

ORIGINAL ARTICLE

High Seafood Intake During Pregnancy and Low Blood Pressure Among Coastal Pregnant Women in Indonesia

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ABSTRACT

Introduction: Hypertension in pregnancy is one of the greatest causes of maternal mortality in Jepara, a coastal area with great fish production. Seafood intake in pregnancy is considered has a beneficial effect on reducing blood pressure due to its EPA and DHA content. However, its consumption is also considered to increase blood pressure because of sodium content. This research is aimed to investigate the effect of seafood intake on blood pressure of pregnant women in coastal area in Jepara Indonesia. **Methods:** This research was a cross-sectional study was conducted among 105 of 175 pregnant women that had been living in coastal area in Jepara for at least a month during pregnancy. Each participant was interviewed about their seafood and other food intake during pregnancy. The blood pressure was examined using sphygmomanometer. Seafood intake was categorized as low to normal (≤ 12 ounces a week) and high (>12 ounces a week). Pregnant women who had smoking habit, hypertension history, and seafood allergy were excluded. **Results:** Most pregnant women in coastal area Jepara had high seafood intake which was more than 12 ounces or 340.2 grams a week. Normal blood pressure was found in 94 pregnant women (89.5%). High seafood intake shown a significant association on lowering blood pressure. ($p < 0.05$; Chi Square test). **Conclusion:** Seafood intake is associated to blood pressure levels in coastal pregnant women. Further research about nutrition content in seafood and recommendation seafood consumed by pregnant women is needed.

Keywords: Seafood intake, Hypertension, Pregnancy, Coastal area

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INTRODUCTION

World Health Organization (WHO) has set a real move to accomplish SDGs 3 “Ensure healthy life and promote wellbeing for all at all ages” in 2030 by reducing the maternal mortality rate to less than 70 per 100.000 live births (1). Hypertension is one of the greatest causes of maternal and fetal mortality in Indonesia, and it shows an increasing trend between 2010 and 2013 (2). Gestational hypertension is defined as systolic blood pressure of 140 mmHg or more or a diastolic blood pressure of 90 mmHg or more which occurs after 20 weeks during pregnancy (3). Hypertension in pregnancy also has negative impact on fetus, such as premature birth, low birth weight, and intrauterine growth retardation (IUGD) (4,5).

The high incidence of hypertension in pregnancy in Indonesia may be related by the dietary intake of the pregnant women, including seafood intake (6). Seafood intake in pregnancy has a beneficial on lowering blood pressure due to eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) content (7). The total omega-3 which is calculated by summing up linoleic acid, EPA, and DHA on fish is 35.19% on snapper, 30.78% on cob, 26.94% on mackerel, and 10.31% on white pomfret (8). EPA and DHA have several mechanisms on lowering blood pressure by reducing stroke volume and heart rate, improve left ventricular diastolic filling, and reduce peripheral resistance (7). Previous study had shown seafood intake reduced the risk of hypertension among pregnant women in Denmark (6). However, sodium is also found in fish which is associated to increase blood pressure. Other studies found that there were about 5.21 grams of sodium and 13.46 grams of salt in a salt-preserved fish (9). Pregnant women who constantly consume rich-

sodium food a day had a 1.6-fold increased risk of hypertension compared to pregnant women who didn't consume it regularly (10).

Based on Jepara Health Profile 2015, the prevalence of hypertension in Jepara was 57.7% and there were 3 out of 11 cases of maternal mortality due to hypertension in pregnancy (11). Jepara is a region with 72 km of coastal lines and had fishery production almost 6,991.6 ton in 2012 (9). With its great fishery production, Jepara residents including pregnant women may have local seafood as their frequently consumed food on daily basis. The seafood consumption has been reported had different effect on lowering or increasing the blood pressure of pregnant mother in different countries (6,10). However, the research of assessing the effect of seafood intake in pregnant women in coastal area Indonesia has not been conducted. Therefore, we investigated the effect of seafood intake on blood pressure of pregnant women in coastal area Jepara, Indonesia.

