Original Article

Impact of Nutrition Education in Improving Dietary Pattern During Pregnancy Based on Pender's Health Promotion Model: A Randomized Clinical Trial

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Access this article online

Website: www.ijnmrjournal.net

DOI: 10.4103/ijnmr.IJNMR_198_16

Quick Response Code:

Abstract

Background: Different types of nutrients in adequate amounts are required to meet the increased demands of the mother and the developing fetus. Therefore, we examined the impact of nutrition education on the number of food servings per day. **Materials and Methods:** Pregnant mothers were recruited to a prospective, randomized clinical trial from May to September, 2016. At 6–10 weeks of gestation, the participants were randomly divided into the intervention (n = 96) or the control group (n = 96), and were followed-up until the end of pregnancy. Each woman in the experimental group met the study nutritionist at the time of enrollment and an individualized nutrition plan was developed. In addition, the nutrition education based on Pender's Health Promotion Model (HPM) was designed, including three 45–60 min training sessions in 6–10, 18, and 26 weeks of pregnancy. The participants' usual food intake using a three-day dietary record was assessed at 6–10 weeks and 34–36 weeks of gestation. **Results:** The mean scores of the perceived benefits, self-efficacy, activity-related affect, interpersonal influences (husband support), and commitment to action increased while the competing demand scores decreased in the interventional group compared with the control group. The mean standard deviation (SD) of food portions from grain [10.40 (1.96) versus 12.70 (1.93) in the control group], vegetable [3.88 (1.33) versus 2.96 (0.91)], fruit [4.02 (0.05) versus 3.95 (0.91)], dairy [2.33 (0.68) versus 2.11 (0.45)], and meat [3.17 (0.68) versus 2.96 (0.67)] were improved in the experimental group. **Conclusions:** Pender's HPM for nutrition education is effective based on the compliance of pregnant women to the dietary guideline and the food guide pyramid.

Keywords: *Diet modification, health promotion, Iran, pregnancy*

Introduction

The important role of nutrition in pregnancy is well recognized and has central implications on subsequent maternal and offspring health. When the intake is inappropriate or inadequate, the risk of preterm delivery and low birth weight is increased.[1,2] On the contrary, women who gain too much weight during pregnancy are at risk of having larger babies and postpartum weight retention.[3] Therefore, nutrition education to promote sustainable healthy eating behaviors is a well-established intervention and the first five components of the healthy eating index during pregnancy are the average daily servings of five food groups.[4,5] Nutrition education was positively associated with a higher intake of vegetables, fish and shellfish, and potatoes, and a lower intake of rice in a group of pregnant Japanese women, but it was not associated with intake of bread, noodles, confectioneries and sugars, fats and oils, pulses and nuts, meat, eggs, dairy products, or fruit.[6] In accordance to the aforementioned study and similar trials about nutrition education, a meta-analyses concluded that additional research grounded in appropriate theories of behavior change are needed to improve confidence in this field.[7] One of the models used in changing the nutritional behavior is Pender's Health Promotion Model (HPM); this is "an attempt to illustrate the multidimensional nature of individuals interacting with their interpersonal and physical environments as they pursue health." In addition, we chose this model to improve the average daily servings of the five food groups, which is practical during pregnancy and in the whole life; this model is not dependent on immediate threatening.[8] Recently, a lifestyle trial showed that motivational interview and HPM-based consultancy had a limited effect on developing dietary

How to cite this article: Goodarzi-Khoigani M, Baghiani Moghadam MH, Nadjarzadeh A, Mardanian F, Fallahzadeh H, Mazloomy-Mahmoodabad SS. Impact of nutrition education in improving dietary pattern during pregnancy based on pender's health promotion model: A randomized clinical trial. Iranian J Nursing Midwifery Res 2018;23:18-25.

Received: June, 2016. **Accepted:** June, 2017.

habits during pregnancy.[9] Other lifestyle interventions were efficient in developing diet habits among pregnant mothers.[10,11] To our knowledge, the previously performed studies changed the dietary patterns for 2–3 months or in some other aspects, while the pregnant mothers needed to adhere to the food guide pyramid recommendations during pregnancy and by cost-effective interventions. Therefore, the present trial was undertaken to examine the effect of nutrition education intervention based on Pender's HPM in improving dietary patterns among pregnant mothers.

