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Association of body mass index pre-pregnancy with hypertension disorders of pregnancy in Bantul District Special Region of Yogyakarta

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Abstract

Purpose: This research was to identify the relationship between body mass index pre-pregnancy and the incidence of hypertension in pregnancy in Bantul District in 2020. **Methods:** This research used a retrospective cohort design based on secondary data from an online maternal cohort with SIPIA Bantul in the Bantul district in 2020. The effect size was calculated using Relative Risk (RR) from bivariate chi-square, multivariate binomial regression, and stratification by Mantel-Haenszel. The total sample of this research was 670 pregnant women. **Results:** Bivariate analysis results showed that there was body mass index pre-pregnancy (RR: 1.45; CI 95%: 1.220 – 1.730; p-value=0,00), mother age (RR: 1.47; CI 95%: 1.243 – 1.745; p-value=0,00), upper arm circumference (RR: 1.45; CI 95%; 1.194 – 1.761; p-value=0,001), and gestational weight gain (RR: 1,34; CI 95%: 1.123 – 1.598; p-value=0,002) have significant association with hypertension in pregnancy in Bantul District 2020. The multivariate analysis showed that body mass index pre-pregnancy and mother's age were the most significant variables with hypertension in Bantul District 2020. The stratification analysis showed that maternal age, upper arm circumference, gestational weight gain, and parity were not confounding. Still, there were modifying effects between body mass index pre-pregnancy and the incidence of hypertension in pregnancy in Bantul District in 2020. **Conclusion:** Pregnant women who are overweight and obese can increase the incidence of hypertension in pregnancy in Bantul District 2020. Collaboration with nutritionist workers needs to be done to reduce the incidence of hypertension in pregnancy in Bantul District.

Keywords: Bantul; body mass index; hypertension in pregnancy

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INTRODUCTION

Maternal mortality has become the second leading cause of reproductive women's death after HIV/AIDS. Maternal mortality is the female death from any cause related to or aggravated by the pregnancy or its management (excluding accidental or incidental causes) during pregnancy and childbirth or within 42 days of termination of pregnancy, irrespective of the duration and site of the pregnancy. The primary complications that account for 80% of all maternal mortality are severe bleeding, high blood pressure during pregnancy, infection, and unsafe abortion [1-3]. In Indonesia, hypertension in pregnancy is the second cause of maternal death after bleeding, with 1066 deaths from 4221 maternal deaths (25,3%) [4]. In 2020, Bantul District was the most significant contributor to maternal mortality in the Special Region of Yogyakarta, with a total of 20 maternal mortality, and 30% of them were caused by hypertension disorder in pregnancy/ Eclampsia/Preeclampsia/PEB. Globally, a high body mass index (obese) with high systolic blood pressure is

a significant risk factor for the incidence of death and disability in women [5]. Obesity, maternal age, nulliparity, history of preeclampsia, and multiple gestations are the main risk factors for the incidence of high blood pressure in pregnancy or preeclampsia [6].

Body mass index (BMI) is a related risk factor for hypertension in pregnancy, with CI 95% = 1,12 – 27,6 and OR = 5,5 [7]. Caroline et al.l in 2011 also said that body mass index is also related to a risk factor for hypertension in pregnancy with p-value < 0,001 and OR = 1,19 [8]. Raoudha Mhiri et al., in 2020, stated parity is a related risk factor for hypertension in pregnancy with a p-value = 0,03. The incidence of hypertension in pregnancy was 2,071 greater risk in pregnant women with nulliparas than multiparous/grande para with a p-value of 0,017 [9].

Getinet Ayele et al. (2016) stated that gravida has a significant relationship with the incidence of hypertension in pregnancy, with a p-value of 0,027 and OR = 4,66 [10]. Maereg Wagnew Meazaw, in 2020, also stated that gravida is a risk factor for hypertension in pregnancy with OR = 2,42 [11]. Elham Kazemian et al. in 2014 stated that there was a relationship between upper arm circumference and the incidence of hypertension in pregnancy with a p-value <0,001 and also stated that pregnant women with upper arm circumference >32 cm will experience an incidence of hypertension in pregnancy by 8,93 more remarkable than pregnant women with upper arm circumference ≤ 32 cm [12]. Raoudha Mhiri et al. in 2020 and Seema Das et al. in 2019 stated that maternal age has a significant relationship with the incidence of hypertension in pregnancy with p-values 0,03 and 0,005 [9]. Yawen Shao et al.l 2017 stated that pregnant women with excessive gestational weight gain have a 1,92 greater risk of developing hypertension in pregnancy than pregnant women with normal gestational weight gain [13]. This research aimed to identify the relationship between body mass index before pregnancy and the incidence of hypertension during pregnancy in Bantul District in 2020.

