Effect of a Nutrition Education Program Based on Pender's Health Promotion Model on the Dietary Patterns of Pregnant Women

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Abstract- A healthy, balanced diet during pregnancy is essential to ensure optimal fetal growth and maternal physiological adaptations. This study aimed to evaluate the effect of a nutrition education program based on Pender's Health Promotion Model on the dietary patterns of pregnant women. **Method.** A quasi-experimental design was employed, utilizing convenience sampling to recruit 60 pregnant women in their first trimester. **Results.** Following the educational intervention, there was a statistically significant improvement in pregnant women's knowledge, dietary patterns, and Pender's Health Promotion Model-based constructs. **Conclusion.** A nutrition education program grounded on Pender's Health Promotion Model is an effective intervention for significantly improving dietary intake among pregnant women. It is recommended that nutrition education programs based on Pender's Health Promotion Model be integrated into routine antenatal care to promote healthy dietary behaviors and improve maternal nutrition outcomes.

Index Terms- maternal nutrition, nutrition education, Pender's health promotion model, pregnant women.

I. Introduction

Pregnancy is a crucial stage in which maternal nutrient intake has a significant impact on maternal health and fetal development (1). Adequate nutrition supports optimal fetal growth, prevents developmental "reprogramming" that may increase the child's risk of chronic diseases, and maintains maternal nutrient stores for future breastfeeding (2).

Inadequate dietary intakes before, during, and after pregnancy can negatively affect both mothers and their offspring (3). Poor nutrition in utero is associated with stunted growth and development in children, short stature in adults, lower intellectual attainment, infants born small for their gestational age are at an increased risk of developing obesity and metabolic disorders during adulthood (4).

Beyond nutrient deficiencies maternal overweight and excessive weight gain during pregnancy are associated with numerous short- and long-term complications for both mother and her offspring (5). Mothers may experience a higher likelihood of gestational diabetes, gestational hypertension, pre-eclampsia, caesarean delivery, postpartum weight retention, long-term obesity, and increased susceptibility to noncommunicable diseases (6). For the offspring, potential consequences include stillbirth, shoulder dystocia, preterm delivery, being born large for gestational age, and a greater risk of developing obesity during childhood (7).

Nutrient requirements increase throughout pregnancy to accommodate maternal physiological changes and fetal growth, with energy and protein needs rising especially in the second and third trimesters (8). Healthy dietary behaviors during pregnancy include consuming foods that contain optimal amounts of energy as well as macro and micronutrients, achieving appropriate weight gain, adhering to general and pregnancy-specific food safety recommendations (9,10).

Pregnancy represents an ideal opportunity to promote healthy behaviors, as women are motivated to optimize outcomes for themselves and their infants. Nutrition education and counseling (NEC) are key approaches recommended to enhance maternal dietary knowledge and practices (11). For NEC to be effective, it should be grounded in behavioral theories, which provide systematic frameworks to address the social, psychological, and environmental determinants of nutrition-related behaviors. (12).

Theory-based approaches provide systematic frameworks to comprehend and target the environmental, social, and psychological factors that influence nutrition-related behaviors, in contrast to traditional health education (13). Research indicates that behavioral theories-based therapies, like the Social Cognitive Theory or the Pender health promotion model, lead to much better behavioral results, motivation, and knowledge retention than non-theoretical approaches (14).

Pender's Health Promotion Model (HPM) provides a comprehensive and adaptable framework for designing effective nutrition education interventions for pregnant women (15). This model moves beyond the avoidance of disease and focuses on proactive health promotion, aligning well with the goals of prenatal care (16). HPM-based interventions significantly improve dietary behaviors and lifestyle choices in pregnant women by enhancing motivation and addressing context-specific barriers (17). Thus, this study aimed to evaluate effect of nutrition education- based on pender's health promotion model on dietary pattern of pregnant women.

II. Method

Study design: This is a quasi-experimental design (one-group pre–posttest).

Setting: The study was carried out in five primary healthcare facilities located in Mansoura districts, Egypt, which offer antenatal care services.

Sampling technique and sample size

The researchers used convenience sampling technique to recruit of sixty pregnant women. The sample size is determined by analysing the power of the test of Cohen (1992) through G*power by setting up the parameter values for testing the 2-tailed hypothesis, the power of the test at 95%, and the alpha error at 0.05, effect type (d). From the estimation of the effect size value at 0.5, the sample size is 54 pregnant women. To account for potential drop-out rate, sample size is increased by 10% to be 60 pregnant women (18).