Materials and Methods

A prospective, randomized clinical trial (possessing the registration number IRCT2016012026129N1) was executed among 192 primiparous pregnant mothers in Isfahan, Iran, between May 2015 and September 2016. Considering a 5% significance level, at least 80% power, and a standard deviation of 7 for at least a 3 kg difference in gained weight between the two groups, 86 participants were computed for each group (an expected attrition rate of 10% during sampling was regarded). Therefore, 15 community health centers, 5 hospitals, and 15 private offices were selected. Pregnant women were medically prescreened by their healthcare provider and recruited for the intervention. The eligibility criteria included gestational age between 6 and 10 weeks, body mass index (BMI) <40 kg/m^2, a history of no smoking, age 18 and older, Iranian by origin, and singleton pregnancy. Women with weight-related complications,[12] a history of diabetes (diabetes mellitus type 1 and type 2),[13] mental disease,[14] anemia, urinary tract complications, usage of a special regimen,[15] chronic disease, addiction[16] as well as the women who did not participate in all the classes because of medical or other reasons were excluded. Randomization occurred in consecutive order at the time of enrollment. In selected settings, responsible persons explained the study goals to the pregnant women who were medically prescreened by their healthcare provider and recruited for the intervention. After providing the written consent, the willing subjects who met the inclusion criteria were randomized by opening the next sealed envelope containing their assignment until the required sample size was achieved. Computer-generated codes were sealed in consecutively numbered opaque envelopes and concealed from the investigator by a responsible person who had no other involvement in the study. Participants attended their regularly scheduled visits with their prenatal care providers; meanwhile, women in the intervention received all aspects of prenatal care plus the present intervention. All of the aforementioned stages were performed by the first author. Midwives and physicians were blinded to the subject randomization and the educational content of the study to prevent contamination.

The demographic characteristics and Pender's HPM constructs were measured by means of a self-administered questionnaire elaborated by the study researchers. To develop the HPM items, we surveyed the related literature and the HPM manual, and interviewed 21 pregnant mothers to collect their opinions concerning nutrition education. They expressed their opinions on the simplicity, clarity, and readability of the items of the instrument. The face validity of questionnaire was confirmed by 10 experts of health education, nutrition, and obstetrics. For improving clarity of the scale, unclear questions and minor wording errors were changed.[17] The content validity of the questionnaire was tested by a panel of 10 experts in the aforementioned fields and the comments of the experts were used to modify each question. The content validity ratio of the instrument as a whole was 0.73, and according to the Lawshe table, this ratio was considered acceptable. The content validity index of the total scale was 0.89; this was acceptable. The reliability of questionnaire was calculated through internal homogeneity and Cronbach's alpha, and the values of these coefficients for every structure (each construct) were calculated. A correlation coefficient ≥0.61 was also considered to be satisfactory.

Benefits such as improved maternal and child health outcome, good looks, and cost-effectiveness were considered in the seven items. Cronbach's α was 0.78. The participants agreed with the positive effects of the interventional program on the outcome of pregnancy and the prevention of obesity. Most of them, however, did not know that healthy eating can cause the childhood well-being of their fetuses. Eight questions about limited time, the absence of enjoyability, tiredness, hunger, obedience with family members' tastes, unsuccessful experience of dietary advices, and Pica-evaluated perceived barriers, which were effective in about 30% on the basis of pretest results (Cronbach's α = 0.80), were asked. Perceived self-efficacy questions involving the following of the food pyramid, eating healthy foods, and considering orders in different places and conditions were asked in seven items. The average of the mothers' scores was about 65 and Cronbach's α was 0.82. Positive feelings such as happiness, success, well-being of the mother and the fetus were included in four questions and negative feeling such as depression was evaluated in one question (Cronbach's α = 0.84). Around 80% of the subjects were in agreement with the positive effect of healthy eating and 20% of the subjects demonstrated a negative feeling. Three categories of questions including the persons who help and encourage the pregnant mother to obey the recommended points were used to measure interpersonal influences (including 10 items for husbands, 4 items for friends, and 8 items for families). A question, for example, was "Does your husband help you find healthy foods?" Cronbach's α for husband and family supports were 0.90 and 0.92, respectively. Husbands, mothers, and mothers-in-law were the most encouraging. Good appearance, reading of the booklet, and participation in classes to encourage subjects were measured for situational influences; for these factors, Cronbach's α was

