Original Article

# Dietary nutrient intake and antioxidant status in preeclamptic women

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## Abstract

**Background:** Preeclampsia (PE) is the most common cause of maternal death in the world. Some studies showed that inadequate intake of foods rich in antioxidant leads to increase oxidative stress and adverting obstetrical outcomes. The aim of the present study was to investigate the relationship between antioxidant status and dietary nutrient intake in pregnant women with PE.

**Materials and Methods:** This cross-sectional study was conducted among 55 pregnant women with PE admitted in the Obstetrics and Gynecology department of Shahid Beheshti Hospital in Isfahan, Iran.The subjects were interviewed about demographic data and dietary intakes by using a 168-items semi-quantitative food frequency questionnaire (FFQ). The total antioxidant capacity (TAC) of this serum was measured by using a double-antibody sandwich enzyme-linked immune-sorbent assay (ELISA). Nonparametric correlation statistics were used to meet assumptions of normality and equal variances.

**Results:** Total antioxidant status was significantly higher in comparison with healthy pregnant women (which measured as pilot). Intake of vitamin E was below the dietary reference intakes, and was positively associated with serum TAC ($r = 0.367$, $P = 0.003$), but this correlation was significantly negative about dietary selenium. There wasn't any significant correlation between intake of vitamin C, β-carotene, riboflavin, copper and serum TAC.

**Conclusion:** Our findings showed that intake of vitamin E was positively associated with serum TAC. Little support was found on a relationship between dietary intakes of other micronutrients and serum TAC. Further research is required to explore the relationships between maternal nutrient intake and antioxidant status in women with PE.

**Key Words:** Antioxidant capacity, antioxidant status, diet, nutrition, preeclampsia

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## INTRODUCTION

Hypertensive disorders of pregnancy, including gestational hypertension and preeclampsia (PE), may involve multiple organ systems and considered as leading causes of worldwide maternal and fetal mortality.[1,2]

By 2015, reducing maternal mortality and morbidity is assumed as an objective of the Millennium



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Development Goals (MDGs) of the United Nations Development Program.[3] PE is the most common cause of maternal death in the world and affecting nearly 10–18% of pregnancies in developing countries.[4]

The etiology of PE still remains unknown; however, several studies have examined the association of oxidative stress and PE together. Oxidative stress is created by an imbalance among the production of free radicals and antioxidant defense system.[5-8] Deficiency of both enzymatic and non-enzymatic antioxidants is also observed in women with PE.[9,10] Some investigators have reported that total antioxidant capacity (TAC) increases in the serum of women with PE.[11] An inadequate intake of food resources of antioxidants leads to increase oxidative stress and adverse obstetrical outcomes.[12-16] Nutrients may affect oxidative stress by increasing or decreasing free radicals or antioxidants or by providing substrate for the formation of free radicals.[17-19] Data suggest that having a very low intake of vitamin C, E, selenium, and zinc in pregnancy is complied with an increased risk of PE.[20,21] Some studies found that a diet rich in antioxidants, based on antioxidant-rich food consumption, increases the total antioxidant status and promotes better health.[17] However, little is known about the role of maternal nutritional status on TAC in the PE. Therefore, we investigated the antioxidant status in pregnant women with PE and its relationship with dietary nutrient intake.

## MATERIAL AND METHODS

This cross-sectional study was conducted between April and July in 2013 among pregnant women with PE admitted in the Obstetrics and Gynecology department of the Shahid Beheshti Hospital in Isfahan, Iran. It was approved by the Research and Ethics Committee of Isfahan University of Medical Sciences, and written informed consent was obtained from all subjects. Due to the lack of standard serum TAC, a preliminary study was conducted on 25 healthy pregnant women; according to its findings, the sample size was calculated to be 49 pregnant women with PE. Because of probable missing data, we considered the sample size to be 55.

Women were excluded if they did not give consent, were of gestational age under 18 years, were having a history of pre-existing health condition, including diabetes of type 1 or type 2, gestational diabetes, hypertension disorders, renal disease, heart disease, or other conditions that require special diets.

A team of trained gynecologist and dietitians conducted the study under standard protocols. Women were interviewed about demographic data. Dietary intakes were obtained by using a validated 168-items semi-quantitative food frequency questionnaire (FFQ) Developed in Iran.[22] The FFQ was a Willet format questionnaire modified for Iranian food items.[23] This questionnaire was administered to determine frequency of food consumption during pregnancy and ask about the average frequency of intake of during last year. Dietary data were extracted by Nutritionist-4 software (First Databank Inc., Hearst Corp., San Bruno, CA) by a trained dietitian.

Gestational hypertensive patients were considered as subjects, namely with a systolic blood pressure of ≥140 mmHg and/or diastolic blood pressure of ≥90 mmHg on two occasions more than 4 h apart after 20 weeks in pregnancy. PE was considered to be gestational hypertension associated with proteinuria ≥300 mg protein in 24-h urine collection.[24]

TAC of serum was determined from the sera that was frozen at –70°C and measured by using a double-antibody sandwich enzyme-linked immune-sorbent assay (ELISA) in samples.

