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Macro- and Micronutrient of Junk Food and Preeclampsia on Pregnant Women

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Abstract

BACKGROUND: Preeclampsia (PE) is still a global public health issue in developed and developing countries. It is a major contributor to maternal and fetal morbidity and mortality. The pathophysiology of preeclampsia during pregnancy is unclear, but the WHO reported that PE is higher in developing countries than developed ones due to lifestyle and nutritional status.

AIM: This study aimed to describe the influence of macro- and micronutrients of junk food on PE.

METHODS: This case–control study was carried out on 148 samples, including pregnant women with preeclampsia (n = 74) and normal pregnant women (n = 74) with gestational age > 20 weeks. Data on junk food intake were collected using the SQ-FFQ form and then estimated using the Nutri Survey. Data were analyzed in SPSS version 17 using descriptive statistics. Pearson correlation coefficient was used to observe the correlation between variables with $p < 0.05$ and 95% confidence interval.

RESULTS: Binary logistic regression revealed that the intake of fat ($p = 0.005$), vitamin C ($p = 0.002$), and sodium ($p = 0.036$) contained in the junk food were significantly associated with PE. The frequency of consumption of junk food also had a significant effect on the incidence of preeclampsia ($p = 0.013$).

CONCLUSION: Intake of fat, vitamin C, and sodium were associated with PE, and they were risk factors of PE. The frequency of consuming junk food gave more risk to have PE.

Introduction

Preeclampsia (PE) is first detected after 20 weeks of gestation with or without generalized edema, which is hypertension accompanied by proteinuria [1], [2]. PE is still a public health issue both in developed and developing countries, affecting around 4.6% of pregnancies globally. It is a leading cause of life-threatening maternal morbidity and mortality [3], [4]. In developing countries, the prevalence of preeclampsia reaches up to 16.7%, and it is estimated to account for about 40–60% of maternal deaths in developing countries [5]. The World Health Organization (WHO) estimates that, in developing countries, the incidence of preeclampsia is 7 times higher (2.8% of live births) than in developed countries (0.4%) [6]. In Indonesia, national data estimated that preeclampsia occurs in 2–8% of pregnancies; preeclampsia patients may reach 105,822–423,291 in a year [7]. The pathophysiology of preeclampsia during pregnancy is not yet clear, but many pathophysiological elements may exist, such as inflammation, dyslipidemia, cytokine production [8], oxidative stress [9], and elevated homocysteine. Many theories explain the cause of preeclampsia in pregnant women, one of which is related to the nutritional pattern of pregnant women. Several studies have reported that inadequate nutritional supply during pregnancy can lead to the development of preeclampsia and eclampsia [10]. The WHO also revealed that PE in developing countries is more than in developed countries due to their lifestyle and nutritional status [6]. The eating habits and nutritional status of pregnant women have an important influence, not only on the journey of pregnancy and fetal development but also on the health of the child during the later years of life [11].

At present, the modern lifestyle has been very developed and impacts all aspects of life, including affecting the diet of people, including pregnant women. A study in 2002 in America found that the dominant types of food eaten by pregnant women were groups with high calories such as carbohydrates and fats and foods with incomplete nutrition such as soft drinks, white bread, and those included in the "junk food" category. This junk food consumption causes the amount of calcium, iron, and folate intake to be less and the formation of excess fat due to excessive calorie intake [12]. Several studies

revealed that the consumption of junk food in big cities in Indonesia is quite worrying. Most children, adults, and even pregnant women, especially middle and upper-class families, are very accustomed to consuming junk food as a daily snack. At present, many foods are commercially processed so that they contain too much fat, calories, sodium but are low in nutrients [13].

Maternal nutritional status during pregnancy have been investigated as one of the targets in preventing preeclampsia. Poor dietary quality in pregnancy, including intake of energy, micronutrients, and macronutrients, has been implicated in an increased risk of preeclampsia. Evidence has shown that some nutrients can improve endothelial function, either by reducing oxidative stress or by modifying certain inflammatory responses. Micronutrients, including folate, sodium, calcium, potassium, iron, copper, and zinc, represent potential etiologic and therapeutic targets for the prevention of preeclampsia. Maternal micronutrient status in pregnancy can affect placental development [11].

