



Dietary Pattern in Patients with Preeclampsia in Fasa, Iran

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Abstract

Background: Preeclampsia is one of the causes of mortality and high-risk pregnancies that endangers the health of mothers in the developing countries.

Objectives: The current study aimed at investigating the nutritional pattern in women with preeclampsia.

Methods: The current cross sectional study was conducted on 182 pregnant women (82 patients with preeclampsia and 100 healthy subjects) selected using easy sampling in Fasa Vali-e-Asr Hospital in 2016. The dietary intake was evaluated using a semi-quantitative food frequency questionnaire and the intensity of day-night activities by a physical activity questionnaire. Anthropometric indicators were calculated according to standard guidelines, measurement, and body mass index. Dietary patterns were characterized by a factor analysis and its relationship with preeclampsia was investigated by logistic regression method.

Results: Two unhealthy and healthy dietary patterns were identified among individuals. In the crude model and after adjusting the effect of confounding variables of unhealthy dietary patterns, no significant relationship was observed between dietary pattern and preeclampsia. In the fourth compare to the first quartile of the healthy dietary pattern, the chance of preeclampsia was 0.219 (95% CI: 0.090 - 0.528, P = 0.001) crude model and 0.178 (95% CI: 0.059 - 0.530, P = 0.002) adjusted model.

Conclusions: The findings indicated that choosing a healthy dietary pattern was associated with a reduction in the risk of preeclampsia. Regarding these results, prevention of preeclampsia maybe possible by the healthy diet recommendation. The occurrence of complications in the mother, the fetus, and the baby in the future can also be prevented through the same way.

Keywords: Preeclampsia, Food Frequency Questionnaire, Dietary Patterns, Pregnant Women

1. Background

Preeclampsia is observed in 2% - 8% of pregnancies (1). In the developing countries, it is considered as one of the most high-risk pregnancy cases that endangers the health of women and ultimately the health of other members of the family (2, 3). Preeclampsia is also one of the causes of maternal mortality in the world (4). Every year, eight million women worldwide die from it (5). Preeclampsia is a condition in pregnancy in which the systolic blood pressure is ≥ 140 mmHg and diastolic blood pressure ≥ 90 mmHg, with 24-hour urine protein excretion rate of 300 mg/dL or +1 on urine dipstick after the 20th week of gestation (6).

Preeclampsia, in addition to temporary and transient complications controlled by rest (3, 7), causes long-term complications during pregnancy and afterwards (2). The complications of this disease include infection, bleeding, cerebrovascular disease, preterm labor, kidney disease,

liver rupture, pulmonary edema, hypothyroidism, and heart disease, which ultimately increases the risk of maternal death (8-13). In Iran, according to the latest statistics released by Maternal Health Department, the mortality rate of preeclampsia is 22 deaths per 100,000 pregnant women (14). This amount causes stress in the individuals and increases the cost of treatment for both the individual and treatment system (15).

The exact cause of preeclampsia in pregnant mothers is still unclear. For this reason, there are many theories to explain why; one of them relates to the nutritional pattern of a pregnant mother (16). Today, the use of nutritional patterns and specifying their relationship with diseases is a relatively new topic in the field of epidemiology of nutrition, and its analysis considering nutritional behaviors also provides researchers with a wealth of information on the nutritional etiology of diseases including preeclampsia (17, 18). Patterns obtained by such methods also reflect

the nutritional habits of individuals (18). Most research on nutritional patterns in pregnant women focuses on micronutrients, certain foods, or certain types of pregnancy (19-21).

Studies found a relationship between food deficiencies and maternal and fetal problems (22, 23). Also, the results of some studies showed that getting some foods increases or decreases the risk of hypertension during pregnancy (24-27).

2. Objectives

Given the lack of research into the effect of nutritional patterns in pregnant women, the increasing trend of preeclampsia in these individuals, the effectiveness of the nutritional pattern of women, especially mothers, on the nutritional pattern of other family members and ultimately the fact that nutritional pattern analysis has helped us make nutritional recommendations for pregnant women, the present study aimed to investigate the nutritional pattern in preeclampsia women.