0.70. More than half of the mothers preferred to participate in classes, and then, to read the booklet. Appearance was important in about 20% of the subjects. Eating in parents' homes, restaurants, and fast food outlets were the most evaluated preferences (Cronbach's $\alpha = 0.77$). A daily record and the buying of healthy foods as the first priority were considered for commitment to plans, and Cronbach's α for this scale was 0.79. Buying the best food products as the first priority was estimated in about 80% of the mothers and a small percentage were confident that they could adjust their schedule for the recommended points. The Likert scale was used for measuring the aforementioned items.

The nutrition-education intervention design, based on Pender's HPM for the experimental group, included three 45–60 min training sessions in 6–10, 18, and 26 weeks of pregnancy. A baseline assessment of the participants' usual food intake using a three-day dietary record (including one weekend day) occurred at 6–10 weeks of gestation in the two groups.[18] The food records were analyzed for the mean number of servings of each food group. Each woman had a meeting with the study nutritionist at the time of enrollment for nutritional assessment; in addition, an individualized nutrition intervention plan was developed. In the first session, the dietary pattern, including the average daily servings of five food groups, was explained to the participants. The food groups were (i) grain (cereal), mostly whole grains; (ii) milk, yoghurt, cheese, and/or alternatives (mostly reduced fat); (iii) lean meat and poultry, fish, eggs, nuts and seeds, and legumes/beans; (iv) fruits; and (v) vegetables. One booklet,[15] which included the benefits of the recommended points, the barriers to implementation, and the ways to overcome these barriers during pregnancy, was given to each of the participants in the experimental group. Each participant was requested to record her daily dietary food intakes on a monthly basis to develop a commitment toward a plan. They were also requested to record the daily food portions on a form and keep this record with them for use in future sessions. These data and responses to questions about the leaflet's points were used to examine the participants' compliance and to give individualized feedback to each woman as needed. With the exception of the first session, pregnant mothers were divided into groups, including 3–8 persons who discussed their opinions about recommended points (through role-playing and brainstorming). In the second session, practical steps (goal-setting techniques) to increase self-efficacy[19] were taught to the mothers in the experimental group. Positive and negative feelings toward the dietary pattern were discussed by mothers. In a training session, the researcher explained to the participants' husbands, mothers, and mother-in-laws about the role of nutrition in improving the outcome of pregnancy and the influencing factors of consumption (such as the availability of healthy foods at home). The researcher asked them to support pregnant mothers with healthy eating. Being familiar with the immediately competing demands, the preferences for dietary pattern were taught through computer-based instruction in the third session. The participants learnt how to replace soft drinks with dairy products, unhealthy snacks with fruits or dried fruits, pickles with vegetables, white bread with high-fiber bread, and so forth. Midwives and physicians were blinded to subject randomization and the educational contents to prevent contamination. Once again, at 34–36 weeks of gestation, a consecutive 3-day food intake record was collected in the two groups and analyzed for number of food servings to assess the effect of intervention. Pregnant mothers were instructed by the first author [Figure 1].

The data were analyzed using the SPSS statistical software package (version 18, IBM Company, the United States), and $p < 0.05$ was considered significant. The normality of the data was also examined through the Kolmogorov–Smirnov test. The homogeneity in the baseline data of the demographic and baseline characteristics of the two groups were analyzed by χ^2 and independent sample *t*-tests. Differences in the average daily servings of the food groups and Pender's HPM constructs before and after the intervention were tested using the paired sample *t*-test and the independent *t*-test. The correlation of daily servings consumption with Pender's HPM constructs were analyzed through the Pearson correlation analysis.

Ethical considerations

Ethics approval was obtained from the Human Research Ethics Board for Health Sciences at the Public Health College of Shahid Sadoughi University of Medical Sciences (4326) and the Vice-chancellor of Research and Technology of the Isfahan University of Medical Sciences. Written informed consent was obtained from participants.

