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

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Abstract

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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 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 = 0.006) 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% 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

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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 [18, 14]. A survey in Jordania (2019) revealed 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 ($p = 74$).

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 (≥ 0.22 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

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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 individual 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 ($p = 0.038$) 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.

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Table 1: Characteristics of case and control groups

Characteristics	Case group (n = 74)			Control group (n = 74)			p value
	Mean \pm SD	Min	Max	Mean \pm SD	Min	Max	
Age	26.64 ± 5.17	18	35	26.03 ± 5.22	18	35	0.661
29	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.

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

Nutrient intake	Case group		Control group		p-value
	Mean \pm SD	Min-Max	Mean \pm SD	Min-Max	
20					
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
Fiber (g)	12.05 ± 6.88	4.2–37.3	13.96 ± 10.28	4.3–46.7	0.311
Consumption	5.19 ± 3.66	0.69–15.66	2.98 ± 3.21	0–14.42	0.000
Frequency					

p-value: Mann-Whitney U-test.

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

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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Appendix

Table S1: Semi quantitative food frequency questionnaire

Food	Frequency (D = Daily, W = Weekly, M = Monthly, A = Annual, N = Never)					Portion Household System of Measurement	Average of Frequency per Day	Average of intake Gram/day
	D	W	M	A	N			
Noodle								
Snacks								
Cookies								
Hamburger								
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								

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