Study tools

The researchers developed structured interview questionnaire for data collection in this study, consisted of four parts as the following:

Part 1: Pregnant women' socio-demographic data as age, marital status, residence, education, occupation, family income, and usual source of health care.

Part 2: Pregnant women' knowledge assessment questions, it consisted of 46 multiple-choice items divided into six categories as healthy nutrition importance, macronutrients, vitamins, minerals, managing nutrition related problems, and food labelling (19,20,21).)

Part 3: Pregnant women' dietary intake assessment questionnaire**,** the researchers used two questionnaires to assess dietary intake of pregnant women (22, 23) as the following.

a-Three days food record; This method required participants to document all foods and beverages consumed over three consecutive days two weekdays and one weekend day to account for daily and weekly dietary variations.

b- The Food Frequency Questionnaire (FFQ); was utilized to evaluate the habitual dietary intake patterns of pregnant women over a defined period . It assessed the frequency of consumption across 17 major food groups, employing a six-point Likert scale (never eaten, 1-2 times per month, 1-2 times per week, every day and more than once a day) For the purpose of quantitative analysis, each response option was converted to servings per week (servings/week), based on the assumption that each reported "time" corresponded to one standard portion.

Part 4: Pender's health promotion model constructs assessment questionnaire; was designed to assess psychosocial determinants of dietary behavior among pregnant women based on Pender's Health Promotion Model (24, 25). The questionnaire categorized into eight domains on a four-point Likert scale (Strongly Agree, Agree, Disagree, Strongly Disagree), capturing the degree of agreement with each statement as including perceived benefits (8 items), perceived barriers (11 items), self-efficacy (10 items), activity-related affect (9 items), interpersonal influences (8 items), situational influencers (8 items), commitment to plan of nutrition (14 items) and immediate competing demands and preferences (14 items).

To ensure the content validity, the questionnaire was developed using reliable scientific resources and 10 experts confirmed their content validity. The Content Validity Ratio (CVR) of the instrument was 0.73, which is considered acceptable. The Content Validity Index (CVI) for the total scale was 0.89, indicating strong agreement among the experts and a high level of content validity. Face validity the experts' panellists testing the clarity, relevance, and appropriateness of the tools to ensure they adequately measure the intended variables. The reliability of the questionnaire was determined using Cronbach's coefficient alpha, showed an acceptable reliability, as the overall reliability was 0.85.

Pregnant women were medically pre-screened with their healthcare providers to confirm eligibility before being enrolled in the intervention. The inclusion criteria required participants to be in their first trimester of pregnancy, aged 18 years or older, with a body mass index (BMI) below 40 kg/m², and carrying a singleton fetus. Women with twin or multiple pregnancies, weight-related complications, chronic illnesses, or those following a special dietary regimen were excluded from the study.

Designing educational materials for intervention

The researcher designed the educational materials content based on scientific literature and evidence-based nutritional guidelines. The credibility of the content was validated by conducting a two-rounds Delphi technique with a panel of experts. Then evaluating the acceptability and clarity of the educational materials through direct feedback from pregnant women before implementation.

Implementation of educational intervention

The intervention was structured into four educational sessions, each lasting approximately 45 to 60 minutes. The first session aimed to enhance participants' knowledge of appropriate dietary patterns during pregnancy. Emphasis was placed on the average daily servings of the five main food groups. Group discussions were facilitated to clarify concepts and encourage participant interaction. Feedback was collected at the end of the session to evaluate comprehension and adjust future sessions accordingly. An educational booklet (available in both printed and digital formats) was distributed at the end of the session.

The second session addressed common barriers to healthy eating and provided actionable strategies to overcome them. Teaching participants how to prepare a balanced plate, demonstrating appropriate proportions of different food groups using sample menus. Enhancing self-efficacy through role-playing, and interactive skill-building activities. Discussing positive and negative emotions related to dietary behaviors and how to manage them effectively. To reinforce self-efficacy and commitment to change, participants were instructed to record their daily food intake on a weekly basis using a structured form provided by the researcher and document daily portion sizes and retain the records for discussion in subsequent sessions. The third session targeted the interpersonal factors influencing pregnant women's nutritional behaviors, a dedicated training session was held for participants' husbands, mothers, and mothers-in-law. This session focused on educating family members about the critical role of nutrition in improving pregnancy outcomes. Inviting guest speakers, including nutritionists and healthcare professionals, to provide expert insights and reinforce key messages. All attendees received an educational pamphlet summarizing the session's content to support continued learning and application of healthy nutritional practices at home.

