
Twice	6	17.1	7	20.0	
Three times or more	5	14.3	2	5.7	
No. of parity					
Nullipara	24	68.6	26	74.3	.824$^{\epsilon}$ >0.05
Once or Twice	7	20.0	6	17.1	
Three times or more	4	11.4	3	8.6	
Abortions					
Yes	1	2.9	2	5.8	.123$^{\epsilon}$ >0.05
No	34	97.1	33	94.2	
Number of antenatal care visits					
Once	2	5.7	4	11.4	1.96$^{\epsilon}$ >0.05
Twice	8	22.9	10	28.6	
Three times	19	54.3	18	51.4	
More than three times	6	17.1	3	8.6	
Gestational age (in weeks)					
Mean ± SD	22.17 ± 1.25		22.46 ± 0.82		t =1.133 >0.05

*A statistical significant difference (P ≤ 0.005) **A high statistical significant difference (P ≤ 0.001) Test t= independent t test $^{\epsilon}$ Fisher Exact Test

Table (4): Comparison of the mean scores of educational and ecological assessment phase structures of PRECEDE–PROCEED Model (Knowledge & Attitude) of control and study groups regarding gestational diabetes at pre and post intervention phases (n= 70)

Items	Maximum score	Before intervention			After intervention		
		Control group n=35	Study group n=35	t test p-value	Control group n=35	Study group n=35	t test p-value
		Mean ± SD	Mean ± SD		Mean ± SD	Mean ± SD	
Predisposing factors							
Knowledge	24	13.54 ± 1.86	13.17 ± 1.65	0.881 >0.05	14.29 ± 2.02	22.86 ± 1.14	21.832 ≤ 0.001**
Attitude	22	12.22 ± 1.64	11.88 ± 1.13	1.015 >0.05	11.97 ± 1.31	20.02 ± 1.46	24.197 ≤ 0.001**

*A statistical significant difference (P ≤ 0.005) **A high statistical significant difference (P ≤ 0.001)

Table (5): Distribution of the studied women (control and study groups) according to their Health-related behaviors regarding gestational diabetes at pre and post intervention phases (n=70).

Health-related behaviors	Before intervention					After intervention				
	Control group n=35		Study group n=35		X2 p-value	Control group n=35		Study group n=35		X2 p-value
	No	%	No	%		No	%	No	%	
Participating in regular physical activity under the supervision of a specialized doctor.										
Always	10	28.6	9	25.7	0.239 (>0.05)	11	31.4	23	65.7	8.235 (≤ 0.05) *
Sometimes	12	34.3	11	31.4		14	40.0	7	20.0	
Never	13	37.1	15	42.9		10	28.6	5	14.3	
Compliance with recommended diet										
Always	1	2.9	1	2.9	1.476 € (>0.05)	0	0.0	32	91.4	41.828 € (≤ 0.001) **
Sometimes	3	8.6	33	94.2		5	14.2	3	8.6	
Never	30	85.7	1	2.9		29	82.8	0	0.0	
Monitoring of blood glucose level daily										
Always	5	14.3	2	5.7	2.109 € (>0.05)	10	28.6	33	94.3	32.302 € (≤ 0.001) **
Sometimes	7	20.0	5	14.3		14	40.0	2	5.7	
Never	23	65.7	28	80.0		11	31.4	0	0.0	
Compliance with prescribed medications										
Always	14	40.0	11	31.4	0.993 (>0.05)	17	48.6	27	77.1	6.739 € (≤ 0.05) *
Sometimes	12	34.3	16	45.7		13	37.1	7	20.0	
Never	9	25.7	8	22.9		5	14.3	1	2.9	
Compliance with recommended antenatal visits										
Always	2	5.7	0	0.0	2.243 € (>0.05)	4	11.4	26	74.3	35.196 € (≤ 0.001) **
Sometimes	12	34.3	11	34.1		15	42.9	9	25.7	
Never	21	60.0	24	68.6		16	45.7	0	0.0	
Drinking 8 to 10 glasses of water daily										
Always	18	51.4	13	37.1	1.499 (>0.05)	20	57.1	34	97.1	15.993 € (≤ 0.001) **
Sometimes	11	31.4	15	42.9		10	28.6	1	2.9	
Never	6	17.2	7	20.0		5	14.3	0	0.0	
Taking rest and adequate sleep										
Always	0	0.0	0	0.0	0.265 € (>0.05)	2	5.7	29	82.8	42.213 € (≤ 0.001) **
Sometimes	25	71.4	23	65.7		27	77.1	5	14.3	
Never	10	28.6	12	34.3		6	17.2	1	2.9	
Managing and coping with stress										
Always	1	2.9	0	0.0	1.269 € (>0.05)	3	8.6	19	54.3	20.265 € (≤ 0.001) **
Sometimes	7	20.0	9	25.7		10	28.6	12	34.3	
Never	27	77.1	26	74.3		22	62.8	4	11.4	
Counting fetal kicks daily										
Always	2	5.7	0	0.0	4.140 € (>0.05)	6	17.2	31	88.5	36.072 € (≤ 0.001) **
Sometimes	15	42.9	10	28.6		16	45.7	3	8.6	
Never	18	51.4	25	71.4		13	37.1	1	2.9	