Several studies have shown that additional energy intake, processed foods, refined grains, and consumption of sugary drinks increase the risk of PE [10], [14]. A survey in Jordania (2019) revealed that a high intake of fat, saturated fat, and sodium and a low intake of Vitamin C was associated with PE [15]. In Iran, a case–control study in 2018–2019 suggested that increased frequency of fast foods, carbonated soft drinks, and table salt was also associated with the incidence of preeclampsia [16]. A study conducted in Indonesia revealed an association between junk food consumption during pregnancy and preeclampsia. The studies reported that women who consume junk food more than 3 times a day risk around 4 times to have preeclampsia [17]. Type of food that concern to junk food and habit of consuming junk food on pregnant women is the novelty of the study. However, studies that focus on the analysis of macronutrient and micronutrient of junk food on pregnant women related to preeclampsia are still scant, including in Indonesia. Meanwhile, modern lifestyle tends to change dietary patterns, including pregnant women in Indonesia.

Objective

The purpose of this study is to describe the influence of macro and micronutrients of junk food on PE. In addition, this study will examine the frequency consumption of junk food during pregnancy period and PE.

Materials and Methods

Subjects

This case–control study was conducted on 148 individuals, including pregnant women with preeclampsia (n = 74) and normal pregnant women (p = 74).

The samples were taken from several health facilities. The inclusion criteria for the sample were being aged 18–35 years, having gestational age > 20 weeks, having single pregnancy and life, and also having parity of 1–4, not having a recommendation for preeclampsia treatment such as Aspirin, and being willing to participate in the research by signing an informed consent form. Meanwhile, the exclusion criteria were, suffering from diabetes and kidney problems.

Instruments and measurement

In this study, PE was defined if a woman had a systolic or diastolic blood pressure of 140/90 mmHg measured twice at 6 h intervals and the presence of proteinuria (≥0.3 g/24 h or 1+ in the urine dipstick measurement). Systolic and diastolic blood pressure was measured by a standard mercury sphygmomanometer [18].

Data on junk food intake were obtained from data collection using the SQ-FFQ form. Then, the data obtained are calculated and estimated using the Nutri Survey. The estimation results, then, calculated the percentage of intake based on the Daily Nutritional Adequacy Rate (RDA) according to the age of the pregnant woman and the addition of the trimester of pregnancy. In addition, data on characteristics of the sample (age, education, occupation, parity, and income) were collected using a questionnaire. The data were analyzed using SPSS software (version 17.0). Fisher exact test and Mann–Whitney test were used to assess the relationship between junk food habit and preeclampsia (p = 0.05 and 95% confidence interval). Moreover, odds ratio (OR) was calculated to estimate the risk of preeclampsia if pregnant women have the habit of consuming junk food during the pregnancy period.

Results

The results indicated that the mean age of respondents was 26.64 ± 5.17 (case group) and 26.03 ± 5.22 (control group). The parity mean was 2.57 ± 1.14 in the case group and 2.72 ± 1.09 in the control group. The majority of individuals in both the case and control group were tertiary level; the percentage was 56.8% in the case group and 45.9% in the control group. In terms of occupation, most of the case group was an employee (37.8%), and the dominant occupation of the control group was a housewife (40.5%). The income mean of participants was 2.45 ± 0.92 (case group) and 1.78 ± 0.84 in the control group (Table 1). Statistics analysis using the Mann–Whitney U-test revealed that

there was a significant association between income and preeclampsia (p = 0.007).

For macronutrient intakes (Table 2), the mean carbohydrate intake of the case group was 230.30 ± 128.57 and 208.50 ± 121.74 in the control group. The protein intake mean of individuals was 68.34 ± 41.85 (case group) and 63.68±49.03 in the control group. Mean fat intake in the case group was 72.30 ± 48.33 and in the control group was 54.41 ± 43.87. The mean vitamin C intake of the case group was 48.36 ± 87.69 and 78.42 ± 77.62 in the control group. Meanwhile, for micronutrient intakes, the mean sodium intake of the case group was 1029.43 ± 710.58 and 554.67 ± 677.37 (control group). The mean was 5.19 ± 3.66 (case group) for the consumption frequency and 2.98 ± 3.21 in the control group. The analysis statistic suggested a significant correlation between vitamin c (p = 0.000) and consumption frequency (p = 0.000) toward the incidence of preeclampsia. In the case group, the average consumption of junk food *was* about 5–15 times a day. In the control group, the average consumption of junk food was about twice a day, with a maximum of about 14 times in a day.