Evaluation of educational intervention

The participants were assessed six weeks post-intervention to evaluate the continuity and sustainability of the behavioral changes achieved through the nutrition-education program.

Ethical Considerations

Ethical clearance was granted by the Research Ethics Committee of the Faculty of Nursing, Mansoura University (IRB. 468). In accordance with ethical research guidelines, written informed consent was obtained from all participants after a thorough explanation of the study's purpose, procedures, and expected outcomes. The researcher introduced himself and clarified the voluntary nature of participation to the pregnant women, who had already been medically pre-screened by their healthcare providers. Participants were assured of their right to withdrawfrom the study at any stage without the need to provide a justification. Confidentiality and anonymity were strictly maintained throughout the research process. Personal data and responses were handled with care and used solely for research purposes. Furthermore, findings derived from this study may be disseminated through academic publications or presentations, but without disclosing any identifying participant information.

Statistics analysis

The data was analyzed using personal computer using Stand for statistical product and service solutions (SPSS) program version deviation (SD). Paired t test to examine associations between categorical variables. Normality of the data distribution was assessed using the Kolmogorov-Smirnov test. Content validity index was used to test content validation. Quantitative variables were expressed as mean ± standard. A p-value of ≤ 0.05 was considered statistically significant for all tests.

III. RESULTS

Sixty pregnant women in their first trimester were enrolled in this research. Table 1 presents 48.3% of the studied sample aged from 25 to less than 35, 98.3 were married and 58.3% reported having families consisting of three to four members.

As shown in table 2 71.7% of the women were not working, 50% reported that their income was sufficient to meet the basic needs of the family. Additionally, 45% of the women reported utilizing more than one source of healthcare

Table 1. Pregnant Women' Sociodemographic Characteristics

Item	n=60	%
Age		
From 18 to less than 25	27	45
From 25 to less than 35	**29**	**48.3**
From 35 to less than 45	4	6.7
Mean (SD)	**25.28 (4.903)**	
Marital Status		
Divorced	1	1.7
Married	**59**	**98.3**
Residence		
Slum	16	26.7
Rural	**28**	**46.7**
Urban	16	26.7
Numbers of family members		
Two	18	30
Three to Four	**35**	**58.3**
Five to more	7	11.7

Table 2. Pregnant Women' Sociodemographic Characteristics (Cont.,)

Item	n=60	%
Wife's job		
Not working	**43**	**71.7**
Unskilled worker	1	1.7
Government employees	6	10
Professionals*	10	16.7
Husband's job		
Unskilled worker	8	13.3
Skilled worker	16	26.7
Traders	**20**	**33.3**
Government employees	7	11.7
Professionals	9	15
Household income		
Indebt	1	1.7
Meet the basic needs of the family	**30**	**50**
Meet basic and emergency needs	17	28.3
Saving and invest	12	20
Usual source of health care		
Traditional medicine and self-treatment	2	3.3
Health insurance	5	8.3
Private clinics and hospitals	13	21.7
Free public healthcare institutions	13	21.7
More than one of the above	**27**	**45**

*Professionals :(doctors - university professors - lawyers - officers)

. Notably table 3 reveals that there was statistically significant improvement in pregnant women's knowledge after the educational intervention ($P < 0.001$ for all domains).

Table 4 illustrates the mean intake of various food groups over three days, comparing values before and after the educational sessions, that was significant improved in some food groups. the food frequency assessment of pregnant women before and after the educational session.

Table 5 reveals the food frequency assessment of pregnant women indicating an increase in the consumption of healthy food groups post-education, including grains, carbohydrates, animal protein, dairy products, fruits, vegetables, unsaturated fats, natural juices, and herbs.

Table 6 presents the assessment of Pender's Health Promotion Model constructs before and after the educational session, showing notable improvements across all constructs.

IV. DISCUSSION

Adequate and balanced nutrition during pregnancy is essential for ensuring both a healthy pregnancy and positive birth outcomes, and it largely depends on a woman's nutritional knowledge and practices (26). The World Health Organization (WHO) acknowledges the importance of nutrition education during pregnancy and recommends that antenatal care (ANC) providers offer tailored, clear, and culturally appropriate nutrition guidance at every prenatal visit. Research has also shown that education plays a crucial role in promoting health (27).