METHODS

The research used a retrospective cohort study design based on secondary data from an online maternal cohort with SIPIA Bantul in the Bantul district in 2020. The time of the study was carried out in July 2021. The inclusion criteria were pregnant women with gestational age ≥20 weeks who made antenatal care visits at the Bantul District Health Center and who had complete register records of weight during pregnancy, height, blood pressure, maternal age, parity, and upper arm circumference on online cohort data, namely SIPIA application in 2020. The exclusion criteria were pregnant women in the online cohort who had not filled in their weight in the first trimester, weight in ≥ 20 weeks or when high blood pressure, and upper arm circumference in the first trimester. The effect size was calculated using Relative Risk (RR) from bivariate by chi-square, multivariate by binomial regression, and stratification by Mantel-Haenszel. The total sample was 670 pregnant women based on inclusion and exclusion criteria.

RESULTS

The result of the univariate analysis of characteristic respondents can be seen in Table 1 and Table 2. The characteristics of respondents consisted of body mass index pre-pregnancy, mother age, parity, upper arm circumference, and gestational weight gain. Hypertension in pregnancy (blood pressure ≥ 140/90 mmHg) is more common in pregnant women with body mass index pre-pregnancy ≥ 25 (overweight and obese), namely 57,5%. Hypertension in pregnancy is more common in pregnant women with age < 35 years old 67,7%, pregnant women with upper arm circumference ≤ 32 cm 81,3%, and pregnant women with primiparity 45,6%. Hypertension in pregnancy in pregnant women underweight is common in pregnant women with gestational weight gain ≤ 18,1 kg, namely 87,5%, in normal-weight is more common in pregnant women with gestational weight gain ≤ 15,9 kg, namely 75,2%; in overweight are more common in the pregnant women with gestational weight gain ≤ 11,3 kg 60,0%, while in pregnant women with obese are more common in the pregnant women with gestational weight gain ≤9,1 kg namely 73,0%.

The result of the bivariate analysis of characteristic respondents with hypertension in pregnancy in Bantul District 2020 can be seen in Table 2. Bivariate analysis showed that body mass index pre-pregnancy was significantly associated with hypertension in Bantul District 2020 (RR: 1,45; CI 95%: 1,220 – 1,730; p-value: 0,00). Besides body mass index pre-pregnancy, mother age (RR: 1,47; CI 95%: 1,243 – 1,745; p-value: 0,00), upper arm circumference (RR: 1,45; CI 95%; 1,194 – 1,761; p-value: 0,001), and gestational weight gain (RR: 1,34; CI 95%; 1,123 – 1,598; p-value: 0,002) also have a significant association with hypertension in pregnancy in Bantul District 2020. The result of bivariate analysis

also showed that parity was no significant association with hypertension in pregnancy in Bantul District 2020, where the value of RR: 0,97; CI 95%: 0,819 – 1,155; p-value: 0,75.

Table 3 shows the results of the multivariate analysis of characteristic respondents with hypertension in pregnancy in Bantul District 2020. The multivariate analysis showed that body mass index pre-pregnancy and mother age were the most significant variables associated with hypertension in pregnancy in Bantul District 2020, with an RR, CI 95%, and p-values for body mass index 1,40, 1,178 – 1,661, and 0,00000 and mother age 1,41, 1,191 – 1,663, and 0,000.

Table 4 shows the stratification analysis results for the characteristics of respondents regarding body mass index and hypertension in pregnancy in Bantul District in 2020. The stratification analysis results showed that maternal age, upper arm circumference, gestational weight gain, and parity modified the effects of body mass index pre-pregnancy on the incidence of hypertension in pregnancy in Bantul District in 2020.

Table 1. The result of univariate analysis of characteristics of pregnant women with blood pressure

Variable	Category	TD ≥ 140/90 mmHg (HDK)		TD < 140/90 mmHg (No HDK)	
		n	%	n	%
Mother age (years old)	< 35	199	67,7	307	81,6
	≥ 35	95	32,3	69	18,4
Upper arm circumference (cm)	≤ 32	239	81,3	341	90,7
	> 32	55	18,7	35	9,3
	Parity				
	Primiparity	134	45,6	175	46,5
Parity	Paritas 0 (nulliparity), parity 2–3, and multiparity	160	54,4	201	53,5
BMI pre-pregnancy (kg/m^2)	< 25	125	42,5	222	59,0
	≥ 25	169	57,5	154	41,0
BMI pre-pregnancy category (kg/m^2)					
Underweight	≤ 18,1	7	87,5	29	90,6
	>18,1	1	12,5	3	9,4
Normal weight	≤ 15,9	88	75,2	163	85,8
	> 15,9	29	24,8	27	14,2
Overweight	≤ 11,3	57	60,0	63	71,6
	>11,3	38	40,0	25	28,4
Obese	≤ 9,1	54	73,0	47	71,2
	> 9,1	20	27,0	19	28,8
	Total	**294**	**100,0**	**376**	**100,0**