3. Methods

The study protocol was in accordance with the Declaration of Helsinki guidelines and was also approved by the Institutional Review Board of Fasa University of Medical Sciences (code: IR.FUMS.95104). Written informed consent was obtained from all the participants.

The current cross sectional study was conducted on 182 pregnant women (82 women with preeclampsia and 100 healthy pregnant subjects) referred to the Gynecology Ward of Vali-e-Asr Hospital in Fasa, Iran in 2016. Convenience sampling method was used to select individuals in the case group; the control group subjects were randomly selected through simple random sampling from other pregnant women without preeclampsia. In the current study, the criteria for the diagnosis of preeclampsia was blood pressure $\geq 190/140$ mmHg after 30 minutes of rest in two different positions with proteinuria of 30 mg/dL (+1 on dipstick) in randomized urine specimens in the case of lack of urinary tract infection or 24-hour urine protein excretion rate of 300 mg, approved by the lab and the attending physician on the wards.

The exclusion criteria for the case group included the history of hypertension before the pregnancy, the subject's inability to respond to questions due to severe illness, and lack of cooperation, and lack of willingness to cooperate with the study.

Before the interview, a brief description of the study objectives and the ethical regulations of the project were

provided to mothers; in addition, they were assured about the confidentiality of their information. Then, eligible subjects were also asked to sign a written informed consent form.

Data collection tools were the demographic questionnaire, food frequency questionnaire (FFQ), and physical activity questionnaire (28). All demographic data including age, level of education, current weight (in kg), gestational weight, height (in m), body mass index (BMI; using the formula of weight in kg divided by height in m^2), a history of the disease for the patient and her first-degree relatives as well as regular food intake in the past year (using the FFQ) were obtained by researchers in face-to-face interviews.

The FFQ is a semi-quantitative questionnaire that asks for the frequency of consuming various food items in a day, week, month, or year. The questionnaire consisted of 168 food items whose reliability and relative validity were assessed in the study of Mirmiran et al. The size of the reported food intake was converted to a gram scale using the Home Scale Handbook to determine dietary patterns, 168 food products were classified into 41 groups (Table 1); similar to the classification in Mirmiran's study (29). The study interviewers were skilled in completing the FFQ.

The data on the level of physical activity of individuals was also obtained through interviews by the researcher. Reliability and validity of the questionnaire were assessed in the study by Farjam et al.; this questionnaire is relied on metabolic equivalent (MET) activity for 24 hours. To calculate the intensity of activity, the time spent on the activity multiplied by the coefficient of that activity indicates the intensity of activity at that time. The sum of values obtained from the hours spent on physical activity in the MET coefficient is calculated as the sum of MET hour/day (28).

Data were analyzed by SPSS version 24. Due to the large number of food items and previous studies, these items were divided into 41 food groups, each with similar food items. Factor analysis was used to report the dominant dietary patterns on data extracted from FFQ. Principal component analysis (PCA) was used with varimax rotation on these food groups. Scree statistical test was used to determine the number of dietary patterns. To compare the energy of modified diet groups, the factors derived from the eigenvalues were used. The dietary pattern score of each individual based on the sum of the values resulting from the multiplication of the amount of food in that pattern was calculated in the parameter estimation. For a better comparison between the case and control groups, the subjects in the two groups were divided into quartiles according to the dietary patterns.

To compare quantitative and qualitative data, the Student t and chi-square tests were used. One-way analysis of variance (ANOVA) was used to compare quantitative data

Table 1. Comparison of the Quantitative General Characteristics of the Subjects^a

	Group		P Value, t Test
	Healthy (N = 100)	Preeclampsia (N = 82)	
Age, y	27.91 ± 4.93	28.96 ± 5.85	0.198
Current weight, kg	73.90 ± 11.22	79.02 ± 13.97	0.007
Weight at the beginning of pregnancy, kg	60.83 ± 11.34	68.39 ± 13.82	< 0.001
Weight difference, kg	13.07 ± 4.90	10.63 ± 5.81	0.002
BMI, kg/m ²	23.83 ± 4.24	26.87 ± 5.67	< 0.001
Number of deliveries, No.	2.31 ± 1.13	2.11 ± 1.07	0.223
Duration from diagnosis, wk	-	29.79 ± 7.88	-
Physical activity, MET	33.12 ± 5.91	32.14 ± 8.14	0.349