Table 1: Characteristics of case and control groups

Characteristics	Case group (n = 74)			Control group (n = 74)			p value
	Mean ± SD	Min	Max	Mean ± SD	Min	Max	
Age	26.64 ± 5.17	18	35	26.03 ± 5.22	18	35	0.661
Parity	2.57 ± 1.14	1	4	2.72 ± 1.09	1	4	0.152
Education							
No Education	0 (0.0)			3 (4.1%)			
Primary school	10 (13.5%)			9 (12.2%)			
Secondary school	10 (13.5%)			20 (27.0%)			
Tertiary school	42 (56.8%)			34 (45.9%)			
University	12 (16.2%)			8 (10.8%)			
Occupation	2.16 ± 0.87	1	4	1.93 ± 0.92	1	4	0.080
Housewife	19 (25.7%)			30 (40.5%)			
Employee	28 (37.8%)			23 (31.1%)			
Entrepreneurships	23 (31.1%)			17 (23.0%)			
Health Provider	4 (5.4%)			4 (5.4%)			
Income (Rupiah/IDR)	2.45 ± 0.92	1	5	1.78 ± 0.84	1	5	0.007

p-value: Fisher exact test.

In this study, all variables related to PE were analyzed by logistic regression (Table 3). The result revealed that the most significant risk factor of PE was vitamin C (p = 0.002) and (OR = 3.081). The next risk factor was fat intake (p = 0.005 and OR = 2.700). Another risk factor was sodium intake (p = 0.036 and OR = 2.330). The frequency variable of junk food consumption has the highest odds ratio, which is 4.906. This high odds ratio means pregnant women who always consume junk food risk 4.906 times more likely to have preeclampsia compared to their counterpart.

Discussion

This study aimed to know how the nutrients of junk foods consumed by pregnant women during the pregnancy period led to having preeclampsia. To the best of our knowledge, this is the first case–control study in Indonesia that assessed macro and micronutrients of junk food as a risk factor for preeclampsia in pregnant women. This finding is similar to the studies in several countries such as Iran, Jordanian, and Norway that processed food, sugar-containing drinks, fast foods, and carbonated soft drink will increase the risk of having preeclampsia [15], [19], [20]. This study found that the more junk food consumed, the higher the risk of having preeclampsia. The result of this study revealed that those who consume junk food more than 4 times/day risk 3 times to have preeclampsia. The income mean of pregnant women in the case group of this study was higher than the control group. Hence, they consume junk food more often than their counterpart.

In this case–control study, the fat intake of pregnant women who have PE was more than the other subjects, and it was significantly associated with PE (p = 0.005). The result of our study was consistent with several studies that have found the association between fat intake and PE [21], [22], [23], [24]. Daily fat intake is found to directly affect the concentration of triglycerides, cholesterol, and total fat in the blood. It was reported that plasma triglycerides, low-high-density lipoprotein cholesterol, and free fatty acids were significantly greater in pregnant women with preeclampsia than in healthy pregnant women [25]. Consumption of high fat also triggers obesity, which, in turn, will increase the risk of preeclampsia about 3 times, even becoming a major risk in people in developed countries [26].

Moreover, in several studies, the association between intake of saturated fatty acids and preeclampsia has been related to endothelial dysfunction caused by acute or chronic consumption of these macro nutrients [21], [23]. Consumption of saturated fatty acids increases low-density lipoprotein cholesterol (LDL-C) levels [27]. On the other hand, some investigations have reported serum levels of LDL-C in women with preeclampsia in the later stages of pregnancy to be 10.4% higher than other pregnant women [28]. In addition, some studies have revealed the association between fatty acids

Table 2: The effect of nutrient intake and consumption frequency on incidence preeclampsia

