An analysis of Mean Arterial Pressure, Roll Over Test and Body Mass Index as Predictors of Hypertension in Pregnancy

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Abstract

Background: Hypertension in pregnancy is one of the three causes of maternal mortality in Indonesia, which proportion increases every year. More than 25% of maternal deaths in Indonesia in 2017 were caused by hypertension in pregnancy (Profil Kesehatan Indonesia, 2018).

Purpose: The purpose of this study was to determine the relationship between MAP, ROT, and BMI on hypertension in pregnancy and to find predictor models of hypertension in pregnancy.

Method: This research was conducted at Kedungadem Public Health Center, Bojonegoro Regency with a cross sectional study method. The sampling technique used purposive sampling with subjects consisting of 100 samples (50 normal tension and 50 hypertension). Data analysis used Chi Square, Logistic Binary Regression and Area Under Curve.

Results: The results showed that a history of preeclampsia (OR 10.29; 95% CI 2.21–47.9), MAP (OR 3.38; 95% CI 2.36 4.84), ROT (OR 19.94; 95% CI5.47) -72.71), excess BMI (OR4.06; 95% CI 1.58-10.44), BMI of obesity (OR 4.8; 95% CI 1.26-18.24), were significantly associated with hypertension at 27 weeks of age. The main predictors of hypertension at 27 weeks were positive MAP (AUC 0.874; 95% CI 0.832-0.966; p = 0.000) and for predictors at 32 weeks, positive ROT at 27 weeks, 28 weeks and 32 weeks (AUC 0.851; 95% CI 0.914-0.993; p = 0.000).

Conclusion: The history of preeclampsia, MAP and BMI were able to predict at 27 weeks of gestation and ROT was able to predict at 32 weeks of age.

Keywords: *MAP, ROT, BMI, hypertension in pregnancy.*

Introduction

The daily maternal mortality rate is still very high, around 830 women around the world die from pregnancy and childbirth, the causes are preventable. There are 99% of maternal deaths occur in developing countries. Maternal Mortality Rate (MMR) is an indicator to assess or measure success in terms of maternal health efforts. In 2017 MMR in Indonesia reached 305 maternal deaths per 100,000 live births, this figure is still very high when compared to the 2030 SDG target of 70 maternal deaths per 100,000 live births. Maternal mortality in Indonesia is still dominated by three main causes of death, namely bleeding, hypertension in pregnancy, and infection. However, bleeding and infection tended to decrease, meanwhile, the proportion of hypertension in pregnancy was increasing. More than 25% of maternal deaths in Indonesia in 2013 were caused by hypertension in pregnancy.[1]

Study stated that second trimester pregnant in hospital of Australian described that women had a Mean Arterial Pressure (MAP) value ≥ 90 mm Hg, indicating that the possibility ratio of preeclampsia was 3 times higher. Measurements using the MAP method

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should be measured at 13-20 weeks of gestation.[2] in her research explained that the combination of Body Mass Index (BMI), MAP and Roll Over Test (ROT) is believed to be 90% affected by preeclampsia if they have two or more positive signs and from 85% who are positive by measuring BMI, MAP and the ROT after further observation was found to be 90% proven to be preeclampsia.

Early detection can be done by calculating Mean Arterial Pressure (MAP), Roll Over Test (ROT) and Body Mass Index (BMI).

Based on the description above, the authors are interested in analyzing Mean Arterial Pressure, Roll Over Test, and Body Mass Index as Predictors of Hypertension in Pregnancy (Study in the working area of Kedungadem Public Health Center, Bojonegoro Regency).