^aValues are expressed as mean ± SD.

of different quartiles between the case and control groups in dietary patterns. The relationship between dietary patterns and preeclampsia was assessed through logistic regression. For this purpose, the prevalence of preeclampsia among the different quartiles was calculated first. In the next stage, where the model was modified, the relationship was calculated for demographic variables. For this analysis people in the first quartile were considered as reference group and the ratio of the other quartiles chance was calculated based of it.

4. Results

The research was conducted on 182 pregnant women. [Table 1](#) shows the general profile of the subjects and their comparison in the case and control groups. The current weight means, the weight at the beginning of pregnancy, and BMI showed significant differences between the two groups ($P < 0.000$). Also, further studies showed that physical activity (MET) did not significantly differ between the case and control groups ($P < 0.001$).

The results of factor analysis indicated two dominant healthy and unhealthy dietary patterns among the studied population. The unhealthy dietary pattern included mayonnaise, pizza fries, etc., and the healthy dietary pattern included food items such as fruits, vegetables, dairy products, etc. Food groups had a positive or negative factor loading. Positive factor loading of the food group meant the positive relationship of that food group and the negative factor loading of the food group indicated the inverse correlation of that food group with that factor. The higher factor loading of a food group in a given factor indicated the high contribution of the food group to the dietary pattern. [Table 2](#) presents the factor loading associated with foods and dominant food groups (Supplementary File Appendix 1).

There was no significant difference in age, place of residence, level of education, occupational status, and number of deliveries as well as qualitative characteristics among the subjects ($P < 0.001$) (Supplementary File Appendix 2).

Supplementary File Appendix 3 illustrates the quantitative characteristics of the women surveyed according to the quartiles of dietary patterns. Mean current weight, pregnancy onset, and BMI were higher in the top quartiles of unhealthy dietary pattern in the control group ($P < 0.000$). Also, in the case group, age and number of deliveries in the top quartiles of unhealthy dietary pattern showed a significant difference. But the rest of the quantitative characteristics did not show significant differences ($P > 0.000$) between the upper and lower quartiles in the case and control groups.

History of different diseases in the studied pregnant mothers and their families are presented in Supplementary File Appendix 4. According to more accurate analyses, there was a significant difference in the history of gestational hypertension, familial diabetes, familial obesity, and digestive disease between the groups. Comparison of the case and control groups in terms of disease and family history is presented in table Supplementary File Appendix 4 ($P < 0.000$).

In [Table 3](#), the ratios of crude and adjusted chance for preeclampsia are among the dominant food quartiles. The Odds of preeclampsia was not significant difference between all quartiles of unhealthy dietary pattern according to cured and adjusted models. It indicate that there were not relationship between dietary pattern and preeclampsia ($P < 0.001$). However, a healthy dietary pattern correlated with the risk of preeclampsia. The chance of preeclampsia in the fourth quartile (the uppermost quartile) of the healthy dietary pattern (those with the highest

Table 2. Factor Loading of Foods and Food Groups in Two Dominant Dietary Patterns^{a,b,c}

Rotated Component Matrix ^d	Component	
	Unhealthy	Healthy
Mayonnaise	0.781	0.187
Juice	0.727	0.258
Fries	0.685	0.156
Red Meat	0.624	0.217
Soft drinks	0.528	-0.060
Pizza	0.515	-0.054
Snacks	0.510	0.253
Sweets and dessert	0.465	0.185
Refined cereal	0.439	-0.142
Hydrogenated oils	0.356	-0.045
High-fat dairy products	0.326	0.179
Sugar	0.302	0.117
Processed meat	0.139	-0.033
Broth	0.117	0.105
Tea	0.083	-0.026
Green leafy vegetables	0.173	0.603
Fruits	0.042	0.603
Nuts	0.198	0.506
Yellow vegetables	0.018	0.456
Dough	0.314	0.439
Fish	0.155	0.429
Other vegetables	0.019	0.416
Cabbage vegetables	0.004	0.388
Poultry	0.062	0.369
Low-fat dairy	0.005	0.354
Visceral meat	0.095	0.331
Dried fruit	-0.011	0.317
Legumes	0.189	0.307
Whole cereals	0.003	0.299
Egg	0.092	0.285
Margarine	-0.065	0.276
Pickle	0.054	0.247
Green olives	0.018	0.245
Date	-0.054	0.180
Tomato	0.033	0.179
Liquid oil	0.147	0.164
Butter	0.036	0.138
potato	0.035	0.083
Coffee	-0.043	0.079
Garlic	0.004	-0.056
Salt	-0.030	0.037