Nutrient intake	Case group		Control group		p-value
	Mean ± SD	Min-Max	Mean ± SD	Min-Max	
Carbohydrates (g)	230.30 ± 128.57	81.60-540.30	208.50 ± 121.74	58.30–579.70	0.495
Protein (g)	68.34 ± 41.85	13–178.70	63.68 ± 49.03	7–251.3	0.615
Fat (g)	72.30 ± 48.33	15.60–172.90	54.41 ± 43.87	10–205.70	0.020
Cholesterol (mg)	191.92 ± 158.84	0–692.30	271.76 ± 212.99	0–926.50	0.028
Vitamin C (mg)	48.36 ± 87.69	1.90–644.40	78.42 ± 77.62	0.50–280.90	0.000
Sodium (mg)	1029.43 ± 710.58	65.50–2691.90	554.67 ± 677.37	40.20–3379.50	0.000
Iron (mg)	8.28 ± 5.52	1.70–25.20	10.21 ± 9.56	1.10–64.20	0.228
Fibber (g)	12.05 ± 6.88	4.2–37.3	13.96 ± 10.28	4.3–46.7	0.311
Consumption Frequency	5.19 ± 3.66	0.69–15.66	2.98 ± 3.21	0–14.42	0.000

p-value: Mann–Whitney U-test.

intake and preeclampsia later in pregnancy by lipotoxicity due to intake of fatty acids, which affects the maternal and placental endothelial function [22].

Table 3: Risk factors of preeclampsia

Risk factors	B	p-value	OR
Fat intake	0.993	0.005	2.700
Vitamin C intake	1.125	0.002	3.081
Sodium intake	1.481	0.036	2.330
Consumption frequency of junk food	1,591	0.013	4.906

Statistical Test: Logistics Binary Regression.

However, our result in terms of fat correlation with PE is not consistent with other studies; a study in Denmark (2011) showed no association between trans fats and preeclampsia [29]. The study is also supported by research in Eastern Massachusetts (2007) which found that intake of trans fat was unrelated to preeclampsia [30].

This study also found that sodium intake was a risk factor for preeclampsia (OR = 2.330). Those who consume more sodium are more likely to have preeclampsia. In this study, the average sodium intake in the case group was much higher than in the control group. Many other studies were already examined the effect of sodium and PE. The results, about 50% of cases and approximately one-third of group controls were not aware that consuming more salt leads to the development of preeclampsia. Morris *et al*. found that sodium intake was not related to the incidence of preeclampsia or pregnancy-associated hypertension [31]. Intake of sodium could have a direct effect on blood pressure. Blood pressure is one of the signs of preeclampsia incidence in pregnant women. Ibrahim *et al*. (2013) reported that leptin levels increased along with increased blood pressure in pregnancy [32]. Moreover, in pregnant women who are obese, leptin resistance in obese women increases sodium reabsorption in the renal tubules, which can lead to water retention and ultimately lead to preeclampsia [33], [34], [35].

Another result obtained in this study was that vitamin C was significantly associated with preeclampsia. It was a risk factor of PE; the less vitamin C intake, the higher risk to have PE. This finding is similar to several studies. For example, a study in Iran (2012) suggested that the mean vitamin C intake of pregnant women with PE was significantly different from other mothers: Those who have PE consumed vitamin C less than healthy pregnant women [24]. Another study in Washington revealed that the incidence of PE was two-fold in women who had a daily intake of ascorbic acid <85 mg [36]. It was also found that there was an association between low dietary intake of vitamin C in the 25th gestational week and PE. The study found that vitamin C could prevent increasing severe PE [37]. Serdar *et al*. also recommended supplementation with vitamins C as beneficial strategies to prevent PE in women at increased risk of the disease [38]. Vitamin C is the most efficacious protection against free radicals in the peripheral circulation during oxidative stress and is the first antioxidant to be exhausted. Consumption of more vegetables and fruits rich in vitamin C may give less risk to developing PE, because vitamin C inhibits LDL oxidation, attenuates the production of reactive oxygen species by vascular cells, and limits cellular responses to oxidized LDL. For example, the expression of adhesion molecules, which has a vital role in regulating vascular tone, is weakened when vitamin C is increased, and endothelial nitric oxide synthesis is inactivated. By consuming more vitamin C, it may also play a role in modulating endothelial function through regulation of the inflammatory response to oxidative stress [37], [39]. Stress plays a role in the pathogenesis of preeclampsia. Supplementing women with antioxidants during pregnancy can reduce oxidative stress and prevent or delay the onset of PE [26], [40], [41].

The limitation of this study is that this is a controlled study in which intake estimation and the frequency was influenced heavily by what respondents remembered. Furthermore, the list of junk food on the SQ-FFQ questionnaire was limited. Moreover, this study examined only a few micronutrients related to PE. A cohort study should be conducted in the future by examining more micronutrients of junk food, more list of fast food, and bigger sample size. Moreover, a mixed method study (quantitative and qualitative) should be applied to explore information about how macro- and micronutrients of junk food influence risk to have PE.