*A statistical significant difference (P ≤ 0.005) **A high statistical significant difference (P ≤ 0.001) € Fisher Exact Test

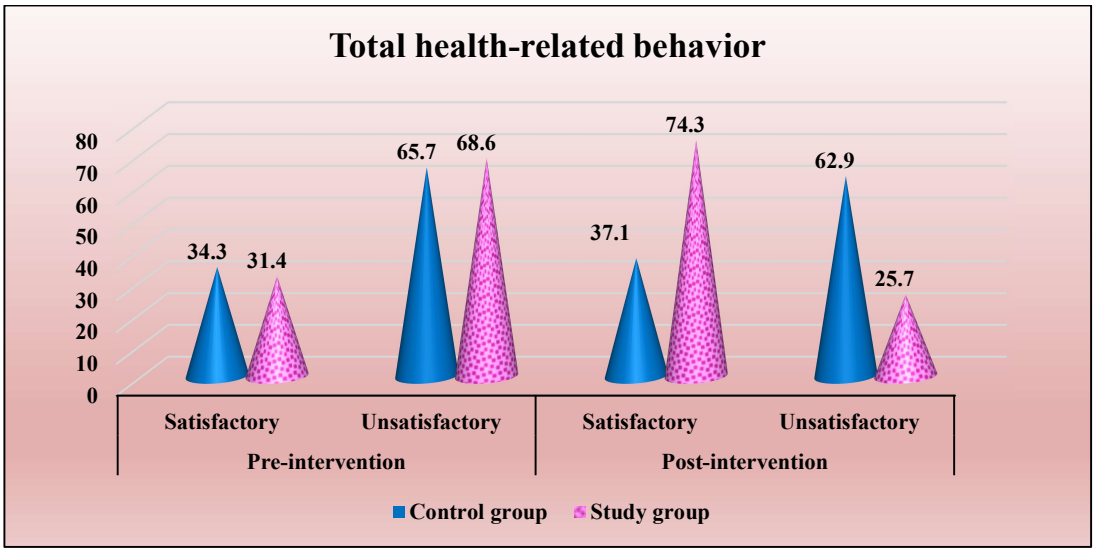


Figure (2): Percentage distribution of the studied women (control and study groups) according to their total score of health-related behaviors regarding gestational diabetes at pre and post intervention phases (n=70).

Table (6): Distribution of the studied women (control and study groups) according to their enabling factors at pre and post intervention phases (n=70).