MATERIALS AND METHODS

Study location

This cross-sectional study was carried out during April and August 2019 in three places: (1) Kartini Regional Public Hospital, Jepara Indonesia, (2) Mlonggo Primary Healthcare, Jepara Indonesia, Central Java, (3) Kedung Primary Healthcare, Jepara Indonesia.

Subject of the study

The inclusions criteria of this study were pregnant women at second trimester gestation who had been living in coastal area in Jepara Indonesia for at least a month during pregnancy. The 175 pregnant women at aged 15 to 49 years old and 23 to 28 weeks' gestation were collected on this study. About 70 samples were excluded because of smokers, hypertension history, and seafood allergy. A total of 105 participants were assessed in this cross-sectional study.

Data collection

Seafood and other food intake were obtained using semi-quantitative food frequency questionnaire that consisted of the frequency during pregnancy and each serving in grams. For better visualizing the seafood intake, the participants were asked using fish mannequin that contained the average weight in 50 grams of each parts of the fish. Other food intake was asked based on household size commonly used in Indonesia and was converted into grams per day (12). Seafood intake was categorized based on Food and Drug Administration (FDA) recommendation as low to normal (≤ 12 ounces a week) and high (> 12 ounces a week), with the value of one ounce equals to 28.35 grams (13). Salt intake were divided into normal ($< 5,000$ mg/day) and high ($\geq 5,000$ mg/day) intake by WHO standard (14).

After being interviewed, the blood pressure of pregnant women was examined on their right arms using mercury sphygmomanometer. The participants were told to remain seated with feet supported for 2-3 minutes before blood pressure was examined. The cuff was inflated to 20 mmHg above the palpable systolic blood pressure, then the cuff deflated slowly. The diastolic blood pressure was recorded as Korotkoff phase V. Blood pressure was categorized based on American College of Obstetricians and Gynecologists (ACOG) classification as normal ($< 140/90$ mmHg) and hypertension ($\geq 140/90$ mmHg) (3). Association between maternal age, gravidity, pre-pregnancy weight, pre-pregnancy BMI, mid-upper arm circumference (MUAC), and salt intake on blood pressure of pregnant women was assessed.

Statistical analysis

Descriptive and hypothesis analysis were done in this study. Descriptive analysis was conducted to summarize the demographic, characteristics, and health status. Hypothesis analysis was done using Chi Square for assessing categorical variables and Mann-Whitney test for assessing numerical variables. Chi Square test was performed to analyze the association between seafood intake, maternal age, gravidity, and salt intake on blood pressure of pregnant women. Mann Whitney test was performed to compare differences between pre-pregnancy weight, pre-pregnancy BMI, and MUAC on blood pressure of pregnant women. The level of significant was set at $p < 0.05$.

Ethical considerations

This research was granted permission by Jepara Regional Government and Diponegoro University Semarang Indonesia. All participants have explained the aims of the study and secured written informed consent from participants prior to data collection. Ethical clearance was obtained from Health Research Ethics Committee Diponegoro University with the study reference number 71/EC/KEPK/FK UNDIP/III/2019.

RESULTS

Among the 175 pregnant women recruited for the study, 105 answered the questionnaire and underwent blood pressure examination using sphygmomanometer. Table I describes the characteristics of the 105 participants in this study. Characteristics are reported for the total sample and according to their blood pressure. Most of the participants were less than 35 years, junior high school graduates, third trimester pregnancy, had normal nutrition status shown by $MUAC \geq 23.5$ cm, had previous pregnancy and high salt intake. Seafood intake of pregnant women in coastal area Jepara was predominantly high (more than 340.2 grams a week). Meanwhile, 94 pregnant women had normal blood pressure, and the average blood pressure of all

Table I : Characteristics of the study population (n=105)