Conclusion

The findings of this study indicate that unbalanced nutrient intake increases the incidence of PE in pregnant women. The consumption frequency of junk food gives a higher risk of developing PE. Macro- and micronutrients in this study (fat, vitamin C, and sodium) were associated with PE in pregnant women. This study indicates that balanced nutrient intake during pregnancy period is very important to prevent morbidity such as PE that may lead to maternal death.

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References

1. Sidani M, Siddik-Sayyid SM. Preeclampsia, a new perspective in 2011. Middle East J Anesth. 2011;21(2):207-14. PMid:22435273

2. World Health Organization. WHO Recommendations for Prevention and Treatment of Pre-Eclampsia and Eclampsia. Geneva: World Health Organization; 2011. http://www.who.int/about/licensing/copyright_form/en/index.html
   PMid:23741776
3. Khan KS, Wojdyla D, Say L, Gülmezoglu AM, Van Look PF. WHO analysis of causes of maternal death: A systematic review. Lancet. 2006;367(9516):1066-74. https://doi.org/10.1016/s0140-6736(06)68397-9
   PMid:16581405
4. Abalos E, Cuesta C, Grosso AL, Chou D, Say L. Global and regional estimates of preeclampsia and eclampsia: A systematic review. Eur J Obstet Gynecol Reprod Biol. 2013;170(1):1-7. https://doi.org/10.1016/j.ejogrb.2013.05.005
   PMid:23746796
5. Osungbade KO, Ige OK. Public health perspectives of preeclampsia in developing countries: Implication for health system strengthening. J Pregnancy. 2011;2011:481095. https://doi.org/10.1155/2011/481095
   PMid:21547090
6. Trogstad L, Magnus P, Skjærven R, Stoltenberg C. Previous abortions and risk of pre-eclampsia. Int J Epidemiol. 2008;37(6):1333-40. https://doi.org/10.1093/ije/dyn167
   PMid:18940837
7. Kemenkes RI. Data informasi profil Kesehatan Indonesia 2018. J Chem Inf. 2013;53(9):1689-99. Available from: https://www.kemkes.go.id [Last accessed on 2021 Aug 20].
8. Scholl TO, Leskiw M, Chen X, Sims M, Stein TP. Oxidative stress, diet, and the etiology of preeclampsia. Am J Clin Nutr. 2005;81(6):1390-6. https://doi.org/10.1093/ajcn/81.6.1390
   PMid:15941892
9. Chappell LC, Seed PT, Briley AL, Kelly FJ, Lee R, Hunt BJ, *et al*. Effect of antioxidants on the occurrence of pre-eclampsia in women at increased risk: A randomised trial. Lancet. 1999;354(9181):810-6. https://doi.org/10.1016/s0140-6736(99)08016-2
   PMid:10485722
10. Chen X, Zhao D, Mao X, Xia Y, Baker PN, Zhang H. Maternal dietary patterns and pregnancy outcome. Nutrients. 2016;8(6):351. https://doi.org/10.3390/nu8060351
    PMid: 7338455
11. Samur G, Akkuş OO, Ede G, Ayaz A, Akyol A, Akkuş M, *et al*. Nutritional status among women with preeclampsia and healthy pregnant women. Prog Nutr. 2016;18(4):360-8. Available from: https://www.mattioli1885journals.com/index.php/progressinnutrition/article/download/5387/4231 [Last accessed on 2021 Aug 20].
12. Adhi P. Patogenesis Preeklamsia and Manifestasi Gejala Klinis dalam Kehamilan Risiko. 1st ed. Jakarta: CV Sagung Seto; 2015.
13. Wulan RS. Dangerous Junk Food. Yogyakarta: O2; 2008.
14. Compher C, Elovitz MA, Parry SI, Chittams J, Griffith CJ. 330: Diet pattern is associated with an increased risk of hypertensive disorders of pregnancy. Am J Obstet Gynecol. 2018;2189(1):S206. https://doi.org/10.1016/j.ajog.2017.10.266
15. Yusuf H, Subih HS, Obeidat BS, Sharkas G. Associations of macro and micronutrients and antioxidants intakes with preeclampsia: A case-control study in jordanian pregnant women. Nutr Metab Cardiovasc Dis. 2019;299(5):458-66. https://doi.org/10.1016/j.numecd.2019.01.008
