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Comparing Dietary Patterns during Pregnancy in Women with Preeclampsia and Healthy Women: A Case-Control Study

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ABSTRACT

Background & aim: Diet and nutritional deficiencies in women during pregnancy are considered among the significant factors inducing preeclampsia. The present study aimed to compare the major dietary patterns during pregnancy in women with preeclampsia and healthy women.

Methods: This unmatched case-control study was carried out on 240 women (90 case and 150 control) referred to the university hospitals in Mashhad, Iran, between 2018 and 2019. The convenience sampling technique was used to select the sample in the case group from hospitalized individuals with a certain diagnosis of preeclampsia, and those in the control group among pregnant women without preeclampsia referred to the midwifery clinics and the maternity wards of the same hospitals to receive prenatal care. The data collection tools included the demographic questionnaire with gynecological/obstetric records, the Clinical Evaluation Form (CEF) to determine preeclampsia symptoms and severity, and the modified Food Frequency Questionnaire (CEF).

Results: There was a significant difference between the two groups in terms of fast-food consumption (p=0.038), consumption of vegetables, carbonated soft drinks, table salt (p<0.05) as well as total diet scores (p=0.019). There was no significant difference between the two groups in terms of educational level (p=0.213), occupation (p=0.118), place of residence (p=0.623), level of income (p=0.583), and parity (p=0.249).

Conclusion: Lower consumption of vegetables and increased frequency of fast foods, carbonated soft drinks, and table salt were also associated with the incidence of preeclampsia. Therefore, encouraging and promoting healthy eating habits and dietary patterns during pregnancy can effectively prevent the incidence of preeclampsia.

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Introduction

Preeclampsia is a multisystemic and multifactorial disorder characterized by new onset of hypertension and proteinuria in pregnancy (1), which often arise in the second half and at the gestational age of 20 weeks, characterized by some symptoms such as high blood pressure (viz. hypertension) and proteinuria (2). With reference to the diagnostic criteria and study populations in developing countries, the prevalence rate of preeclampsia has been reported between 1.8 and 16.7% (3). Preterm birth and intrauterine growth restriction (IUGR) are among the neonatal complications of preeclampsia. Neonatal intensive care units (NICUs) admission can put too much physical and mental pressure on mothers. The incidence of preeclampsia in some women also causes cerebral complications in their lifetime. The perinatal mortality rate due to severe preeclampsia is about 15%, and that is 22% in eclampsia and HELLP syndrome (viz. hemolysis, elevated liver enzyme levels, and low

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platelet levels) (4). Preeclampsia syndrome can even lead to cardiovascular, cerebrovascular, endocrine, and metabolic dysfunction in mothers, and make major changes in peripheral circulation (blood flow) (4, 5).

Even though the exact etiology for preeclampsia is still unknown, numerous factors including genetics, immunology, infections, high body mass index (BMI), advanced maternal age pregnancy, psychological stress exposure, diet (6), nulliparity, history of preeclampsia, kidney disease, and diabetes mellitus are involved in the development of this condition (7). Changes in maternal nutrition and increased oxidative stress can likely influence telomere homeostasis. The serum nutrient levels (such as elevated polyunsaturated fatty acids, and decreased vitamins C and E, zinc, and iron) have been associated with increased inflammation and oxidative stress (8). Previous reviews reported that calcium supplementation is promising for reducing the risk of PE, while there was a lack of evidence for supplementary vitamin C, E or D (9). The findings by the study of Grum et al. (2018) had further revealed that fruit and vegetable consumption during pregnancy could be a protective factor for preeclampsia or eclampsia, so women with low intakes of this food category, were more likely to develop preeclampsia or eclampsia compared with those using them on a daily basis (10). On the other hand, some studies had reported that high consumption of calcium, vitamins C, D, and E, milk, magnesium, and iron are not considered as an effective factor in reducing the risk of preeclampsia (11). Regarding the inconsistent results about the effect of dietary patterns during pregnancy on the incidence of preeclampsia and its relationship with nutritional factors, which can be employed as a guide to prevent preeclampsia and even contribute to its care and treatment; the present study was aimed to compare the major dietary patterns during pregnancy in women with preeclampsia and healthy women.