Table 2. The result of bivariate analysis between body mass index pre-pregnancy, mother age, gestational weight gain, upper arm circumference, and parity with hypertension in pregnancy

Variable	Blood pressure				RR	CI 95%	p - Value
	Hypertension		Not hypertension				
	n	%	n	%			
Body mass index (BMI)							
Risk	169	57,5	154	41,0	1,45	1,220 – 1,730	0,00
No risk	125	42,5	222	59,0			
Mother age							
Risk	95	32,3	69	18,4	1,47	1,243 – 1,745	0,00
No risk	199	67,7	307	81,6			
Upper arm circumference							
Risk	54	18,4	36	9,6	1,45	1,194– 1,761	0,001
No risk	240	81,6	340	90,4			
Gestational weight gain							
Risk	88	30,0	74	19,7	1,34	1,123 – 1,598	0,002
No risk	206	70,0	302	80,3			
Parity							
Risk	134	45,6	176	46,8	0,97	0,819 – 1,155	0,75
No risk	160	54,4	200	53,2			

Table 3. The result of multivariate analysis between body mass index pre-pregnancy, mother age, gestational weight gain, and upper arm circumference with hypertension in pregnancy

No	Variable	RR	CI 95%	p-Value	Standard Error	BIC
Model 1						
	Body mass index (BMI) pre-pregnancy	1.25	1,032 – 1,505	0,022	0,12	-3451,651
	mother age	1.42	1,209 - 1.669	0,000	0,12	
	Gestational weight gain	1.29	1,090 – 1,521	0,003	0,11	
	Upper arm circumference	1.22	1,006 – 1,484	0,044	0,12	
Model 2						
	Body mass index (BMI) pre-pregnancy	1,32	1,107 – 1,572	0,002	0,12	-3454,397
	mother age	1,44	1,220 – 1,694	0,000	0,12	
	Gestational weight gain	1,28	1,074 – 1,513	0,005	0,11	
Model 3						
	Body mass index (BMI) pre-pregnancy	1,40	1,178 – 1,661	0,000	0,12	-3453,899
	mother age	1,41	1,191 – 1,663	0,000	0,20	
Model 4						
	Body mass index (BMI) pre-pregnancy	1,33	1,102 – 1,601	0.003	0,13	-3450,261
	mother age	1,40	1,181 – 1,647	0,000	0,12	
	Upper arm circumference	1,20	0,977 – 1,474	0.082	0,13	
Model 5						
	Body mass index (BMI) pre-pregnancy	1,31	1,079 – 1,580	0,006	0,13	
	Gestational weight gain	1,25	1,055 – 1,493	0,010	0,11	-3442,524
	Upper arm circumference	1,26	1,028 – 1,550	0,026	0,13	
Model 6						
	Body mass index (BMI) pre-pregnancy	1,39	1,168 – 1,664	0,000	0,13	
	Gestational weight gain	1,23	1,033 – 1,472	0,020	0,11	-3444,693
Model 7						
	BBody mass index (BMI) pre-pregnancy	1,37	1,135 – 1,657	0,001	0,13	-3443,123
	Upper arm circumference	1,23	0,998 – 1,519	0,053	0,13	

Table 4. The result of stratification in upper arm circumference, gestational weight gain, mother age, and parity between body mass index pre-pregnancy and hypertension

Body mass index pre-pregnancy	Upper arm circumference > 32 cm			Upper arm circumference ≤ 32 cm		
	≥ 140/90 mmHg	< 140/90 mmHg	Total	≥ 140/90 mmHg	< 140/90 mmHg	Total
≥ 25	53	34	87	116	120	236
< 25	1	2	3	124	220	344
Total	54	36	90	240	340	580
Risk Ratio (RR)		1,83			1,36	
CI 95%		0,366 – 9,135			1,126 – 1,651	
p-Value		0,338			50,46	
p-Value			0,72			
RR Crude			1,45			
CI 95% Crude			1,220 – 1,730			
RR M-H combined			1,37			
CI 95% M-H combined			1,134 – 1,660			