Enabling factors	Before intervention					After intervention				
	Control group n=35		Study group n=35		X2 p-value	Control group n=35		Study group n=35		X2 p-value
	No	%	No	%		No	%	No	%	
Previously receive an educational program or attending workshops or seminars regarding gestational diabetes										
Always	1	2.9	0	0.0	2.222 € (>0.05)	2	5.7	28	80.0	40.783 € (≤ 0.001) **
To some extend	14	40.0	10	28.6		18	51.4	6	17.1	
Never	20	57.1	25	72.4		15	42.9	1	2.9	
Knowing available resources and having easy access to healthcare facilities for prevention and management of gestational diabetes										
Always	1	2.9	1	2.9	1.476 € (>0.05)	4	11.4	26	74.3	35.196 € (≤ 0.001) **
To some extend	3	8.6	33	94.2		15	42.9	9	25.7	
Never	30	85.7	1	2.9		16	45.7	0	0.0	
Talking to doctor about health concerns										
Always	2	5.7	0	0.0	4.140 € (>0.05)	3	8.6	19	54.3	20.265 € (≤ 0.001) **
To some extend	15	42.9	10	28.6		10	28.6	12	34.3	
Never	18	51.4	25	71.4		22	62.8	4	11.4	
Allocating a portion of the income to the purchase of healthy food and nutritional supplements.										
Always	10	28.6	9	25.7	0.239 (>0.05)	10	28.6	33	94.3	32.302 € (≤ 0.001) **
To some extend	12	34.3	11	31.4		14	40.0	2	5.7	
Never	13	37.1	15	42.9		11	31.4	0	0.0	
Having enough time daily to read and make exercises										
Always	14	40.0	11	31.4	0.993 (>0.05)	11	31.4	23	65.7	8.235 (≤ 0.05) *
To some extend	12	34.3	16	45.7		14	40.0	7	20.0	
Never	9	25.7	8	22.9		10	28.6	5	14.3	

*A statistical significant difference (P ≤ 0.005) **A high statistical significant difference (P ≤ 0.001) € Fisher Exact Test

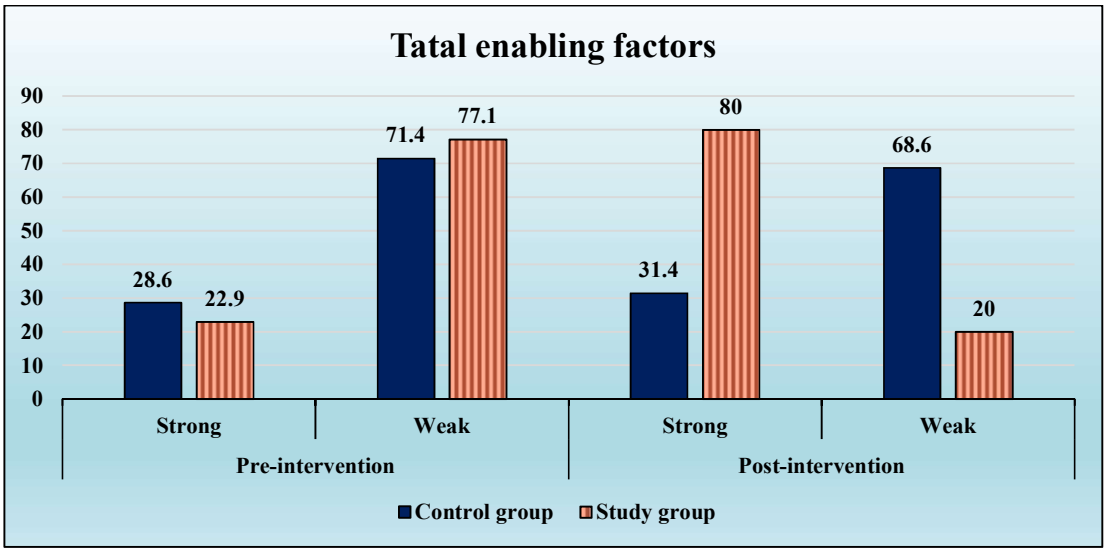


Figure (3): Percentage distribution of the studied women (control and study groups) according to their total score of enabling factors regarding gestational diabetes at pre and post intervention phases (n=70).

Table (7): Distribution of the studied women (control and study groups) according to their reinforcing factors at pre and post intervention phases (n=70).