Material and Method

This study used a cross sectional and a prospective cohort approach. This study aims to analyze the Mean Arterial Pressure, Roll Over Test, and Body Mass Index, as predictor factors of hypertension in pregnancy in the working area of Kedungadem Public Health Center, Bojonegoro Regency. Research time is the length of time that taken by researchers to obtain the research data.[3] This research started from January 2020. The research place is the place used during data collection during the case. This research was conducted in the area of Kedungadem Public Health Center, Bojonegoro Regency. The population is the whole subject under study.[4] The population in this study were all mothers with gestational age more than 20 weeks who experienced hypertension in pregnancy and normal tension who visited the ANC at Kedungadem Public Health Center, Bojonegoro Regency. Furthermore, the sample consists of a part of the affordable population that can be used as research subjects through sampling. And sampling is the process of selecting a portion of the population that can represent the existing population.[5] The data sample of this study were 50 samples of normal pregnant women and case groups, as well as 50 samples of pregnant women with hypertension in pregnancy, so that the total sample was 100 samples. Data collection was carried out through two procedures, namely administrative procedures and technical procedures. The editing or checking the data that has been collected to check the completeness or correctness of the data by checking whether the respondent filled out all the interview sheets. The editing was conducted on Wednesday, February 1, 2020. The coding is changing data from the form of sentences or checklists into numerical or numeric data. The coding was conducted on Wednesday 1st February 2020. Tabulating (compiling data) is organizing data so that it is easily added and arranged to be presented and analyzed.[6] Tabulating uses the Microsoft Excel application program to perform univariate analysis with the percentage formula then processed using SPSS 16 for windows. It was conducted on Wednesday, February 1, 2020. Analysis was carried out on all data. The data obtained is analyzed and described in a frequency distribution table which produces data in the form of frequency numbers or percentage numbers.[7] Regency work area in February, July 2019. The population in this study were all pregnant women with preeclampsia who came to do an examination in an independent midwife practice area in Jombang Regency in February, March 2019 with 168 pregnant women. The sampling technique in this study was total sampling. The research instrument used a questionnaire with the value of Cronbach's Alpha 0.862. For data collection, the questionnaire form is ready.[8] After determining the appropriate patient exclusion criteria, and who agrees to participate study and sign an informed agreement form, information collected and filled in the form. That data entered in a specific database, using SPSS 16 statistical program. Data analysis is conducted by regression analysis at the 5% significance level. The research population is pregnant women with preeclampsia.

Result

Table 1. The relationship between sample characteristics, sample obstetric history and hypertension in pregnancy

Variable	Normal tension		Hypertension in pregnancy		p value	OR (95% CI)
	n	(%)	n	(%)		
Status of work						
Have a job	23	46,9	26	53,1	0,689	0,786 (0,358-1,725)
Jobless	27	52,9	24	47,1		
Education						
High	30	52,6	27	47,4	0,686	1,278
Low	20	46,5	23	53,5		(0,578-2,825)
Age						
Low risk	41	51,2	39	48,8	0,803	1,285
High risk	9	45	11	55		(0,496-3,127)
Income						
≥ 2,7 million	39	51,3	37	48,7	0,815	1,246
< 2,7 million	11	45,8	13	54,2		(0,496-3,127)
Wife's salary						
≥ 2,7 Million	8	36,4	14	63,6	0,227	0,490
< 2,7 Million	42	53,8	36	46,2		(0,185-1,300)
Husband's Salary						
≥ 2,7 Million	32	49,2	33	50,8	1	0,916
< 2,7 Milion	18	51,4	17	48,6		(0,403-2,084)
Hystory of PE						
None	42	50,6	41	43,4	0,026	1,667 (1,278-17,879)
available	3	17,6	14	82,4		
History of abortion						
None	34	43	45	57	0,604	0,836
available	11	52.,4	10	47,6		(0,513-1,362)
Parity						
Primi	17	47,2	19	52,8	0,900	1,066
Multi	28	43,8	36	56,3		(0,731-1,554)

Cont... Table 1. The relationship between sample characteristics, sample obstetric history and hypertension in

Pregnancy interval						
≥ 24 months	34	40,5	50	59,5	0,070	0,525
< 24 months	11	68,8	5	31,3		(0,249-1,109)

Source: Primary Data, 2020

The table describe shows that the status of work, education, age, household income, wife's salary, and husband's salary does not show any significant differences between the group of mothers with normal tension and the group of mothers with hypertension. shows that the history of abortion, parity and pregnancy interval did not show any significant differences in the two groups, but pregnant women with a history of PE / E will have a 10 times higher risk of developing hypertension than pregnant women who do not have a history of PE / E (95% CI 2.209-47,901).