The present study found that the mean age of participants was 25.28 ± 4.90 years, which is consistent with Osman, Shalaby, El-Shabory, Mohamed, and Shehata (2022), who reported a mean age

of 27.5 ± 4.6 years among 270 pregnant women in Port Said, Egypt. In contrast, Kocyłowski et al. (2018) reported a higher mean age of 31.4 ± 4.9 years among pregnant women in Poland. This difference may be attributed to earlier marriage and childbearing practices among Egyptian women.

Regarding pregnant women's knowledge about nutrition, there was a significant difference between the pre-test and post-test scores ($P < 0.05$). This finding is consistent with Permatasari, et al., (2021) and Teweldemedhin et al. (2021), studies which reported that women in the intervention groups showed a notable increase in knowledge after receiving nutrition education. Similarly, the current results align with Khani Jeihooni, Rakhshani, Harsini, and Layeghiasl (2021), who observed that the experimental group demonstrated a significant improvement in knowledge and nutritional practices three months following the educational intervention.

One of the key findings of the study was an improvement in the intake of micronutrient-rich food groups, as well as an increase in the number of servings of grains, proteins, fats, fruits, and vegetables following the educational intervention. The program also encouraged the consumption of a more varied and balanced diet. These changes may be attributed to the participants' enhanced understanding of the benefits of macronutrients, the recommended servings for each food group, sources of essential micronutrients, and strategies for planning balanced meals. From a research perspective, this suggests that targeted nutrition education can effectively translate knowledge into healthier dietary behaviors among pregnant women. This supports the finding of Li, Piaseu, Phumonsakul, and Thadakant, (2024); Katenga-Kaunda et al., (2020); Sunuwar et al., (2019) that indicated increased intakes of dairy products, dark leafy vegetables, beans/pulses, and nuts and seeds among the women in the intervention group.

This is the same as what was stated in the study of Katenga-Kaunda et al., (2021), which presented that there was significant improvements in nutrition knowledge, dietary diversity and nutrition behaviour in the intervention group compared with controls. However, this finding contrasts with Fujimoto et al. (2024), who reported no significant difference in protein intake between the intervention and control groups following the educational program.

Pender's Health Promotion Model (HPM) is a widely used framework for promoting health-enhancing behaviors and explaining factors influencing a healthy lifestyle (38). In the present study, significant improvements were observed across all constructs of the HPM, with the largest effect sizes noted for perceived self-efficacy, competing demands and preferences, and commitment to healthy food planning ($t = 23.6$, 24, and 49, respectively). These findings suggest that participants experienced increased confidence in adopting health-promoting behaviors and were better able to overcome barriers to making healthy food choices. This aligns with previous research indicating that nutrition education grounded in Pender's HPM effectively enhances pregnant women's adherence to dietary guidelines (39).

V. Conclusion

Both subject experts and participants positively evaluated the adequacy, coverage and readability of contents of the booklet. Nutrition educational session based on Pender health promotion model is an effective intervention for significantly improving knowledge, high dietary diversity, higher consumption of nutrient-dense foods and decreased intake of unhealthy food among pregnant women compared to pre-educational intervention.

VI. Recommendation

1.Train healthcare providers to use behavioral change models, such as the Health Promotion Model (HPM), to develop patient-centered nutrition education that empowers pregnant women to adopt healthy dietary patterns.

2.Provide prenatal nutrition counseling by qualified professionals to pregnant women and their support networks, including spouses and family members (e.g., mothers and mothers-in-law).

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Table 3. Pregnant Women' Knowledge Regarding Balanced Nutrition During Pregnancy

Knowledge items	Pre	Post	T	P value
	Mean (SD)	Mean (SD)		
Healthy nutrition	5.53 (2.18)	10.16 (1.04)	15.81	0.000
Macronutrients	11.75 (5.28)	25.45 (1.09)	19.51	0.000
Vitamins	14.83 (12.30)	62.46 (7.05)	27.59	0.000
Minerals	10.40 (7.38)	50.76 (6.46)	36.29	0.000
Nutrition problems	14.45 (4.92)	27.15 (3.55)	18.57	0.000
Food labels	1.33 (1.98)	8.66 (1.43)	25.56	0.000
Total knowledge	58.30 (29.51)	184.6 (17.11)	32.42	0.000