    PMid:30952573
16. Moradi M, Niazi A, Salajegheh F, Mazloumi E. Comparing dietary patterns during pregnancy in women with preeclampsia and healthy women: A case-control study. J Midwifery Reprod Health. 2022;10:3084-92.
17. Rahayu LD, Suryandari AE. Hubungan kebiasaan konsumsi junk food dengan kejadian preeklampsia pada Ibu Hamil di RSUD Prof. Dr. Margono soekarjo. J Involusi Kebidanan. 2014;4:1-10. https://doi.org/10.26751/ijb.v1i1.245
18. Buchanan S. The Accuracy of Alternatives to Mercury Sphygmomanometers. Health Care Research Collaborative; 2009. p. 1-22.
19. Clausen T, Slott M, Solvoll K, Drevon CA, Vollset SE, Henriksen T. High intake of energy, sucrose, and polyunsaturated fatty acids is associated with increased risk of preeclampsia. Am J Obstet Gynecol. 2001;185(2):451-8. https://doi.org/10.1067/mob.2001.116687
    PMid:11518908
20. Brantsæter AL, Haugen M, Samuelsen SO, Torjusen H, Trogstad L, Alexander J, *et al.* A dietary pattern characterized by high intake of vegetables, fruits, and vegetable oils is associated with reduced risk of preeclampsia in nulliparous pregnant Norwegian women. J Nutr. 2009;1399(60):1162-8. https://doi.org/10.3945/jn.109.104968
    PMid:19369368
21. Fuentes F, López-Miranda J, Sánchez E, Paez J, Paz-Rojas E, Marín C, *et al*. Mediterranean and low-fat diets improve endothelial function in hypercholesterolemic men. Ann Intern Med. 2001;134(12):1115-9. https://doi.org/10.7326/0003-4819-134-12-200106190-00011
22. Jarvie E, Hauguel-de-Mouzon S, Nelson SM, Sattar N, Catalano PM, Freeman DJ. Lipotoxicity in obese pregnancy and its potential role in adverse pregnancy outcome and obesity in the offspring. Clin Sci. 2010;119(3):123-9. https://doi.org/10.1042/cs20090640
    PMid:20443782
23. Brenna JT, Lapillonne A. Background paper on fat and fatty acid requirements during pregnancy and lactation. Ann Nutr Metab. 2009;55(1-3):97-122. https://doi.org/10.1159/000228998
    PMid:19752538
24. Khoigani MG, Paknahad Z, Mardanian F. The relationship between nutrients intake and preeclampsia in pregnant women. J Res Med Sci. 2012;17:S210-7.
25. Ge J, Wang J, Xue D, Zhu Z, Chen Z, Li X, *et al.* Why does a high-fat diet induce preeclampsia-like symptoms in pregnant rats. Neural Regen Res. 2013;8(20):1872-80. https://doi.org/10.3969/j.issn.1673-5374.2013.20.006
    PMid:25206496
26. Roberts JM, Bodnar LM, Patrick TE, Powers RW. The role of obesity in preeclampsia. Pregnancy Hypertens. 2011;1(1):6-16. https://doi.org/10.1016/j.preghy.2010.10.013
    PMid:21532964
27. Lichtenstein AH. Dietary fat and cardiovascular disease risk: Quantity or quality? J Women's Health. 2003;12(2):109-14. https://doi.org/10.1089/154099903321576493
    PMid:12737709
28. Enquobahrie DA, Williams MA, Butler CL, Frederick IO, Miller RS, Luthy DA. Maternal plasma lipid concentrations in early pregnancy and risk of preeclampsia. Am J Hypertens. 2004;17(7):574-81. https://doi.org/10.1016/j.amjhyper.2004.03.666
29. Chavarro JE, Halldorsson TI, Leth T, Bysted A, Olsen SF. A prospective study of trans fat intake and risk of preeclampsia in Denmark. Eur J Clin Nutr. 2011;65(8):944-51. https://doi.org/10.1038/ejcn.2011.66
    PMid:21559043
30. Oken E, Ning YI, Rifas-Shiman SL, Rich-Edwards JW, Olsen SF, Gillman MW. Diet during pregnancy and risk of preeclampsia or gestational hypertension. Ann Epidemiol. 2007;17(9):663-8. https://doi.org/10.1016/j.annepidem.2007.03.003