Results

The two groups were not significantly different with respect to the participants' characteristics [Table 1], Pender's HPM constructs [Table 2], and the number of food servings [Table 3]. The independent sample *t*-test indicated that the mean scores of the perceived benefits, self-efficacy, activity-related effect, interpersonal influences (husband support), and commitment to action increased significantly in the experimental group. In addition, there was significant reduction in the competing demands construct in comparison to the control group [Table 2]. The average daily number of food servings significantly improved in experimental group [Table 3]. Before intervention, the average daily serving of grain in interventional group was significantly correlated with husband support ($r = 0.29$, $p = 0.009$) and commitment to plan ($r = 0.36$, $p = 0.006$). The servings of fruit and the competing demands ($r = 0.35$, $p = 0.003$) were related as well. After intervention, the

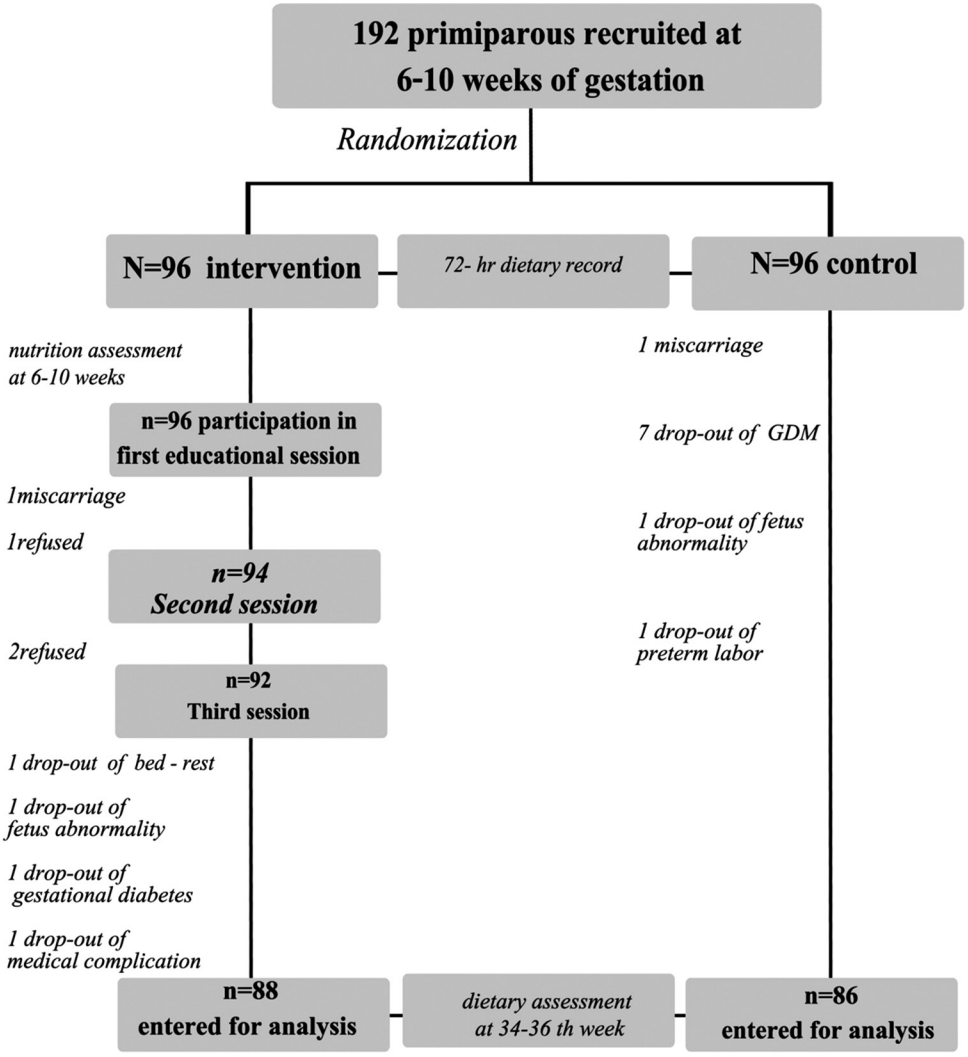

Figure 1: CONSORT trial flow diagram for pregnant mothers who recruited

average daily servings of fruit ($r = -0.28$, $p = 0.016$) and vegetable ($r = 0.24$, $p = 0.039$) were significantly correlated with the perceived benefits. In addition, the meat group and self-efficacy ($r = 0.33$, $p = 0.003$), the meat group and social support ($r = 0.19$, $p = 0.045$), competing demands and grain ($r = 0.20$, $p = 0.040$), competing demands and vegetable servings ($r = -0.20$, $p = 0.043$), and commitment to plan and the fruit group ($r = -0.31$, $p = 0.007$) were associated in the interventional group. There was a significant negative association between the vegetable portions ($r = -0.25$, $p = 0.018$) and the competing demand in the control group [Table 4].

Discussion

Our results showed that nutrition education intervention based on Pender's HPM was effective in improving the dietary pattern among pregnant mothers. In the present study, higher scores of perceived benefits in the interventional group increased after the intervention. In addition, other researchers reported that women's compliance to advice increased when healthcare professionals provided specific explanations about the importance of the recommended points.[20,21] Therefore, in order to increase the effect of nutrition education interventions, an emphasis on increasing the knowledge of pregnant mothers about the positive or the reinforcing consequences of healthy eating seems necessary. Participants' self-efficacy for healthy eating increased in the present study. In a similar study among Korean women, it was found that there was a positive association between self-efficacy and dietary behavior.