Materials and Methods

This unmatched case-control study was performed on 240 women referred to the university hospitals (Imam Reza, Ghaem, Umm Al-Banin, and Hasheminejad) in Mashhad, Iran, 2018-2019. The data collection accordingly started after obtaining the permission from the Ethics Committee of the School of Nursing and Midwifery and other necessary agreements. The inclusion criteria were Iranian nationality, gestational age of 28-40 weeks, no speech, hearing, or mental problems, absence of chronic diseases affecting pregnancy diet such as diabetes mellitus and hyperlipidemia, as well as definite diagnosis of preeclampsia in the case group and no preeclampsia in the controls. On the other hand, the exclusion criteria during the study included unwillingness to continue participating in the study. According to the rule of thumb in logistic regression, at least 10 cases (events) are considered for each independent variable in the model (12). On the other hand, in case-control studies, if the exposure variable is a risk factor, the number of controls should be greater than the number of cases(13). According to these cases, 90 women were considered in the case group and twice in the control group, which included 150 women and a total of 240 people were included in the study. The diagnosis of preeclampsia was done based on systolic blood pressure equal to or above 140 mmHg and/or diastolic blood pressure equal to or above 90 mmHg, with proteinuria greater than 300 mg in the 24-h urine or equal to or greater than +1 in the strip test (1). In the case group, sampling was correspondingly performed using the convenience sampling technique among women admitted to the midwifery clinics and maternity wards of the mentioned hospitals with the definite diagnosis of preeclampsia based on clinical and laboratory signs and symptoms, reviews of their clinical records, and blood pressure measurements by the researchers and a gynecologist. The control (healthy) group was selected through the convenience sampling technique among pregnant women with no preeclampsia, referred to the midwifery clinics and the maternity wards of the university hospitals to receive prenatal care. In the event of preeclampsia in the control group, the patients were transferred from the control group to the case group based on 24-h follow-up after delivery.

The data collection tools included the demographic characteristics information questionnaire with gynecological/obstetric records, the Clinical Evaluation Form (CEF) to determine preeclampsia symptoms and severity, and the modified Food Frequency Questionnaire (FFQ). The FFQ was in a Willet format adjusted for Iranian food items. The FFQ also asked about the usual dietary intake in the last six months. The validity of the researcher-made demographic characteristics information questionnaire with gynecological/obstetric records was confirmed through content validity using the opinions of seven faculty members at Mashhad University of Medical Sciences, Mashhad, Iran. The CEF was also taken from Williams Manual of Obstetrics: Pregnancy Complications, as a reference (1). For all study samples, the validated and reliable modified FFQ, containing information on diet, was completed by the researchers. The questionnaire consisted of a list of typical food items (i.e., fruit, vegetables, dairy products, food and drinks, carbonated soft drinks, salt, oils, meat, beans, eggs, nuts, and supplements taken during pregnancy according to national guidelines). The items related to the main food categories were then scored as zero, 1, and 2 based on their daily servings, and the ones associated with the supplements were scored as no consumption, irregular consumption, and regular consumption. The weekly, monthly, and no use of carbonated soft drinks were also scored as zero, 1, and 2, respectively. Moreover, table salt intake was scored as zero, 1, and 2 for always, sometimes, and never, respectively. The consumption of vegetable oil had correspondingly a score of 2, a combination of vegetable and animal oils was assigned with a score of 1, and animal oil alone had a score of zero. The minimum and maximum scores obtained from the modified FFQ were zero and 14, respectively (14).

To describe the demographic characteristics, the mean and standard deviation (SD) were used for the quantitative variables, and the relative and absolute frequency distribution were used for the qualitative variables,. The Kolmogorov-Smirnov test was used to determine data normality. The data were also analyzed using the SPSS Statistics software (ver. 20) and Mann-Whitney U test, Chi-square test, and Fisher's exact test. Logistic regression was also practiced to obtain odds ratio (OR). P<0.05 was considered statistically significant.

Results

A total number of 240 women, 90 in the case (preeclampsia) group (40 cases with severe preeclampsia and 50 with non-severe preeclampsia) and 150 in the control (healthy) group, were included in this study.

The results revealed no statistically significant difference between the two study groups in terms of educational level (p=0.213), occupation (p=0.118), place of residence (p=0.623), level of income (p=0.583), and parity (p=0.249), and two groups were consequently homogenous. Also, the mean age of the mothers in the control group was 29.0±6.5 and in the control group was 31.5±7.0. Based on the Mann-Whitney test results, a statistically significant difference was observed between the two groups (p=0.008). Correspondingly, according to the Mann-Whitney test findings, there was a significant difference between the two groups in terms of body mass index (BMI, p=0.01) and mean gestational age (p<0.001) (Table 1).

According to the Mann-Whitney test results, there was no significant difference between the two groups in terms of daily fruit intake (p=0.242), and two groups mostly had three servings of fruit in their daily diet routines. The two groups also mentioned three daily servings of dairy products in their diets, and no significant difference was observed between the two groups in this regard (p=0.144). As well, 94% of the controls and 95% of the patients with preeclampsia noted the consumption of meat, beans, eggs, and nuts in their diets per day; however, there was no significant difference between the two groups in terms of the consumption of this food category (p=0.267).