^a Values less than 0.2 were removed to make the Table 2 easier to read.

^b Extraction method: Principal component analysis.

^c Rotation Method: Varimax with Kaiser normalization.

^d Rotation converged in 3 iterations.

compliance with this pattern of food) in the crude model was 0.219, and after the adjustment was 0.178 times of the first quartile (people with the lowest compliance with this dietary pattern) of this group. Also, in the third quartile, the healthy dietary pattern in the crude model was 0.293

and after the adjustment of the risk level was 0.258 times less than that of the first quartile of this group; which had a significant and strong correlation in both the fourth and third quartiles.

The prevalence of preeclampsia in the second quartile of the healthy dietary pattern was 0.465 times less than the first quartile of this group and this significant relationship in this quartile was eliminated after adjustment ($P = 0.134$).

5. Discussion

The results of the current study indicated two healthy and unhealthy dietary patterns among pregnant women. There was a significant difference between the current weight and BMI among the healthy pregnant women and the ones with preeclampsia as well as the ones in the upper quartile of the unhealthy food group. It is also shown that the employment of healthy dietary patterns is associated with preeclampsia, since people in the fourth quartile of the healthy dietary pattern are at a lower risk of preeclampsia than the ones in the first quartile.

Increased weight and ultimately increased BMI among pregnant women may increase the risk of preeclampsia. High intake of foods including meat, fats, and sweets classified as unhealthy in the dietary pattern can increase body weight and BMI. Kazemian et al. (25) confirmed this conclusion. It is therefore necessary to pay more attention to weight gain during pregnancy since with increasing weight and BMI, the risk of preeclampsia also increases (30).

More accurate analysis of the demographic data of the subjects showed a significant difference in the BMI values between the two groups, which were confirmed by other studies (3, 6, 20). The other demographic variable evaluated in the current study was age that had no significant difference between the two groups of pregnant women consistent with the results of the study by Zaroudi et al. (31). But in other studies with the increase of age, the risk of preeclampsia increased (6, 10, 21, 29). These differences among studies can be due to the classification of subjects in different age groups, the entry of individuals to study at certain ages, being in certain weeks of pregnancy, age grouping according to BMI, the existence of people with very young, and very high ages.

Research show that by implementing the weight control program, a dramatic effect can be observed on reducing preeclampsia prevalence among pregnant women. This program includes dietary regimen, physical activity, or a combination of both, which is far more relevant to the nutritional efficiency than physical activity (32). In the current study, there was no significant relationship between the risk of preeclampsia and physical activity, but a

Table 3. Crude and Adjusted Chance Ratios and 95% Confidence Interval for Preeclampsia Among the Dominant Quartiles of the Dietary Patterns^a

	Unhealthy Dietary Pattern												
	Q1			Q2			Q3			Q4			
Healthy	24			25			24			27			
Preeclampsia	22			20			21			19			
	OR	OR	95% CI		P Value	OR	95% CI		P Value	OR	95% CI		P Value
Crude model	1	0.873	0.383	1.99	0.746	0.955	0.419	2.174	0.912	0.768	0.337	1.75	0.529
Adjusted model	1	1.043	0.384	2.831	0.934	2.045	0.678	6.172	0.204	1.381	0.462	4.126	0.564
	Healthy Dietary Pattern												
	Q1			Q2			Q3			Q4			
Healthy	15			24			30			31			
Preeclampsia	31			21			16			14			
	OR	OR	95% CI		P Value	OR	95% CI		P Value	OR	95% CI		P Value
Crude model	1	0.423	0.181	0.991	0.048	0.258	0.109	0.613	0.002	0.219	0.09	0.528	0.001
Adjusted model	1	0.465	0.171	1.266	0.134	0.293	0.107	0.805	0.017	0.178	0.059	0.53	0.002