PMid:17521921

31. Morris CD, Jacobson SL, Anand R, Ewell MG, Hauth JC, Curet LB, *et al.* Nutrient intake and hypertensive disorders of pregnancy: Evidence from a large prospective cohort. Am J Obstet Gynecol. 2001;184(4):643-51. https://doi.org/10.1067/mob.2001.111101

PMid:11262466

32. Ibrahim, HS, Omar E, Froemming GR, Singh HJ. Leptin increases blood pressure and markers of endothelial activation during pregnancy in rats. Biomed Res Int. 2013;2013:2984401. https://doi.org/10.1155/2013/298401

33. Salimi S, Farajian-Mashhadi F, Naghavi A, Mokhtari M, Shahrakipour M, Saravani M, *et al*. Different profile of serum leptin between early onset and late onset preeclampsia. Dis Markers. 2014;2014:628476. https://doi.org/10.1155/2014/628476

34. Townsend R, O'Brien P, Khalil A. Current best practice in the management of hypertensive disorders in pregnancy. Integr Blood Press Control. 2016;9:79-94. https://doi.org/10.2147/ibpc.s77344

PMid:27555797

35. Yeboah FA, Ngala RA, Bawah AT, Asare-Anane H, Alidu H, Hamid AM, *et al.* Adiposity and hyperleptinemia during the first trimester among pregnant women with preeclampsia. Int J Womens Health. 2017;9:449-54. https://doi.org/10.2147/ijwh.s134088

PMid:28670144

36. Zhang C, Williams MA, King IB, Dashow EE, Sorensen TK, Frederick IO, *et al.* Vitamin C and the risk of preeclampsia: Results from dietary questionnaire and plasma assay. Epidemiology. 2002;13(4):409-16. https://doi.org/10.1097/00001648-200207000-00008

PMid:12094095

37. Klemmensen AK, Tabor A, Østerdal ML, Knudsen VK, Halldorsson TI, Mikkelsen TB, *et al.*, Intake of Vitamin C and E in pregnancy and risk of pre-eclampsia: Prospective study among 57 346 women. BJOG. 2009;116(7):964-74. https://doi.org/10.1111/j.1471-0528.2009.02150.x

PMid:19522799

38. Serdar Z, Gür E, Çolakoðullarý M, Develioðlu O, Sarandöl E. Lipid and protein oxidation and antioxidant function in women with mild and severe preeclampsia. Arch Gynecol Obstet. 2003;268(1):19-25. https://doi.org/10.1007/s00404-002-0302-y

PMid:12673470

39. Xu H, Shatenstein B, Luo Z-C, Wei S, Fraser W. Role of nutrition in the risk of preeclampsia. Nutr. Rev. 2009;67(11):639-57. https://doi.org/10.1111/j.1753-4887.2009.00249.x

PMid:19906251

40. Kiondo P, Wamuyu-Maina G, Wandabwa J, Bimenya GS, Tumwesigye NM, Okong P. The effects of Vitamin C supplementation on pre-eclampsia in Mulago hospital, Kampala, Uganda: A randomized placebo controlled clinical trial. BMC Pregnancy Childbirth. 2014;14(1):1-10. https://doi.org/10.1186/1471-2393-14-283

41. Mistry HD, Williams PJ. The importance of antioxidant micronutrients in pregnancy. Oxid Med Cell Longev. 2011;2011:841749. https://doi.org/10.1155/2011/841749

PMid:21918714

Appendix

Table S1: Semi quantitative food frequency questionnaire

Food	Frequency (D = Daily, W = Weekly. M = Monthly, A = Annual, N = Never)					Portion		Average of Frequency per Day	Average of intake Gram/day
	D	W	M	A	N	Household System of Measurement	Gram		
Noodle									
Snacks									
Cookies									
Humburger									
Fried Chicken									
Hot Dog									
Pizza									
Sandwich									
Spaghetti									
Chicken Nugget									
Donuts/Bread									
Chocolate									
French Fries									
Bakwan									
Pisang Goreng (Fried Banana)									
Bakso (Meat ball)									
Cheese									
Ice Cream									
Frozen Cake									
Pudding									
Salad									
Coca Cola									
Fanta									
Sprite									
Juice									
Coffee									
Tea									