Moreover, there was a significant difference between the two groups in terms of fast-food consumption (p=0.038), so that it was higher in the case group, but 54% of the individuals in the control group had never used fast food during pregnancy.

Table 1. Mean and SD of demographic/gynecological/obstetric variables of study samples in healthy and preeclampsia groups

Variables	Groups		Test results
	Healthy	Preeclampsia	
	Median (interquartile range)	Median (interquartile range)	
Maternal age(year)	29(10)	32(10.5)	Z=-2.6 p=0.008 Mann-Whitney U test
BMI(m/s^2)	55.24(7.93)	26.7(9.55)	Z=-2.6 p=0.010 Mann-Whitney U test
Gestational age (based on the first day of the last menstrual period [LMP])	38.14(1.15)	35.21(6.57)	Z=-5.0 p<0.001 Mann-Whitney U test
	Frequency (%)	**Frequency (%)**	
Level of Education			
Illiteracy	4 (2.6)	5 (5.5)	Chi =5.8 (df)=4 p=0.213 Chi-square test
Elementary school	39 (26)	27 (30)	
Middle school	41 (27.3)	24 (26.6)	
High school	56 (37.3)	23 (25.5)	
University	10 (6.6)	11 (12.2)	
Occupation			
Homemaker	137 (91.3)	81 (90)	Chi =5.7 df=3 p=0.118 Chi-square test
Employee	0 (0)	4 (4.4)	
Self-employed	13 (8.6)	5 (5.5)	
Place of residence			
Urban	98 (65.3)	61 (67.7)	Chi =0.2 df=1 p=0.623 Chi-square test
Rural	52 (34.6)	29 (32.2)	
Level of income			
<Sufficient	91 (60.6)	55 (61.1)	Chi =1.7 df=2 p=0.573 Chi-square test
Sufficient	59 (39.3)	34 (37.7)	
>Sufficient	0 (0)	1 (1.1)	
Parity			
Nulliparity	40 (26.6)	31 (34.4)	p=0.249 Mann-Whitney U test
Multiparity	110 (73.3)	59 (56.5)	

Besides, vegetable oil obtained the maximum intake in both groups, and there was no difference between the two groups in terms of the type of oil consumed (p=0.518). As well, a statistically significant difference was observed between the two groups in terms of the consumption of vegetables, carbonated soft drinks, and table salt (p<0.05). Furthermore, there was a statistically significant difference between the two groups in terms of total diet scores (p=0.019), and the score was lower in the case group (Table 2).

According to national guidelines, the regular use of supplements (i.e., iron, folic acid, and multivitamins as well as vitamins E, C, and D and Omega 3) was reported higher in the control group, but there was no statistically significant difference between the pregnant women in the preeclampsia and healthy groups (p>0.05) (Figure 1).

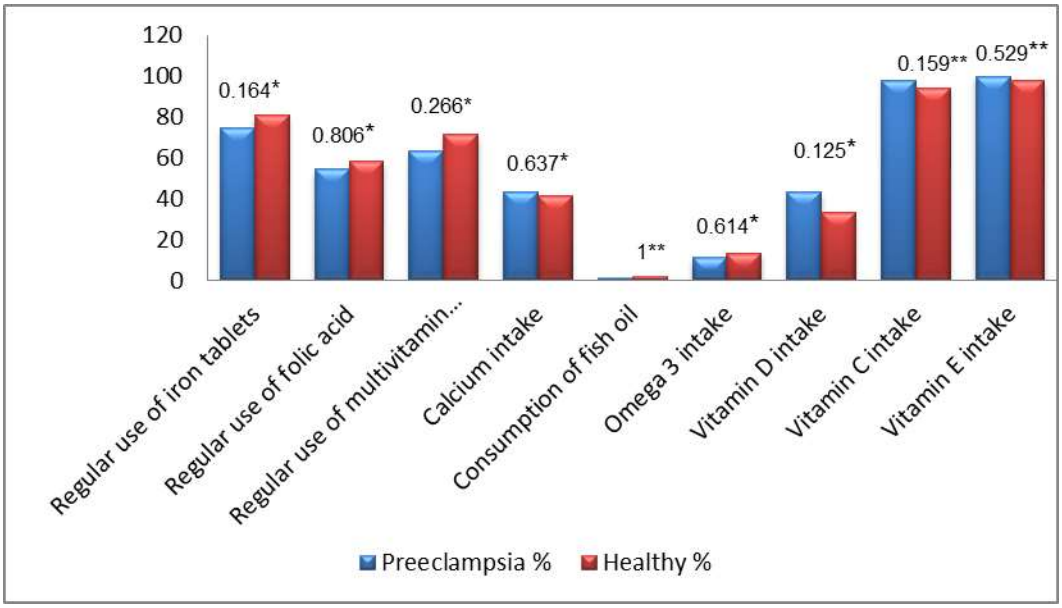
Table 2. Frequency and mean consumption of vegetables, carbonated soft drinks, table salt, and total diet score between healthy and preeclampsia groups