Reinforcing factors	Before intervention					After intervention				
	Control group n=35		Study group n=35		X2 p-value	Control group n=35		Study group n=35		X2 p-value
	No	%	No	%		No	%	No	%	
Supporting of husband and health care provider for the woman to adapt this stage safely and change bad health behaviors										
Always	0	0.0	0	0.0	1.429 € (>0.05)	2	5.7	25	71.4	28.802 € (≤ 0.001) **
To some extend	5	14.3	9	25.7		12	34.3	7	20.0	
Never	30	85.7	26	74.3		21	60.0	3	8.6	
Emotional support from family and friends										
Always	18	51.4	13	37.1	1.499 (>0.05)	20	57.1	34	97.1	15.993 € (≤ 0.001) **
To some extend	11	31.4	15	42.9		10	28.6	1	2.9	
Never	6	17.2	7	20.0		5	14.3	0	0.0	
Receiving a reward from family members for following a healthy lifestyle and implementing preventive behavior										
Always	2	5.7	0	0.0	2.243 € (>0.05)	17	48.6	27	77.1	6.739 € (≤ 0.05) *
To some extend	12	34.3	11	34.1		13	37.1	7	20.0	
Never	21	60.0	24	68.6		5	14.3	1	2.9	
Praising of other people easily for achievements										
Always	1	2.9	0	0.0	1.269 € (>0.05)	0	0.0	32	91.4	41.828 € (≤ 0.001) **
To some extend	7	20.0	9	25.7		5	14.2	3	8.6	
Never	27	77.1	26	74.3		29	82.8	0	0.0	
Encouraging of medical authorities to check on health continuously										
Always	5	14.3	2	5.7	2.109 € (>0.05)	6	17.2	31	88.5	36.072 € (≤ 0.001) **
To some extend	7	20.0	5	14.3		16	45.7	3	8.6	
Never	23	65.7	28	80.0		13	37.1	1	2.9	
Talking with women of the same condition helps to overcome obstacles and encourage to change unhealthy habits										
Always	0	0.0	0	0.0	0.265 € (>0.05)	2	5.7	29	82.8	42.213€ (≤ 0.001) **
To some extend	25	71.4	23	65.7		27	77.1	5	14.3	
Never	10	28.6	12	34.3		6	17.2	1	2.9	

*A statistical significant difference (P ≤ 0.005) **A high statistical significant difference (P ≤ 0.001) € Fisher Exact Test

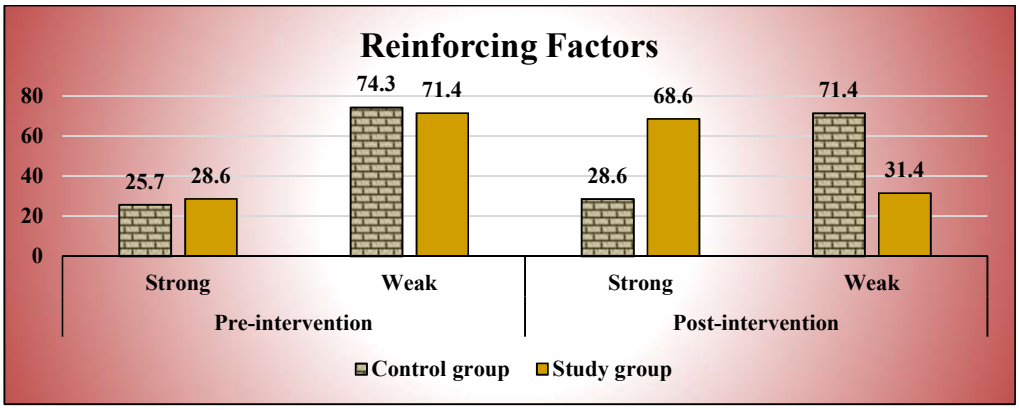


Figure (4): Percentage distribution of the studied women (control and study groups) according to their total score of reinforcing factors regarding gestational diabetes at pre and post intervention phases (n=70).