Characteristics	Blood pressure	
	Normal (n=94)	Hypertension (n=11)
	n (%)	n (%)
Age (years)		
≤ 35	80 (89.9)	9 (10.1)
> 35	14 (87.5)	2 (12.5)
Educational background		
Elementary school	13 (81.3)	3 (18.7)
Junior high school	42 (89.4)	5 (10.6)
Senior high school	33 (91.7)	3 (8.3)
College	6 (100.0)	0 (0.0)
Gravidity		
Primigravida	29 (87.9)	4 (12.1)
Multigravida	65 (90.3)	7 (9.7)
Gestational age		
Second trimester	34 (97.1)	1 (2.9)
Third trimester	60 (85.7)	10 (14.3)
MUAC (centimeter)		
< 23.5	18 (94.7)	1 (5.3)
≥ 23.5	76 (88.4)	10 (11.6)
Salt intake		
Normal (<5.000 mg/day)	11 (91.7)	1 (8.3)
High (≥5.000 mg/day)	83 (89.2)	10 (10.8)

MUAC, mid-upper arm circumference.

participants was 119/73 (90-160/50-120) mmHg.

Table II shows the association between characteristics of participants and their blood pressure. It was statistically analyzed using Chi Square test and Mann Whitney test. There was no significant association between characteristic variables on blood pressure of pregnant women.

FDA (Food and Drug Association) recommends seafood intake of pregnant women should be 8-12 ounces or equal to 226.8-340.2 grams a week. Majority of pregnant women in coastal area of Jepara had high seafood intake (Fig. 1), with the median value converted to grams was 390.0(23.3-2,300.0) grams a week.

Raised seafood intake lowered blood pressure of pregnant women in coastal area of Jepara Indonesia were described in Table III using mean (± SD) and median (minimal – maximal) . The data as shown in Table IV was analyzed using Chi Square and showed there was a statistically significant association between seafood intake and blood pressure (p value<0.05). Pregnant women who had low to normal seafood intake had 0.2 times greater risk to experience hypertension.

DISCUSSION

This study stated that seafood intake was associated with blood pressure of pregnant women in coastal area of Jepara, Indonesia. This result is concurrent with previous research that reported the similar finding seafood intake

Table II : The association between characteristics of the study population on blood pressure (n=105)

	Blood pressure				p-value
	Normal (n=94)		Hypertension (n=11)		
	Median (min-max)	n (%)	Median (min-max)	n (%)	
Age (years)					0.527 ^a
≤ 35		80 (89.9)		9 (10.1)	
> 35		14 (87.5)		2 (12.5)	
Gravidity					0.474 ^a
Primigravida		29 (87.9)		4 (12.1)	
Multigravida		65 (90.3)		7 (9.7)	
Pre-pregnancy weight	53.2 (30.0-110.0)		56.5 (40.0-83.0)		0.343 ^b
Pre-pregnancy BMI	22.8 (14.5-36.0)		24.1 (18.0-33.7)		0.303 ^b
MUAC	26.1 (20.0-38.0)		27.3 (21.0-34.0)		0.227 ^b
Salt intake					0.634 ^a
Normal (<5.000 mg/day)		11 (84.6)		1 (8.3)	
High (≥5.000 mg/day)		84 (89.4)		10 (10.8)	

BMI, body mass index; MUAC, mid-upper arm circumference.

^aChi-Square test

^bMann-Whitney test

Table III : The average blood pressure of pregnant women in coastal area of Jepara Indonesia (n=105)

	Blood pressure (mmHg)	
	Mean ± SD	Median (min-max)
Seafood intake		
Low to normal (≤ 12 ounces/week)	121/74±14.78/11.47	120/70(100-160/50-120)
High (> 12 ounces/week)	118/73±12.29/7.72	120/70(90-150/52-90)

Mean ± SD, mean ± standard deviation.

Table IV : Association between seafood intake on blood pressure of pregnant women in coastal area of Jepara, Indonesia (n=105)

	Blood pressure		p-value	OR	95% CI
	Normal	Hyper-tension			
	n (%)	n (%)			
Seafood intake			0.027*	0.222	0.055-0.894
Low to normal (≤12 ounces/week)	35 (81.4)	8 (18.6)			
High (>12 ounces/week)	59 (95.2)	3 (4.8)			
Total	94 (89.5)	11 (10.5)			

OR, odd ratio; 95% CI, 95% confidence interval.