[22] Following the present intervention, the perceived barriers scores did not decrease significantly, while most of barriers themes in this study were similar to those reported in other studies;[23] this provides further confidence in the reliability of our results. We observed a marginal decrease in the baseline value after intervention because some of the items such as gastrointestinal problems require special treatment and some of them (like prices) will be decreased by public policies.[24] Further work is needed to develop the interventions that modify or remove these barriers.

Table 1: Comparison of participants' characteristics according to study groups (*n*=174)

Variable	Intervention (*n*=88) Mean (SD)	Control (*n*=86) Mean (SD)	*t**	*p*
Age (years)	26.31 (3.99)	26.83 (3.89)	−0.86	0.387
Pregravid weight (kg)	62.72 (11.66)	60.27 (9.73)	1.52	0.129
Pregravid BMI (kg/m^2)	23.75 (4.15)	23.15 (3.7 1)	1.03	0.303
Education	***n*(%)**	***n*(%)**	***z*****	***p***
Diploma and < diploma	30 (34.09)	31 (36.05)	−0.35	0.725
Undergraduate	49 (55.68)	50 (58.14)		
Postgraduate	9 (10.32)	5 (5.81)		
Family income (Rials)	***n*(%)**	***n*(%)**	***z***	***p***
<6000000	19 (21.59%)	17 (19.77%)	−0.48	0.627
6000000-12000000	48 (54.55%)	54 (62.79%)		
>12000000	21 (3.86%)	15 (17.44%)		

*t: t-statistic **z: Z-statistic

Table 2: Comparison of constructs of Pender's HPM before and after intervention within and between study groups

Variable	Intervention (*n*=88)		*t*	*p**	Control (*n*=86)		*t*	*p**	*t*	*p***
	Baseline Mean (SD)	Follow-up Mean (SD)			Baseline Mean (SD)	Follow-up Mean (SD)				
Perceived benefits	74.91(17.69)	79.61(15.56)	−4.63	0.00	73.89(16.95)	73.09(16.88)	0.63	0.53	2.58	0.01
Perceived barriers	32.78(16.11)	30.19(14.49)	1.77	0.08	32.85(15.65)	32.54(15.43)	1.80	0.07	−1.01	0.31
Perceived self-efficacy	68.31(19.25)	74.58(16.27)	−3.74	0.00	67.59(26.20)	65.10(17.19)	1.17	0.24	3.64	0.00
Activity-related affect	90.54(17.22)	93.82(16.60)	−1.44	0.15	87.69(13.28)	89.03(13.50)	−0.87	0.38	2.07	0.04
Interpersonal influences (hus sup)	84.13(14.85)	87.18(12.72)	−2.90	0.005	82.65(13.25)	82.48(12.79)	0.63	0.53	2.37	0.01
Interpersonal influences (soc sup)	74.22(14.77)	76.04(13.40)	−1.64	0.10	75.40(12.95)	74.93(12.93)	1.22	0.22	0.51	0.60
Situational influences	70.15(14.56)	73.83(14.64)	−34.65	0.00	67.17(17.51)	68.75(17.85)	−12.07	<0.001	1.95	0.05
Competing demands and preference	32.42(15.17)	28.11(12.21)	4.51	0.00	32.74(15.86)	32.94(13.25)	0.06	0.94	−2.44	0.01
Commitment to plan of action	73.33(17.78)	76.26(15.90)	−4.18	0.00	68.19(14.74)	68.25(14.72)	−0.13	0.89	3.38	0.001