Table (8-A): Distribution of the studied women (control and study groups) according to maternal outcomes at pre and post intervention phases (n=70).

Variables	Control group n=35		Study group n=35		X2	P value
	No	%	No	%		
During pregnancy:						
Polyhydramnios	6	17.1	1	2.9	3.968	(≤ 0.05) *
Pyelonephritis	4	11.4	0	0.0	4.242	(≤ 0.05) *
Vaginal infection	18	51.4	6	17.1	9.130	(≤ 0.05) *
Pre-eclampsia	8	22.9	2	5.7	4.200	(≤ 0.05) *
Abortion	2	5.7	0	0.0	2.059	(> 0.05)
During labor:						
Mode of delivery						
Vaginal delivery	10	28.6	19	54.3	4.769	(≤ 0.05) *
Cesarean section	25	71.4	16	45.7		
No. maternal complications	23	65.7	11	31.4	8.235	(≤ 0.05) *
Abnormal uterine contraction	11	31.4	2	5.7	7.652	(≤ 0.05) *
Preterm labor	15	42.9	5	14.3	7.000	(≤ 0.05) *
Obstructed labor	13	37.1	4	11.4	6.293	(≤ 0.05) *
Operative interference	9	25.7	2	5.7	5.285	(≤ 0.05) *
Instrumental interference	10	28.6	3	8.6	4.629	(≤ 0.05) *
Postpartum hemorrhage	11	31.4	3	8.6	5.714	(≤ 0.05) *
Infection	6	17.1	4	11.4	0.467	(> 0.05)

*A statistical significant difference (P ≤ 0.005) **A high statistical significant difference (P ≤ 0.001)

Table (8-B): Distribution of the studied women (control and study groups) according to fetal outcomes at pre and post intervention phases (n=70).

Variables	Control group n=35		Study group n=35		Independent t test	P value
	No	%	No	%		
Need for ICU	23	65.7	11	31.4	8.235	**(≤ 0.05) ***
Jaundice	28	80.0	16	45.7	8.811	**(≤ 0.05) ***
Fetal macrosomia	21	60.0	10	28.6	7.006	**(≤ 0.05) ***
Hypoglycemia	20	57.1	8	22.9	8.571	**(≤ 0.05) ***
Prematurity & respiratory distress	14	40.0	5	14.3	5.851	**(≤ 0.05) ***
IUFD	2	5.7	0	0.0	2.059	**(> 0.05)**

*A statistical significant difference (P ≤ 0.005) **A high statistical significant difference (P ≤ 0.001)

Table (9): Correlation coefficient between total knowledge score, total attitude score and total health-related behaviors) of the studied women at pre and post-intervention phases (n=70).

Variables	Total Knowledge							
	Control group n=35				Study group n=35			
	Before intervention		After intervention		Before intervention		After intervention	
	r	p-value	R	p-value	r	p-value	R	p-value
Total attitude	0.773	≤ 0.001**	0.930	≤ 0.001**	0.676	≤ 0.001**	0.739	≤ 0.001**
Total health-related behaviors	0.815	≤ 0.001**	0.823	≤ 0.001**	0.804	≤ 0.001**	0.850	≤ 0.001**

*A statistical significant difference (P ≤ 0.005) **A high statistical significant difference (P ≤ 0.001) € Fisher Exact Test

Discussion

One in six babies is affected by the common pregnancy problems known as gestational diabetes mellitus. GDM may cause numerous adverse pregnancy outcomes as cesarean section, preeclampsia, and subsequent development of type 2 diabetes, macrosomia, shoulder dystocia, neonatal hypoglycemia and respiratory distress syndrome. Hence, providing pregnant women with basic knowledge and education regarding pathophysiology of gestational diabetes, treatment options and self-care practices can help to promote better outcomes for both mother and fetus **(Staynova and Yanachkova, 2021)**.