Data analysis was performed using Statistical Package for the Social Sciences (SPSS) (version 20:0, SPSS Inc., Chicago, IL) software. Continuous variables are reported as the mean and standard deviation (SD). Non-parametric correlation statistics were used data failed to meet the assumptions of normality and equal variances. Spearman's rho was used to explore the relationships of both maternal dietary antioxidant and TAC. A $P < 0.05$ was considered as statistically significant.

## RESULTS

A total of 55 eligible women consented to participate in the study. Table 1 presents data concerning socio-demographic and lifestyle variables. Mean values of age and gestational week were 29 years (SD = 5.5; range = 18–38) and average weeks 34 weeks (SD = 2.7; range = 30–40), respectively. 25.5% of women had a history of PE.

**Table 1: General characteristics of women with preeclampsia**

| Characteristics | SD±Mean (*N*=55) |
|---|---|
| Age (years) | 29.3±5.5 |
| Education (years) | 9.3±4.5 |
| Gestational age (weak) | 34.1± 2.7 |
| Pre-pregnancy BMI (kg/m$^2$) | 25.7±5.5 |
| Primiparous (%) | 10.9 |
| History of preeclampsia (%) | 25.5 |
| History of abortion (%) | 21.8 |
| History of stillbirth (%) | 7.3 |
| History of twin birth (%) | 5.5 |

Based on the results obtained from the FFQ, the mean value of energy intake was 2157.7 ± 670.6 kcal/day. Women had significantly lower intakes of milk ($P$ = 0.0001), meat or beans ($P$ = 0.015) and higher consumption of grains ($P$ = 0.0001) and fruit, vegetables ($P$ = 0.012) compared to the recommended minimum number for pregnant women [Table 2]. All women were not taking supplements except iron and folic acid supplementation that is routinely used during pregnancy.

Table 3 compares the mean nutrient intake with Dietary Reference Intakes (DRIs). Women had significantly lower intakes of vitamin E, D, B6, niacin, magnesium, zinc, iron ($P$ < 0.05), and higher consumption of vitamins A, C, thiamin, riboflavin, selenium, copper and calcium ($P$ < 0.05) in comparing with DRI.

Mean of TAC was 3.86 ± 1.19 μmol/l and significantly higher than healthy pregnant women in pilot study ($P$ < 0.04). Because serum TAC failed to meet assumptions of normality distribution, nonparametric Spearman correlation were used. Correlation between serum TAC and dietary antioxidants are shown in Table 4, dietary intake of vitamin E had a significantly positive relationship with serum TAC ($r$ = 0.367, $P$ = 0.003) and selenium had a significantly negative relationship with serum TAC ($r$=–0.298, $P$ = 0.014). However, no relationship was found between intake of vitamin C, ß-carotene, riboflavin and copper with serum TAC.

**Table 2: Comparison of dietary intakes of some different food group in subjects with recommended values**

| Food group | SD±Mean *N*=55 | Recommended minimum number[25] | *P** |
|---|---|---|---|
| Meat or beans (ounce) | 3.7±2.1 | 7 | 0.0001 |
| Milk (cup) | 2.4±1.6 | 3 | 0.015 |
| Grains (ounce) | 10.7±5.3 | 7 | 0.0001 |
| Fruit, vegetables (cup) | 5.7±1.4 | 5 | 0.012 |

**P* < 0.05 was considered significant. SD: Standard deviation

**Table 3: Dietary nutrient intake and comparing with DRIs among subjects**

| Nutrient intake | SD±Mean *N*=55 | Dietary reference intakes[26] | *P** |
|---|---|---|---|
| Vitamin A (μg) | 1334.3± 807.4 | 770 | 0.0001 |
| Beta-carotene (μg) | 869.5± 758.9 | - | - |
| Vitamin C (mg) | 135.9±66.6 | 85 | 0.0001 |
| Vitamin D (μg) | 2±1.6 | 15 | 0.0001 |
| Vitamin E (mg) | 13.9±5.3 | 15 | 0.12 |
| Thiamin (mg) | 1.6±0.5 | 1.4 | 0.005 |
| Riboflavin (mg) | 2.4±0.8 | 1.4 | 0.0001 |
| Niacin (mg) | 15.3±4.6 | 18 | 0.0001 |
| Vitamin B6 (mg) | 1.4±0.4 | 1.9 | 0.0001 |
| Selenium (μg) | 81.5±40.7 | 60 | 0.0001 |
| Zinc (mg) | 9.9± 3.1 | 11 | 0.011 |
| Iron (mg) | 13.5± 4.7 | 27 | 0.0001 |
| Copper (mg) | 1.6± 0.5 | 1 | 0.0001 |
| Magnesium (mg) | 317.9±102.9 | 350 | 0.02 |
| Calcium (mg) | 1196.2±538.5 | 1000 | <0.0001 |