t: t-statistic; *p**: Paired; *p***: Independent (after intervention)

Table 3: Comparison of daily average number of food servings within and between study groups

Variable	Intervention (*n*=88)		*t*	*p**	Control (*n*=86)		*t*	*p**	*t*	*p***
	Baseline Mean (SD)	Follow-up Mean (SD)			Baseline Mean (SD)	Follow-up Mean (SD)				
Grain	10.15 (1.70)	10.40 (1.96)	−1.02	0.30	10.38 (1.66)	12.70 (1.93)	−9.95	<0.001	−7.72	0.00
Vegetables	2.48 (0.57)	3.88 (1.33)	−9.76	0.00	2.52 (0.61)	2.96 (0.91)	−4.16	<0.001	5.21	0.00
Fruit	3.00 (0.54)	4.02 (0.05)	−8.26	0.00	2.97 (0.48)	3.59 (0.91)	−5.45	<0.001	2.47	0.01
Dairy	1.72 (0.48)	2.33 (0.68)	−9.02	0.00	1.81 (0.48)	2.11 (0.45)	−5.19	<0.001	2.11	0.03
Meat	1.90 (1.33)	3.17 (0.68)	−8.27	0.00	1.64 (1.37)	2.96 (0.67)	−8.58	<0.001	2.05	0.04

t: t-statistic; *p*-value*: Paired *t*-test; *p*-value**: Independent *t*-test (after intervention)

We observed a significant improvement in the mean score of husband support in the experimental group. In addition, Thornton *et al.*[25] reported that husbands and female relatives were important sources of support for weight and diet among pregnant Latino women. The mean score of situational influences in the experimental group marginally increased. The score of participation in the classes was the highest and mothers stated that the reading booklet was an important item. In accordance to other studies, pregnant women preferred to receive nutrition advice in the form of a written pamphlet[21] and adolescents reported that listening to teachers and healthcare professionals was the best way to learn about nutrition.[26] Both of these groups could, therefore, act as important cues for pregnant nutrition education.

Activity-related effect scores increased significantly in women who obeyed the recommended points. In line with

Table 4: Correlation of daily average number of food servings with each of Pender's HPM constructs after intervention according to study groups

Variable	Intervention (*n*=88)					Control (*n*=86)				
	Grain	Vegetable	Fruit	Dairy	Meat	Grain	Vegetable	Fruit	Dairy	Meat
Perceived benefits	0.08	0.24*	−0.28*	0.12	0.07	−0.09	0.12	0.01	−0.05	−0.04
	0.47	0.03	0.01	0.28	0.54	0.37	0.24	0.88	0.62	0.69
Perceived barriers	0.11	−0.09	0.01	−0.02	−0.08	0.06	0.13	0.01	0.08	−0.02
	0.31	0.42	0.88	0.81	0.44	0.56	0.23	0.92	0.42	0.79
Perceived self-efficacy	−0.14	0.10	−0.18	−0.004	0.33**	0.16	−0.20	−0.03	−0.19	0.003
	0.20	0.38	0.11	0.97	0.003	0.12	0.05	0.76	0.07	0.97
Activity-related affect	−0.11	−0.001	−0.05	0.18	0.11	−0.15	0.06	−0.08	0.16	0.01
	0.32	0.99	0.67	0.12	0.32	0.16	0.57	0.46	0.13	0.86
Interpersonal influences (hus sup)	−0.09	0.12	−0.18	0.10	0.08	0.10	0.09	−0.06	0.002	−0.03
	0.40	0.31	0.13	0.39	0.48	0.34	0.37	0.56	0.98	0.74
Interpersonal influences (soc sup)	−0.02	0.05	−0.09	0.05	0.19*	0.05	0.07	−0.05	−0.14	−0.06
	0.82	0.66	0.45	0.67	0.04	0.61	0.51	0.63	0.18	0.56
Situational influences	−0.15	0.005	0.01	0.01	0.15	0.08	−0.02	−0.12	0.01	−0.08
	0.19	0.96	0.87	0.91	0.18	0.47	0.84	0.26	0.91	0.43
Competing demands and preference	0.20*	−0.20*	−0.10	−0.05	−0.15	0.08	−0.25*	0.03	0.09	0.03
	0.04	0.04	0.40	0.68	0.17	0.46	0.01	0.74	0.40	0.72
Commitment to plan of action	−0.08	0.15	−0.31*	0.09	0.13	−0.08	0.04	0.07	0.09	−0.08
	0.49	0.21	0.007	0.46	0.23	0.45	0.67	0.51	0.38	0.46