Application of an educational program intended to increase clinical rule knowledge has seemed to be effective in improving clinical outcomes, including gestational diabetes, and health care managers' performance. As gestational diabetes may have an impact on the health of the fetus, women with the disease are more likely to monitor it, however structured health education and self-care programs utilizing PRECEDE–PROCEED Model for women with GDM are limited, especially in high-income nations **(Oakley L.L., Deepa R., Namara A., Sahu B. and Nadal I. P., et al., 2021)**.

The current study aimed to assess the effect of self-care program guided by PRECEDE–PROCEED model on maternal and fetal outcomes among gestational diabetic women. The aim of the study was significantly supported through the foregoing study results which illustrated high statistical significant improvement in pregnant women's knowledge, attitude, preventive health-related behaviors, enabling factors and reinforcing factors regarding gestational diabetes after the application of the health education program. Therefore, the study hypotheses were reinforced.

With regard to demographic characteristics of the studied women, the current study's findings showed that fewer than half and more than half of the study and control groups respectively were over 30 years old with mean age 28.63 ± 1.78 and 29.41 ± 1.93 years for study and control groups respectively. Furthermore, less than half of the study group had a secondary education, while more than half of the control group had a secondary education. Regarding occupation, more than two-thirds of the study group and more than half of the control group were housewives. Concerning residence, less than three-quarters and the majority of study and control groups were from rural places respectively. In addition, less than three-quarters and more than two-thirds of study and control groups had not enough monthly income respectively. Regarding demographic characteristics, there was no statistically significant difference between two groups. Thus, there was homogeneity between two groups. These factors were significantly associated with inadequate knowledge, negative attitude and poor self-care practices of women with gestational diabetes.

These results are in line with **Saboula N.E., Ahmed N.A., and Rashad R.H., (2018)** who illustrated that (56.7%) of the pregnant women aged 31 years and more, more than one third of them (35%) had secondary education only and about (75.0%) of them were housewives. Also, **El-Ansary and Fouad, (2020)** demonstrated that above (56.7%) of the studied sample had a middle level of education, about (82.5%) didn't have work and above half of them (55.7%) living in rural region.

Moreover, **Farahani M.A., Abdollahian M., and Kolahduzan S., (2020)** demonstrated in

his study that more than three quarters of the study group and the majority of the control group were housewives. Also, the majority of both groups had medium level of income.

Additionally, the current study's findings demonstrated that the study and control groups' mean body mass indices were 31.64±5.04 kg / m2 and 29.80±4.98 kg / m2 respectively, this result come in line with **Said and Aly, (2019)** who found that the mean body mass index in study and control groups were 30.46 ±1.53kg / m2 and 30.34 ± 1.75kg / m2 respectively.

In relation to source of information, the findings of the present study illustrated that above three-quarters and fewer than two-thirds of both study and control groups respectively obtained their information regarding gestational diabetes from friends and relatives, while, fewer than one third and above one third of both study and control groups respectively obtained their information from doctors and nurses this result constitute an obstacle that hindered pregnant women's acceptance to the recommendations of health professionals and failed to follow the prescribed diet, by eating a large amounts of calories which makes women are prone to severe hyperglycemia or hypoglycemia. In contrast, a study conducted by **Islam B., Islam F., Nyeem M., and Neaz A., (2017)** who mentioned that the more than half of respondents (50.5%) obtained their knowledge about disease from hospital or clinics.

Regarding obstetrics history of the studied sample, the findings of the study shows that, less than three-quarters and more than two-thirds of the study and control groups respectively were primigravida and nulliparous. This result is similar to **Kiiza F., Kayibanda D., Tumushabe P., Kyohairwe L. and Atwine R., et al., (2020)** who found that most of the study participants were primigravida. On the other hand, this result is contradicted with **El-Ansary and Fouad, (2020)** who found that more than three quarters (76.3%) of the studied women were multigravida and more than two thirds of them (71.1%) were multipara.