Body mass index pre-pregnancy	Gestational weight gain (over)			Gestational weight gain (normal and less)		
	≥ 140/90 mmHg	<140/90 mmHg	Total	≥ 140/90 mmHg	< 140/90 mmHg	Total
≥ 25	58	44	102	111	110	221
< 25	30	30	60	95	192	287
Total	88	74	162	206	302	508
Risk Ratio (RR)		1,14			1,52	
CI 95%		0,839 – 1,542			1,230 – 1,873	
p-Value		0,40			0,0001	
p-Value			0,125			
RR Crude			1,45			
CI 95% Crude			1,220 – 1,730			
RR M-H combined			1,40			
CI 95% M-H combined			0,176 – 1,663			

Body mass index pre-pregnancy	Mother age ≥ 35			Mother age< 35		
	≥ 140/90 mmHg	<140/90 mmHg	Total	≥ 140/90 mmHg	< 140/90 mmHg	Total
≥ 25	55	33	88	114	121	235
< 25	40	36	76	85	186	271
Total	95	69	164	199	307	506
Risk Ratio (RR)		1,19			1,55	
CI 95%		0,909 – 1,552			1,241 – 1,927	
p-Value		21,46			0,0001	
p-Value			0,13			
RR Crude			1,45			
CI 95% Crude			1,220 – 1,730			
RR M-H combined			1,42			
CI 95% M-H combined			1,196 – 1,686			

Body mass index pre-pregnancy	Primiparity			Nulliparity, parity 2 – 3, and multiparity		
	≥ 140/90 mmHg	< 140/90 mmHg	Total	≥ 140/90 mmHg	< 140/90 mmHg	Total
≥ 25	86	76	162	83	78	161
< 25	48	100	148	77	122	199
Total	134	176	310	160	200	360
Risk Ratio (RR)		1,64			1,33	
CI 95%		1,245 – 2,153			1,058 – 1,677	
p-Value		0,0002			0,015	
p-Value			0,259			
RR Crude			1,45			
CI 95% Crude			1,220 – 1,730			
RR M-H combined			1,46			
CI 95% M-H combined			1,224 – 1,742			

DISCUSSION

Body mass index pre-pregnancy, maternal age, upper arm circumference, and gestational weight gain are variables that have a relationship and risk to the incidence of hypertension in pregnancy in Bantul District 2020. High body mass index is a nutritional problem related to the presence of an excess of fat deposits in the body. It can be a risk factor for various types of diseases, including hypertension in pregnancy. The upper arm circumference of pregnant women is related to the nutrition of pregnant women; the size of the upper arm circumference of pregnant women > 32 cm is included in the obesity category. Gestational weight gain is also related to the nutrition of pregnant women, where pregnant women with gestational weight gain that exceeds the recommendation according to their body mass index status will be at risk for the incidence of hypertension in pregnancy.

Being overweight and obese can increase the risk of maternal and fetal morbidity and mortality, including increasing the risk of hypertension in pregnancy. People who are obese will work harder to burn excess calories in their bodies; burning these calories will require an oxygen supply in the blood. The more calories burned, the more oxygen supply in the blood. More blood supply will make the heart work harder, affecting the increasing blood pressure [14].

Maternal age is one of the risk factors for hypertension in pregnancy because maternal age is associated with an increase or decrease in the function of the organs of the human body, which can affect human health. Pregnant women with an age that tends to be too old can affect the condition of the mother's blood pressure, which increases during pregnancy and is related to the absorption of the body of pregnant women and will tend to deteriorate. Some of their reproductive organs have degenerated so that hypertension complications can occur in pregnancy [15].

Maternal age is one of the risk factors for hypertension in pregnancy because the aging of uterine blood vessels and increased arterial stiffness leads to gradual loss of compliance of the cardiovascular vessels, causing endothelial dysfunction (a characteristic of pre-eclampsia). The function of the organs will decrease, where there is a degenerative process that will cause structural and functional changes in peripheral blood vessels responsible for changes in blood pressure [16].

The multivariate analysis showed that after controlling for another variable, body mass index before pregnancy and the mother's age were the most significant variables associated with hypertension in pregnancy in Bantul District in 2020. The stratification analysis showed that maternal age, upper arm circum-

ference, gestational weight gain, and parity were modifying effects, not confounding factors, between body mass index before pregnancy and hypertension in Bantul District in 2020. The results of this study are indeed expected to have implications for the Bantul District Government, which needs to collaborate with nutritionist workers to reduce the incidence of hypertension in pregnancy in the Bantul District.