*Correlation is significant at the 0.05 level (two-tailed); **Correlation is significant at the 0.01 level (two-tailed)

our results, Szwajcer *et al*. showed that healthy nutritional behavior could help pregnant mothers to feel healthier, both physically and mentally.[27] In our study, we observed a significant decrease in the average score of the competing demands construct in the experimental group in comparison to the control group after the intervention. Mancino *et al*. concluded that to induce change, it would be beneficial to provide nutritional information about the foods prepared away from home. They showed how well an individual would be able to match the intentions of healthy eating, which changes with time pressure, hunger, and the source of food.[28] Other researchers showed that an emphasis on interventions, which are considered as tasty and affordable health-food substitutes, is necessary for this group.[29]

There was a significant improvement in the mean score of the commitment to action in the intervention group. In accordance to the participants' statements, their daily dietary records were adjusted frequently and followed recommended points.

In accordance to Pender *et al*., "individuals commit to actions based on perceived benefits, barriers, and self-efficacy to establish or continue health-promoting behavior. Interpersonal influences (family, peers, support system, and sociocultural norms) and situational influences (environmental cues that trigger specific actions and available options) are also frame parts of the environmental context that can either impede or facilitate health-promoting behavior. Competing demands may reduce the commitment to a plan of care, particularly when demands are immediate and pervasive. However, if health actions are attractive and embraced by the individual (preferences), commitment to a health promotion plan is strengthened."[8]

As mentioned above, the enhancement in the mean score of commitment to action was foreseeable.

Moreover, our study led to an increased consumption of the fruit, the vegetable, the dairy, and the meat groups, and a decreased consumption of grains in the experimental group. Positive associations between education and diet quality (favorable dietary intake patterns) have also been reported in several other surveys on pregnant women.[30,31] In addition, Rauh *et al*. found that the lifestyle intervention group had a lower energy intake than the control group while comparing the differences between groups in terms of the changes from the baseline to the 36–38th week interval of gestation.[32] The strengths of this study included its randomized blinded design, its inclusion of lean, normal-weight, overweight, and obese women (a sample of the community), its follow-up from early pregnancy through to delivery, and the use of intervention strategies that have practical relevance during prenatal care within the clinical setting. The limitations of this study were partly due to the nature of that. This was primarily an educational intervention, and therefore, we could not design a two- or three-blinded trial. In addition, filling the questionnaire enhanced the control group questions, and consequently, the nutritional knowledge that accompanied dietary counseling as a part of the standard maternity care that might have influenced the control's dietary pattern and

the study results. To remain within the word limit, we did not discuss nutrient intake in this paper.

Conclusion

The usage of Pender's HPM for nutrition education is effective for the compliance of pregnant women on the dietary guideline and the food guide pyramid. We suggest a repetition of this study for all the BMI groups with an adequate sample size in primiparous and multiparous women.

Acknowledgement

We are grateful to Public Health College of Shahid Sadoughi University of Medical Sciences because of financial support and Vice-chancellor of Research and Technology of Isfahan University of Medical Sciences (294048) because of settings.

Financial support and sponsorship

Public Health College of Shahid Sadoughi University of Medical Sciences,Yazd, Iran.

Conflicts of interest

There are no conflicts of interest.

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