^aAdjusted for age, educational level, BMI, weight changes in pregnancy, number of deliveries, getting gestational diabetes in previous pregnancy, occupational status, and physical activity.

significant relationship was observed between the risk of preeclampsia and the dietary pattern. In support of this finding of the present study, it can be referred to the results of a review article in which 10 cohort studies confirmed this conclusion. But contrary to the current study findings, there are other studies indicating the effect of physical activity on preventing the risk of preeclampsia. In this case, it can be referred to 11 case-control and clinical trials of this review article on the significant effect of physical activity on reducing the risk of preeclampsia (33). A study on the relationship between sleep quality and preeclampsia showed that women with preeclampsia had a short sleep duration and poor sleep quality (34).

Preeclampsia was more prevalent in mothers experiencing it in their previous pregnancies. Studies show that the risk of cardiovascular disease and hypertension in such mothers also increases due to changes in metabolism and vascular system and the result of the study by Sharma et al., on pregnant women with preeclampsia also confirmed it (2).

In this regard, knowledge of nutritional patterns in different societies and its relationship with social, demographic, and lifestyle factors can be influential in planning for education, nutritional intervention, nutritional literacy, and nutrition policies (35-38). Using a factor analysis on food consumption of pregnant women, two patterns were reported. The first dietary pattern including high consumption of mayonnaise, fried potatoes, soft drinks, pizza, red meat, hydrogenated oils, sugar, etc., was placed in the category of unhealthy dietary patterns and accord-

ing to evidence, excessive consumption of this type of food increases the risk of preeclampsia in pregnant women. The second type of food classified as the healthy dietary pattern included high consumption of green leafy vegetables, fruits, nuts, fish, low-fat dairy products, legumes, etc.; it was observed that their consumption has an inverse relationship with the risk of preeclampsia. In fact, the dietary pattern obtained by the factor analysis indicated that the food items were consumed together or were successors of one another, but had the same repetition (24). Paying attention to the dietary patterns helps explaining the implications of diet guides in terms of dietary patterns for the community (39, 40).

Starling et al. (41) and Moran et al. (42) in their research, observed two healthy and unhealthy patterns, which were similar to those obtained in the current study, but the results of other papers showed three dietary patterns among the subjects (35, 38). The reason to report various dietary patterns is the difference in research objectives, subjects studied, and different dietary habits according to the geographical area, race, culture, place of residence, etc.

Among the dietary patterns observed in the current study, the unhealthy dietary pattern did not specifically correlate with the risk of preeclampsia; however, people with a healthy dietary pattern had an inverse relationship with the risk of preeclampsia and these relationships were independent of other confounding factors including age, gender, education, BMI, familial history of diabetes, and hypertension, and it is more likely that the risk

of preeclampsia is reduced with high intake of vegetables among pregnant women and such foods have protective effects. The results of two studies on more than 20,000 Norwegian pregnant women indicated the impact of vegetable, herbal products, and herbal oils consumption on reducing the risk of preeclampsia, which similar to the present study results showed their protective effects as a healthy pattern (24, 43). Endeshaw et al. also pointed to the effect of vegetable consumption on reducing the risk of preeclampsia (44).

The results of studies show that high intake of fruits and vegetables during pregnancy, due to the presence of micronutrients such as antioxidants and vitamins such as vitamin B12 and folate that affects the functioning of the central nervous system as well as the adjustment of the mood mechanism, has a protective role against depression and reduces the risk of postpartum depression (45). These foods were classified as a healthy dietary pattern in the present study, which can reduce the risk of preeclampsia as a risk factor for pregnancy.