Variables	Groups		Test results
	Healthy	Preeclampsia	
	Median (interquartile range)	Median (interquartile range)	
Servings of daily vegetable consumption	3(1.57)	3(2.43)	p=0.005 Mann-Whitney U test
Servings of daily fruit consumption	3(2.12)	2.12(2.18)	p=0.242 Mann-Whitney U test
Servings of daily milk/dairy product consumption	3(2)	2.5(1.75)	p=0.144 Mann-Whitney U test
Servings of daily meat/beans/egg/nuts consumption	2(1.5)	1.92(1.5)	p=0.267 Mann-Whitney U test
	Frequency (%)	**Frequency (%)**	
Consumption of carbonated soft drinks			Chi =14.7 df=3 p=0.005 Chi-square test
Always	44 (29.3)	23 (25.6)	
Sometimes	17 (11.3)	27 (30.0)	
Rarely	27 (18.0)	8 (8.9)	
Never	62 (41.3)	32 (35.6)	
Consumption of table salt			Chi=13.0 df=3 p=0.005 Chi-square test
Always	50 (33.3)	26 (28.9)	
Sometimes	16 (10.7)	22 (24.4)	
Rarely	17 (11.3)	2 (2.2)	
Never	67 (44.7)	40 (44.4)	
Total diet score			Chi =7.2 df=2 p=0.019 Chi-square test
Zero	2 (1.3)	3 (3.3)	
1	68 (45.3)	55 (61.1)	
2	80 (53.3)	32 (35.6)	

Table 3. Results of logistic regression for some demographic and underlying variables effective in incidence of preeclampsia in study samples

	Coefficient	Coefficient criterion error	Wald test	OR	CI 95% OR		Test results
					Lower bound	Upper bound	
BMI	0.030	0.020	2.253	1.030	0.991	1.071	0.133
Servings of daily vegetable consumption	-0.195	0.073	7.039	0.823	0.713	0.950	0.008
Use of table salt							
Always (reference)							
Sometimes	0.972	0.408	5.682	2.644	1.189	5.882	0.017
Rarely	-1.486	0.786	3.578	0.226	0.049	1.055	0.059
Never	0.138	0.314	0.194	1.0148	0.621	2.123	0.660
Consumption of carbonated soft drinks							
Always (reference)							
Sometimes	1.111	0.403	7.621	3.038	1.380	6.688	0.006
Rarely	-0.568	0.478	1.412	0.567	0.222	1.446	0.235
Never	-0.013	0.337	0.001	0.987	0.510	1.911	0.970
Total diet score							
Zero (reference)							
1	-0.618	0.931	0.440	0.539	0.087	3.342	0.507
2	-1.322	0.937	1.992	0.267	0.043	1.672	0.158

Based on the logistic regression results and removing the effects of age and BMI, the risk of developing preeclampsia was significantly higher in women who had sometimes used table salt (OR: 2.6, confidence interval [CI] 95% 1.1-5.8) and carbonated soft drinks (OR: 3 CI 95% 1.3-6.6). Moreover, the chance of developing preeclampsia subsided by 0.8 times following a reduction in the consumption of vegetables (Table 3).



P-value: *Chi-square, **Fisher's exact test

Figure 1. Use of supplements between healthy and preeclampsia groups

Discussion

Based on the study results, preeclamptic and healthy women were significantly different in terms of total diet scores, which were lower in the case groups, but the pregnant women recruited as controls had healthy dietary patterns. There was also a statistically significant difference between the two groups in terms of the servings of vegetables used per day and preeclampsia; so that, the predominant consumption of vegetables was three servings in the healthy controls and two servings in preeclampsia women. The chance of developing preeclampsia was 0.8 times higher in cases having two or fewer servings, depending on their vegetable intake. Fruit and vegetable consumption can reduce the extent of the damage to DNAs by free radicals in the human body. Besides, Grum et al. (2018) had found that women having no fruit and vegetables, were more likely to develop preeclampsia or eclampsi compared with those using this food category (10). Inadequate consumption of fruit and vegetables is thus considered as a risk factor leading to negative health consequences, so that the World Health Organization (WHO) has announced the minimum recommended amount of fruit and vegetables by 3-5 servings per day (15). As well, Roozbehani et al. (2007) had reported that individuals who had consumed less than eight servings of fruit and vegetables per week were more likely to develop preeclampsia (16). A case-control study by Nikpour et al. (2004) had correspondingly reported that the chance of developing preeclampsia was 4.7 times lower in cases with high daily intake of fruit and vegetables (17), which was consistent with the findings in the present study.