*significance at level 0.05

and hypertension incidence of 18 years old participants in Malalayang Dua, Manado (15).

This study showed that raised seafood intake had statistically significant to reduce the blood pressure. This result was strengthened by the research held in Bristold, UK which stated that raised seafood and vegetable intake reduced the risk of hypertension in pregnancy (6). Omega-3 polyunsaturated fatty acids (n-3 PUFAs) is beneficial to human development and physiological function, such as maintaining blood pressure (7). The most commonly ingested n-3 PUFAs are alpha-linolenic acid (ALA), eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA), which EPA and DHA are easily obtained by consuming seafood (7). EPA and DHA has positive impact on lowering blood pressure by decreasing adrenal synthesis of aldosterone, suppress vasoconstrictor prostanoids, release nitric oxide, and increase HDL cholesterol (16).

Seafood intake also has negative impact on increasing blood pressure due to its sodium content in a salt-preserved seafood and type of food processing. A cohort study in Korea stated the participants who consumed high amount of salt-preserved seafood had a 28% greater risk to experience hypertension than those who didn't consume it regularly (17). An average sodium content of a salt-preserved seafood is approximately 5,210 mg, meanwhile the recommended sodium intake for pregnant women is less than 2,300 mg per day (18). Cardiac benefits of seafood intake may also depend on the type of seafood processing such as using frying oil (19). Fried seafood may increase omega-6/omega-3 ratio, as the higher intake of omega-6 may shift the human metabolic pathways of omega-3 and omega-6 fatty acid more towards the omega-6 products, which stimulates vasoconstriction and platelet aggregation then lead to elevate blood pressure (19). In this study, majority of participants didn't consume salt-preserved seafood, therefore sodium and salt content in seafood didn't result a significant correlation on blood pressure changes.

A variety of changes in cardiovascular system during pregnancy begins early in 8 week's gestation including increases in cardiac output caused by peripheral vasodilatation mediated by endothelium-dependent factors such as nitric oxide synthesis, which leads to decrease total peripheral resistance (20,21). Blood pressure decreases gradually in the first and second trimester, but increase to pre-pregnancy levels in the third trimester (20,21). However, poor dietary intake and other lifestyle factors have been hypothesized to influence cardiovascular adaptation during pregnancy, especially high intake of fat and saturated fatty acids due to their potential adverse effects on endothelial function (22,23). The vascular endothelium has important role on maintaining vascular homeostasis and blood pressure by producing vasodilators and vasoconstrictor substances

(24). Endothelial dysfunction may lead to changes in blood vessel morphology and adverse cardiovascular events (24). EPA and DHA contents in seafood can maintain the nitric oxide bioavailability which leads to beneficial effect on endothelial function (16).

Maternal age was not significantly associated with blood pressure of pregnant women in coastal area of Jepara, Indonesia. Adverse result was found in the previous study in Rotterdam which reported that older maternal age is associated with lower second and third trimester systolic blood pressure, but higher third trimester diastolic blood pressure (25). Previous study in Italy stated that pregnant women over 40 years old had higher risk of developing gestational hypertension and preeclampsia due to age-related dysfunction of the vascular endothelium, which leads to disability to cope with the physiologic hemodynamic changes of pregnancy (26). Differences in this study and the study in Rotterdam might be explained by the difference of study methods, the previous study categorized the maternal age into six groups of age range and the blood pressure was measured in each trimester. Also, differences in lifestyle related determinants between the Dutch and the Indonesian population may explain the difference in the observed association, such as alcohol intake and smoking habits. Alcohol intake may increase blood pressure by several mechanisms such as increasing sympathetic activity, cortisol, and stimulate endogenic vasoconstrictor, angiotensin II (27). Nicotine contained in cigarette acts as an adrenergic agonist, stimulating vasopressin and local and systemic catecholamine release to elevate arterial pressure (28).