Among the factors predicting preeclampsia, inadequacy of some nutrients such as protein, calcium, magnesium, selenium, and vitamins A, C, and D can be considered. Lack of vitamin D increases the risk of preeclampsia in the second trimester (46). According to today's lifestyle, the reduction of micronutrients in the soil due to over-cultivation, etc., the use of vitamin supplements is recommended to all pregnant women. Selenium is one of the antioxidant minerals that plays an important role in the immune system function and resistance to infections. In extensive studies on pregnant women, low serum levels of selenium and increased risk of preeclampsia are reported (3). This mineral is mostly found in foods that are classified as a healthy dietary pattern in the present study.

The risk of preeclampsia is reduced in women consuming dairy products, especially milk, which is classified in the current study as a healthy dietary pattern (47). Per capita milk and dairy consumption in Iran is about 139 g/day, which is 20% less than the recommended amount. In contrast, the important point is the over consumption of sweets and fats by pregnant women; in this regard, it is essential for them to hold nutrition classes during pregnancy (48).

Contrary to the results of Hosseini Esfahani et al. in the current study with the increase of age, unhealthy dietary patterns (49) also increased; it is expected that pregnant women spend less time preparing food due to pregnancy conditions and mostly use ready-to-eat processed foods that ultimately leads to increased energy intake, and increased waist circumference and BMI in individuals (50).

In Iranian families food basket, the consumption of sugar, oil, and bread and rice is 38%, 20%, and 5% higher

and legumes, fruits and vegetables, milk and dairy products, and eggs were 30%, 25%, and 20% lower than the recommended amount, respectively. According to this dietary pattern, Iran is classified as a high-risk country in the global food security map. It should not be forgotten that people with low income experience more nutritional transition than other people in the community. In addition to the risk of health, the incidence of diseases also increase in such people. As a result, foods such as legumes and veggies in the traditional dietary pattern are replaced by high-fat meals, drinks, and sugary foods (48).

The findings of the current study showed that choosing a healthy dietary pattern was associated with a reduction in the risk of preeclampsia and this dietary pattern includes fruits, vegetables, dairy products, etc. According to these results, pregnant mothers with preeclampsia and their nutritional patterns during pre-pregnancy and pregnancy can be identified and controlled; also, preeclampsia and its complications can be prevented in the mother, the fetus, and the baby in the future. Changes in diet are low-cost and low-risk compared to medical interventions and even an increase in the average consumption of vegetables and vegetarian foods may be of great importance.

One of the limitations of the current study was to use FFQ to collect nutritional data of pregnant mothers completed with respect to people's memory and there might be faults in reporting for the correct understanding of food consumption; nevertheless, the current study subjects minimized this error. In completing the physical activity questionnaire, responses were accepted based on trust in the individuals.

On the strengths of the study, we can consider quantities such as age, education, BMI, number of births, current weight as confounding variables and try to adjust them.

One of the drawbacks of the current study was its cross sectional nature, which did not allow to conclude a definitive or causal relationship. It is suggested that longitudinal and prospective study models be employed to better evaluate the results.

5.1. Conclusions

The results of the current study showed that using healthy diet patterns and avoiding unhealthy foods that form the Western food pattern can be useful in preventing pregnant women from developing preeclampsia.

Supplementary Material

Supplementary material(s) is available [here](#) [To read supplementary materials, please refer to the journal website and open PDF/HTML].

Footnotes

Authors' Contribution: Conceptualization: Reza Homayounfar and Elham Ehrampoush; methodology: Reza Homayounfar. Software: Mohammad Mehdi Naghizadeh. Validation: Reza Homayounfar and Mohammad Mehdi Naghizadeh. Formal analysis: Mohammad Mehdi Naghizadeh. Investigation: Saeideh Zareei, Zohre Amiri, Maryam Rahimi and Lida Tahamtani. Resource: Lida Tahamtani and Reza Homayounfar. Data curation: Saeideh Zareei and Reza Homayounfar. Writing and drafting of the manuscript: Saeideh Zareei and Reza Homayounfar. Reviewing and editing of the manuscript: Saeideh Zareei, Elham Ehrampoush and Reza Homayounfar. Visualization: Reza Homayounfar and Lida Tahamtani. Supervision: Reza Homayounfar. Project administration: Reza Homayounfar. Funding acquisition: Reza Homayounfar.

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