**P* < 0.05 was considered significant. DRIs: Dietary Reference Intakes

**Table 4: Correlation between serum TAC and dietary antioxidants**

| Variables | *r* | *P** |
|---|---|---|
| Vitamin E | 0.367 | 0.003 |
| Vitamin C | −0.041 | 0.384 |
| β-carotene | 0.125 | 0.181 |
| Riboflavin | 0.152 | 0.134 |
| Selenium | −0.298 | 0.014 |
| Copper | −0.036 | 0.398 |

**P* < 0.05 was consideredsignificant. TAC: Total antioxidant capacity

## DISCUSSION

In this study intake of vitamin E in women with PE was positively related to serum TAC; however, intake of vitamin E was lower than the dietary reference intakes. Rumbold *et al.*[20] showed a very low intake of vitamin E in mid to late pregnancy associated with an increased risk of PE and gestational hypertension, even after adjusting for confounding factors. Limberaki *et al.*[17] found that high consumption of antioxidant-rich foods increased the total antioxidant status and developed better health.

Our findings showed no significant correlation between intake of vitamin C, β-carotene, riboflavin, copper and serum TAC. A possible explanation for this might be concluded as dietary intake of vitamin C was higher than recommended allowance and fruit–vegetable consumption was more than recommended minimum number during pregnancy. Conflicting evidence was shown in the literature as to approve the relationship of intake of vitamins C and E with PE. Zhang *et al.*[27] demonstrated that women who consumed <85 mg of vitamin C daily (lower than the recommended dietary allowance), as compared with others, experienced a doubled risk with PE. However, Klemmensen *et al.*[28] concluded that incidence of PE did not correlate with dietary vitamin C and E intake. There was a decreasing trend in the incidence of severe PE and eclampsia with increasing dietary vitamin C intake.

In the present study dietary intake of selenium had a significant negative relationship with serum TAC. Intake of selenium was higher than dietary reference intakes and grain consumption was more than recommended minimum number during pregnancy.

Wheat is the major dietary sources of selenium and its content in foods depends on the selenium content of the soil in which plants are grown or animals are raised.[29-31] But bioavailability and effects on expression of the various selenoproteins depend on the form of selenium-containing products.[32]

Selenoprotein S is an anti-inflammatory protein that acts primarily to limit the damaging consequences of endoplasmic reticulum stress.[33] Some studies have suggested that selenium deficiency may be linked to PE.[34,35] Conversely, others have shown higher serum selenium concentrations have been reported in women with PE.[36]

Our finding showed women had significantly lower intakes of milk, meat or beans and higher consumption of grains and fruit, vegetables compared to the recommended minimum number for pregnant women, whereas Brantsaeter *et al.*[37] suggested that a dietary pattern characterized by high intake of vegetables, plant foods, and vegetable oils decreases the risk of PE, whereas a dietary pattern characterized by high consumption of processed meat, sweet drinks, and salty snacks increases the risk.

Little studies were found on investigating issues of the serum TAC in pregnant women with PE and its relationship with dietary nutrient intake, but some research measured total oxidant status (TOS) and TAS in women with PE.

Ozturk *et al.*[38] findings showed that maternal and cord plasma levels of TAS were significantly correlated with maternal and cord plasma levels of TOS in PE. Women whose pregnancies were complicated with PE and IUGR had elevated levels of TOS and TAS in comparison with healthy pregnant women.[39] Fenzl *et al.*[16] found that serum TAC and TOS concentrations were significantly higher in pregnant women with PE compared to pregnant controls. Increase of TOS in all pregnant women points to latent oxidative stress in pregnancy while increase of TAC in the early steps of preeclampsia might represent a defense mechanism of body against stress.

The current study has limitations that should be viewed cautiously. The smaller sample size and observational study design prevent establishing a definitive influence of maternal nutrient intake on antioxidant status. One explanation may be used on conflicting findings in the process of methodology in order to assess dietary intake, where some studies have used 24-h recall compared with a food frequency questionnaire. The study did not provide information regarding serum micronutrient concentrations and limited our ability to assess diet intake and serum TAC.

A major strength of this study is designing a preliminary test for accessing a normal range of TAC among normal pregnant women. However, women were carefully interviewed by dietitian about demographic data and dietary intakes were compared to questionnaires which have been filled by the subjects.

However, more prospective studies with larger sample size are needed to explore the relationships of both maternal nutrient intake and antioxidant status and to confirm the existing findings. These findings highlight that the intake of vitamin E was positively associated with serum TAC. Little support was found in the relationship between dietary intakes of other micronutrients and serum TAC. These data suggest that antioxidant activity could be increased by high dietary intakes of fruit, vegetables and other rich in antioxidant constituents and that increasing consumption of foods rich in antioxidant, may improve pregnancy-induced hypertension and PE. Further research is required to explore the relationships of maternal nutrient intake and antioxidant status in women with PE.

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