Gravidity had no significant association with blood pressure of pregnant women in coastal area of Jepara, Indonesia. Studies focused on the association of gravidity and blood pressure of pregnant women are scarce, but several studies had been performed to identify the association between parity and hypertension in pregnancy in Indonesia. Previous research in Bukittinggi reported that there was no significant association between parity and severe pre-eclampsia (29). Meanwhile, the significant association was found in previous research in Manado regarding the association of parity and hypertension in pregnancy, stated that primigravida had more emotional stressor than multigravida, which leads to stimulate hypothalamus to release CRH and stimulate cortisol to elevate sympathetic effect such as increasing cardiac output to maintain blood pressure (30). Previous research in China showed that primigravida had higher risk to develop hypertension (31). Differences in this result and the study in Manado might be explained by the characteristic difference of participants, the majority of participants in previous study had hypertension history, and meanwhile pregnant women who had hypertension history were excluded in the present study. Also, difference in geographic area and lifestyle such as alcohol intake and smoking habits might influence the

different result of this study and the study in China. The previous study in China assumed that cold temperature in winter may stimulate vasoconstriction which leads to elevate blood pressure, but further research about the association between environmental temperature and blood pressure is needed (31).

Pre-pregnancy weight and BMI were not significantly associated with blood pressure of pregnant women in coastal area of Jepara, Indonesia. Previous research in Rotterdam reported that maternal overweight and obesity were strongly associated with the risk of gestational hypertensive disorders (32). Previous research in Lazou, China, stated that pre-pregnancy overweight and excessive weight gain during pregnancy (GWG) were associated with an increased risk of preeclampsia, and higher BMI is associated with a risk of pre-eclampsia due to the chronic inflammatory condition of overweight/obesity may lead to systemic inflammatory response, then increase neutrophils that release the toxic compounds which capable of attacking and destroying vascular endothelium cell integrity, which lead to clinical symptoms of pre-eclampsia (33). This adverse result might be because of the different lifestyle, majority of participants of the study in Rotterdam had alcohol intake (50.5%) and smoking habits (25.9%), meanwhile none of the participants of this study had alcohol intake and smoking habits.

MUAC has no significant correlation with blood pressure of pregnant women in coastal area of Jepara. The similar result was also found in previous research of 329 residents age 60 years and older in Taiwan (34). Meanwhile, adverse result was found in analytic observational study using Riskesdas 2013 data which stated that pregnant women with MUAC ≥ 30 cm had higher risk to incident hypertension than those with MUAC < 30 cm (10). Differences in this study and analytic observational study using Riskesdas 2013 data might be explained by the different classification of MUAC criteria.

Salt intake in pregnancy had no significant association with blood pressure of pregnant women in coastal area of Jepara. Previous study stated that restriction salt intake has beneficial to reduce blood pressure in adult (35). No previous literature was found about the association between salt intake and blood pressure of pregnant women. The result could be influenced due to majority of participants of this study were 35 years old or younger, had normal BMI, no hypertension history, and high seafood intake. Further research about the association between salt and blood pressure in pregnant women is needed.

This study had several limitations. First, There was minimum literature of local seafood nutrition content consumed by pregnant women in coastal area of Jepara, Indonesia. Second, the data obtained by interviewing

the participants might tend to be subjective, especially the amount of seafood or other food intake collected by food recalling. Third, ratio sample size between normal and hypertension group were not balance.

CONCLUSION

The seafood intake among pregnant women in coastal area of Jepara, Indonesia is at high level (55.71 (3.3-328.6) grams a day) and it is associated with lower blood pressure in pregnant women. Further research about local seafood nutrition content is needed to know the detail mechanism of seafood intake in lowering blood pressure, as well as to recommend the best seafood species to consume during the pregnancy.

ACKNOWLEDGEMENT

The authors would like to thank Diponegoro University, Jepara Regional Health Office, Kartini Regional Public Hospital, Mlonggo Primary Healthcare, and Kedung Primary Healthcare for their support and assistance throughout this study. This study was financially supported by Faculty of Medicine Diponegoro University, Research Grant No 588/UN7.5.4/HK/PP/2018 and Ministry of Research and Technology Republic of Indonesia, Research Grant No. 225-121/UN7.6.1/PP/2020.

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