Worldwide, PRECEDE–PROCEED model has been used for numerous chronic illnesses and in our study researchers applied this model on gestational diabetes to determine maternal and fetal outcomes. Predisposing factors are one of the ingredients of the educational assessment based on PRECEDE–PROCEED model and such factors make patients get ready to embrace desired behaviors. The result of the current study showed that there was no statistical significant difference in the mean scores of total predisposing factors (knowledge and attitudes) between the study and control groups before implementation of the program however, after the program implementation, the mean scores of total knowledge and attitudes of the study group was statistically significant higher than the mean scores of the control group. These results pointed to the positive effect of the educational program utilizing PRECEDE–PROCEED Model on improving pregnant women's knowledge concerning gestational diabetes which in turn reflected on their attitudes that also improved in the study group post program application compared to preprogram.

This result matches with **Barasheh N, Shakerinejad G, Nouhjah S and Haghighizadeh MH., (2017)** who found that there was a significant increase in the score of knowledge and attitude in the study group after the intervention compared to the control group ($P<0.05$). Also, **Hailuet F.B., Moen A. and Hjortdahl P., (2019)** who found that the difference in the mean score of Diabetes

Knowledge Scale scores pre and post the application of diabetes self-management education intervention was significantly higher in the intervention group (p = 0.044) and a slight decrease in the control group. Additionally, **Said and Aly, (2019)** illustrated in their study that there was a high statistical significant difference concerning all elements of knowledge before and four weeks after the application of gestational diabetes educational package (P< 0.000) where in control group there was no statistical significant difference concerning all knowledge items.

Similarly, **Saboula et al., (2018)** discovered in his study that the overall mean score of knowledge prior to educational intervention was 20.2±0.4 and increased to 36.4±5.5 after intervention also, a high statistical significant difference regarding all attitude scale factors among studied sample was found before and after educational intervention. In contrast, another studies conducted by **Bidi F., Hassanpour K., Ranjbarzadeh A., Kheradmand A., (2013)** found that Knowledge was not significantly affected by the instructional program. Additionally, a study conducted by **Habibeh M., Babak R. and Eshagh A.M., (2014)** found that there was no significant relation between knowledge of studied sample and quality of life pre and post the intervention.

Concerning adherence of pregnant women to health-related behaviors regarding gestational diabetes, the results of this study showed that there was a statistically significant improvement in all health-related behaviors within the study group as compared to the control group after implementation of the program than before its application ($p \leq 0.001$) and ($p \leq 0.05$) as demonstrated from the results that nearly three quarters of the study group had satisfactory level of health-related behaviors after program implementation compared to less than one third pre-program implementation .

This result may be related to the enhancement of pregnant women's knowledge after program application that helps pregnant women to comply with health-related behaviors regarding gestational diabetes. In the same line **Park and Lee, (2020)** found that after health care programs were implemented for pregnant women with GDM, blood glucose control improved, anxiety and depression decreased, self-management and self-care behavior improved, self-efficacy increased, and maternal identity improved. Also, **Saboula et al., (2018)** found a high statistical significant relationship regarding all self-care activities subscales of gestational diabetes before and after the educational interventions.

Additionally, **Said and Aly, (2019**) found in their study that nutrition, physical activity, management of stress and health responsibility was improved after 4 weeks of implementation of educational package regarding gestational diabetes in the study group. These results are matched also with **Arbab A., Mansouri A., Shahrakivahed A., Ghalehno A.T., and Nodratzehi S., (2017)** who illustrated that the mean score of all elements of quality of life improved after the intervention in comparison to before intervention.

Moreover, **Harafteh F.S., Mohajeri Z.K., Kia S., (2020)**found in his study that the study and control groups in the pre intervention phase showed no significant difference related to perceived stress, health literacy and self-care behaviors (p>0.05); although after the intervention, a statistical significant difference was found in the previous illustrated three variables (p<0.001) which indicated that the self-care training

program cause a significant decline in perceived stress and a significant increase in health literacy and self-care behaviors in gestational diabetic women ($p<0.001$).

The early behavioral and/or environmental changes brought about by the creation of environmental policies or motivations are known as enabling factors. The findings of the study displayed that the majority of study group had strong enabling factors after implementation of the program in comparison to less than one-third of the control group as the pregnant women become more aware of the available resources and having easy access to healthcare facilities, consult with doctor about health issues, set aside a portion of money for the purchase of wholesome food and dietary supplements and make regular exercise.