CONCLUSION

There was an association between body mass index pre-pregnancy, mother age, upper arm circumference, gestational weight gain, and hypertension in pregnancy. Body mass index and maternal were the most significant variables of hypertension in pregnancy. Mother age, upper arm circumference, gestational weight gain, and parity were modifying factors, not confounding factors, between body mass index pre-pregnancy and incidence of hypertension in pregnancy in Bantul District in 2020.

Based on this study, collaborations needed to be done to reduce the incidence of hypertension in pregnancy in the Bantul District. In addition, further research is required on matters related to the incidence of hypertension in pregnancy that have not been studied, family history of hypertension, a pregnant woman's diet, knowledge of pregnant women related to hypertension in pregnancy, and other factors.

REFERENCES

1. World Health Organization. Trends in maternal mortality 2000 to 2017: estimates by WHO, UNICEF, UNFPA, World Bank Group, and the United Nations Population Division.World Health Organization. 2019.
2. World Health Organization. World health statistics 2019: monitoring health for The SDGs. World Health Organization. 2019.
3. World Health Organization. Hypertension. WHO. 2019.https://www.who.int/news-room/fact-sheets/detail/hypertension
4. Kementerian Kesehatan Republik Indonesia. Profil Kesehatan Indonesia Tahun 2018. Jakarta: Kementerian Kesehatan Republik Indonesia. 2019.
5. Savitri AI, Zuithoff P, Browne JL, et al. Does pre-pregnancy BMI determine blood pressure during pregnancy? A prospective cohort study. BMJ Open 2016;6:E011626. doi:10.1136/bmjopen-2016011626.
6. Uzan J, Carbonnel M, Piconne O, Asmar R, Ayoubi JM. Pre-eclampsia: pathophysiology, diagnosis, and management. Vascular Health and Risk Management. 2011;7:467-74. doi: 10.2147/VHRM.S20181
7. Kahsay HB, Gashe FE, Ayele WM. Risk factors for hypertensive disorders of pregnancy among mothers in Tigray region, Ethiopia: matched case-control study. BMC Pregnancy Childbirth. 2018;18(1):482. doi: 10.1186/s12884-018-2106-5
8. Dalmáz CA, Santos KG, Botton MR, Roisenberg I. Risk factors for hypertensive disorders of pregnancy in southern Brazil. Revista da Associação Médica Brasileira. 2011;57(6):692-6. doi: 10.1590/s0104-42302011000600018
9. Mhiri R, Mvogo A, Kamga A, Yassinguezo S, Fagla H, Kallel H, et al. Epidemiology and maternal prognosis of hypertension disorders of pregnancy in French Guiana. Pregnancy Hypertension. 2020;20:96-101. doi: 10.1016/j.preghy.2020.03.010.
10. Ayele G, Lemma S, Agedew E. Factors associated with hypertension during pregnancy in Derashie Woreda South Ethiopia Case-Control. Quality in Primary Care. 2016;24 (5): 207-213.
11. Meazaw MW, Chojenta C, Muluneh MD, Loxton D. Factors associated with hypertensive disorders of pregnancy in sub-Saharan Africa: A systematic and meta-analysis. PLOS ONE. 2020. doi: 10.1371/journal.pone.0237476.
12. Kazemian E, Sotoudeh G, Dorosty-Motlagh AR, Eshraghian MR, Bagheri M. Maternal obesity and energy intake as risk factors of pregnancy-induced hypertension among Iranian women Journal of Health, Population, and Nutrition. 2014;32(3):486-493.
13. Shao Y, Qiu J, Huang H, Mao B, Dai W, Zhang Y, et al. Pre-pregnancy BMI, gestational weight gain and risk of preeclampsia: a birth cohort study in Lanzhou, China. BMC Pregnancy and Childbirth. 2017;17:400. doi: 10.1186/s12884-017-1567-2.
14. Fitriani dan Syahruni. The Effect of pre-pregnancy body mass index (BMI) with the incidence of hypertension in pregnancy. Muhammadiyah Jurnal of Epidemiology. 2021;1(1):73-80.
15. Yurianti R, Umar MY, Wardhani PK, Kameliawati F. Hubungan umur dan paritas ibu dengan kejadian hipertensi pada ibu hamil di Puskesmas Rajabasa Indah. Jurnal Ilmu Kesehatan Indonesia (JIKSI). 2020;1(2):1–7.
16. Das S, Das R, Bajracharya R, Baral G, Jabegu B, Odland M, et al. Incidence and risk factors of

pre-eclampsia in the paropakar maternity and women's hospital, Nepal: A retrospective study. International Journal of Environmental Research and Public Health. 2019;16(19), 1–8. doi: 10.3390/ijerph1619357