It has been also advocated to have at least 3-4 servings of milk and dairy products per day during pregnancy (18). According to Richardson et al. (1995), preeclampsia was lower in women drinking two glasses of milk a day than in other women, while the relative risk of preeclampsia was lower in women having less than one glass or more than three glasses of milk a day, which was 1.9 and 2, respectively (19). The results of this survey were accordingly in line with the present study, so that 40% of healthy women and 51% of those with preeclampsia in the present study reported three or more servings of milk and dairy products, although no statistically significant difference was observed between the two groups. These findings can be attributed to the presence of fat in milk and dairy products, because milk fat increases the risk of preeclampsia by altering the levels of plasma lipids or other compounds existing in prostacyclin synthesis pathway (19). Moreover, in the present study, 40% of women with preeclampsia and 43% of healthy controls had used calcium supplements during pregnancy, but no significant difference was observed between the two groups in this regard. Kyozuka et al. (2020) in a survey on 33894 nulliparous women had also reported no significant relationship between early or late onset of high blood pressure and calcium supplement intake (20), which supported the results of the present study. Type of diet was further associated with plasma homocysteine level, so that homocysteine was inversely correlated with the use of food categories rich in fruit, vegetables, and fish, but positively associated with the high consumption of fat, sugar, caffeine, and carbonated soft drinks (21, 22). In the present study, a statistically significant difference was reported between the two groups in terms of fast-food consumption. In addition, the use of table salt and the consumption of carbonated soft drinks intensified the relative risk of preeclampsia by 2.6 and 3.03 times, respectively in both groups. Brainater et al. (2009) in their study found that diets containing fruit, vegetables, fiber, and vegetable oils could minimize the risk of preeclampsia, while meat, sugary drinks, and fast food had increased the risk of preeclampsia (23), which was consistent with the results of the present study.

In the study performed by Malakouti et al. in 2012, it was also found that folic acid intake in the early second trimester had decreased blood homocysteine levels, and it was associated with a reduced risk of developing preeclampsia (24). In the present study, 58% of healthy women and 54% of those with preeclampsia reported the regular consumption of folic acid during pregnancy. Although the amount of folic acid intake was lower in the affected women, no statistically significant difference was observed between the two groups. Low serum activity of antioxidants such as vitamins A, E, C, and D had been further reported in patients with preeclampsia. Deficiency of these substances may thus contribute to the pathogenesis of preeclampsia by diminishing superoxide dismutase activity and escalating lipid peroxidase(25, 26). In the present study, more than 90% of women in both case and control groups had taken vitamins C and E. Azami et al. in their study in 2017 reported that the consumption of a combination of vitamins C and E was ineffective to prevent preeclampsia (27). Rahmanian et al. (2011) had additionally stated that the use of the compounds of vitamins C and E had not mitigated the risk of preeclampsia during pregnancy, which was in agreement with the results of the present study (28). Moreover, Bahjat et al. (2017) had found that vitamin D intake could be effective in preventing preeclampsia (29). In the present study, the amount of vitamin D consumption was 43% in the control group and 33% in the preeclampsia group; however, no significant difference was observed between the two groups.

Among of the strengths of the present study was that it case-control research design and implementation of a logistic regression model. Some limitations of this study included not performing randomization and there was no possibility to reflect on biochemical factors of maternal blood and mere dependence on mothers' memory to complete the modified FFQ.

Conclusion

It was concluded that the higher total diet score (namely, healthy diet) had a protective effect on the risk of developing preeclampsia. Low consumption of vegetables and increased frequency of fast food, carbonated soft drinks, and table salt was also associated with preeclampsia. As pregnant women are eager to become aware of the health qualities of dietary patterns during pregnancy and actively search for health care information, including diet-related ones, it is suggested to develop appropriate educational programs and interventions to raise their awareness of types of diet, before and during pregnancy. Also, we should take some effective steps to promote healthy eating habits, and subsequently moderate the incidence rate of high blood pressure and preeclampsia.

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Conflicts of interest

Authors declared no conflicts of interest.

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