Table 4. Pregnant Women' Three-day food record

Food group	Pre	Post	T	P value
	Mean (SD)	Mean (SD)		
Grains (6- 8 servings)				
Day 1	7.30 (1.690)	8.62 (1.367)	4.88	0.00
Day 2	9.02 (1.490)	7.45 (1.383)	6.16	0.00
Day 3	8.03 (1.235)	6.72 (1.151)	6.59	0.00
Protein (3-4 servings)				
Day 1	2.92 (1.078)	4.32 (1.06)	7.85	0.00
Day 2	2.67 (.896)	3.28 (.783)	4.20	0.00
Day 3	2.52 (.854)	2.97 (.663)	3.05	0.003
Fats (2-3 servings)				
Day 1	2.72 (1.043)	3.12 (.976)	2.20	0.031
Day 2	2.55 (0.891)	2.75 (.704)	1.25	0.214
Day 3	2.03 (0.712)	2.87 (.700)	6.08	0.00
Milk/ milk products (2-3 servings)				
Day 1	1.55 (.811)	2.48 (.701)	6.650	0.00
Day 2	1.83 (1.011)	2.33 (.681)	3.22	0.002
Day 3	2.15 (.936)	2.37 (.663)	1.585	0.118
Vegetables (5-6 servings)				
Day 1	2.65 (1.071)	3.08 (.766)	2.621	0.011
Day 2	2.37 (.920)	2.70 (.671)	2.57	0.013
Day 3	2.77 (1.031)	2.93 (.821)	1.032	0.306
Fruits (3-4 servings)				
Day 1	2.13 (.892)	2.40 (.741)	2.01	0.048
Day 2	2.30 (.889)	2.37 (.712)	0.456	0.650
Day 3	2.38 (0922)	2.60 (.827)	1.314	0.194

Table 5 Pregnant Women' Food frequency assessment

Food items (No of servings/week)	Pre	Post	T	P value
	Mean (SD)	Mean (SD)		
Bread and grains (35-49)	9.9 (1.315)	10.5 (0.00)	3.435	0.001
Starchy vegetables (7-14)	5.3 (2.216)	4.6 (2.120)	1.577	0.120
Animal protein (14-21)	3.5 (1.740)	4.4 (1.779)	2.663	0.010
Plant protein (7-14)	2.9 (2.093)	1.2 (0.489)	6.334	0.000
Dairy products (14-21)	5.2 (2.500)	7.7 (2.145)	5.630	0.000
Fruits (14-21)	6.5 (2.246)	7.9 (2.080)	4.244	0.000
Vegetables (21-35)	5.3 (1.410)	8.5 (1.749)	10.55	0.000
Unsaturated fats (7-10)	1.6 (2.461)	7.9 (2.246)	15.70	0.000
Saturated fats (0)	5.6 (1.765)	1.6 (1.585)	11.51	0.000
Natural juices (1-7)	2.4 (2.179)	3.9 (2.236)	3.62	0.001
Canned juices (0)	0.8 (1.412)	0.07 (0.15)	4.07	0.000
Herbs (Variable)	3.5 (2.407)	4 (2.762)	1.04	0.301
Caffeine (7 cups)	4.9 (2.500)	4 (3.185)	1.64	0.105
Soft drinks (0)	0.7 (1.287)	0.0 (0.00)	4.48	0.000
Desserts & Snacks (0)	3.8 (2.790)	0.2 (0.53)	9.24	0.000
Fast food (0)	2.3 (2.104)	0.1 (0.387)	7.83	0.000
Canned foods (0)	0.2 (0.899)	0.0 (0.00)	2.45	0.017

Table 6 Assessment of Pender's health promotion model constructs

PHPM constructs	Pre	Post	T	P value
	Mean (SD)	Mean (SD)		
Perceived benefits	3.5 (.471)	4.0 (.000)	8.047	0.000
Perceived barriers	2.7 (.490)	3.9 (.735)	17.690	0.000
Perceived self-efficacy	2.6 (.424)	3.9 (.021)	23.680	0.000
Activity-related affect	2.7 (.522)	4.0 (.000)	19.096	0.000
Interpersonal influences	2.3 (.574)	3.9 (.088)	20.428	0.000
Situational influences	2.2 (.614)	4.0 (.654)	16.467	0.000
Competing demands and preference	2.3 (.510)	3.9 (.065)	24.125	0.000
Commitment to healthy food planning	2.0 (.305)	4.0 (.000)	49.312	0.000