Also, reinforcing factors are another component of the PRECEDE–PROCEED Model and include factors that cause persistent following and rewarding the behaviors that precipitate holding and maintaining the behavior. Supportive groups are necessary to increase the motivation of diabetic women to take care of themselves. The present study showed that above two-thirds of study group had strong reinforcing factors when compared with above one-quarter of the control group after implementation of the program as the pregnant women got the emotional support from family members, friends and health care providers as a reinforcing factors that may improve self-care behaviors regarding gestational diabetes. These results may indicate the positive impact of the educational program utilizing PRECEDE–PROCEED Model and pregnant women interaction and participation during the teaching sessions that helped to improve pregnant women's awareness about enabling and reinforcing factors regarding GDM.

These results are in line with **Nejhaddadgar N., Darabi F., Rohban A., Solhi M. and Kheire M., (2018)** who found that all components of PRECEDE model involving predisposing factors (knowledge, attitude), enabling and reinforcing factors, were significantly improved in the study group after the educational program. Also, **Azar et al., (2018)** showed that the mean scores of knowledge, attitude, enabling and reinforcing factors were significantly differences in both groups pre and post the intervention ($p < 0.05$).

Regarding maternal and fetal outcomes pre and post application of the program, the findings of the current study illustrated a statistically significant high proportions of maternal complications in the control group than the study group, except regarding abortion and infection. In addition, there was increased rate of normal delivery in the study group compared with elevated level of CS rate in the control group. Moreover, the incidence of fetal complications was significantly higher in the control group than in the study group except in IUFD. This result indicated that the educational program succeeded in achieving it aim regarding improving gestational diabetic women's knowledge, attitude, health related behaviors, enabling and reinforcing factors which reflected on improving maternal and fetal outcomes.

The results of the present research demonstrated that there was a high statistical significant positive correlation between total knowledge score and total attitude of both study and control groups pre and post implementation of program ($P \leq 0.001$). Also, a high statistical significant positive correlation was found between total

knowledge score and total health-related behaviors of both study and control groups before and after implementation of program ($P \leq 0.001$). These results pointed to the need for continuous education of pregnant women utilizing different teaching methods that help to upgrade pregnant women's knowledge and improve quality of life. This result agrees with a study conducted by **George G., Sasikala T. and Chidambaran R., (2021)** and illustrated that a positive correlation was found between knowledge and self-care practices of pregnant women. Also, **Ghannadi et al., (2016)** illustrated that a statistical significant correlation was found between women's knowledge and practice with their self-care activities.

Conclusion

The current study's findings concluded that the application of self-care program guided by PRECEDE–PROCEED model had positive impact on improving gestational diabetic women's knowledge, attitude, health related behaviors, enabling and reinforcing factors related to gestational diabetes after program implementation. Additionally, PRECEDE–PROCEED model had improved maternal and fetal outcomes in the study group compared to the control group. Hence, the results of the current research had supported the research hypotheses and achieved the aim of the research.

Recommendations

The current study recommended that:

- An educational intervention guided by PRECEDE–PROCEED should be conducted at postpartum period to help gestational diabetic women to adopt healthy lifestyles during breastfeeding.
- Preventive Programs involving physical activity, healthy diet and promotion of breastfeeding should be implemented to prevent gestational diabetes.
- Regular in-service training and workshops are necessary to enhance nurses' knowledge, attitudes and practices about gestational diabetes.

Further studies to be performed: -

- Future studies are recommended on a large sample in order to generalize the results, demonstrate the value of PRECEDE–PROCEED model and examine improved implementation strategies.

Limitations of the study

The researchers met certain limitations during the study as non-probability purposive sampling interfere with the generalization of research findings and there was no fixed place for implementing the educational sessions that caused the researchers to postpone some sessions, The researchers also discovered that planning and scheduling phone conversations presented challenges. Furthermore, there were insufficient local and international references that investigate the chosen variables.

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