Table 2. The relationship between Mean Arterial Pressure (MAP), Roll Over Test (ROT), Body Mass Index (BMI) and hypertension at 27 and 32 weeks of gestation.

Variable	**Normal tension**		**Hypertension in pregnancy**		**p value**	**OR (95% CI)**	
	n	**(%)**	**n**	**(%)**			
MAP at 27 weeks of gestation							
Negative	20	69	9	31		2,088	
Positifve	25	35,2	46	64,8	0,004	(1,182-3,688)	
MAP at 28 weeks of gestation							
Negative	16	76,2	5	23,8	0,003	2,658	
MAP at 32 weeks of gestation							
Negative	14	100	0	0	0,001	0,360	
Positive	31	36	55	64		(0,272-0,478)	
ROT at 27 weeks of gestation							
Negative	40	58	29	42		1,996	
Positive	5	16,1	26	83,9	0,001	(1,182-3,688)	
ROT at 28 weeks of gestation							
Negative	39	72,2	15	27,8	0,001	3,130	
Positive	6	13	40	87		(2,007-4,882)	
ROT at 32 weeks of gestation							

Cont... **Table 2. The relationship between Mean Arterial Pressure (MAP), Roll Over Test (ROT), Body Mass Index (BMI) and hypertension at 27 and 32 weeks of gestation.**

Negative	44	72,1	17	27,9	0,001	98,353	
Positive	1	2,6	38	97,4		(12,498-773,965)	
ROT at 27 weeks of gestation							
Negative	40	58	29	42		1,996	
Positive	5	16,1	26	83,9	0,001	(1,182-3,688)	
ROT at 28 weeks of gestation							
Negative	39	72,2	15	27,8	0,001	3,130	
Positive	6	13	40	87		(2,007-4,882)	
ROT at 32 weeks of gestation							
Negative	44	72,1	17	27,9	0,001	98,353	
Positive	1	2,6	38	97,4		(12,498-773,965)	
Chi-square							

The table describe shows that MAP at 27 weeks' gestation has a significant relationship with hypertension in pregnancy with p value <0.05. Pregnant women with a positive MAP value were 3 times more likely to have hypertension. Pregnant women with a positive MAP at 27 weeks 'gestation (RR = 2.088) and a positive MAP at 28 weeks' gestation (RR = 2.658) were more likely to experience hypertension at gestational age 32 week. ROT at 27 weeks of gestation has a significant relationship with hypertension in pregnancy with p value <0.05. Pregnant women with a positive ROT value had a 20 times greater chance of developing hypertension. Pregnant women with positive ROT at 32 weeks of gestation had a greater chance of experiencing hypertension in pregnancy (OR = 98.353) compared with positive ROT at 27 weeks of gestation (RR = 1,996) and ROT positive at 28 weeks' gestation (RR = 3,130). BMI at 27 weeks' gestation has a significant relationship with hypertension in pregnancy with p value <0.05. Obesity at 28 weeks of gestation tends to have hypertension by 8 times compared to pregnant women with normal BMI and pregnant women at 32 weeks of gestation with obesity have 4 times the chance of experiencing hypertension than pregnant women with normal BMI.

Table 3. The results of multivariate logistic regression analysis between wife's salary, history of PE / E, pregnancy interval, MAP at 27 weeks 'gestation, MAP at 28 weeks' gestation, MAP at 32 weeks 'gestation, ROT at 27 weeks' gestation, ROT at gestational age 28 weeks, ROT at 32 weeks gestation, BMI at 27 weeks gestation, BMI at 28 weeks gestation, and BMI at 32 weeks gestation, with the occurrence of hypertension at 32 weeks gestation

Variable	P value	OR	95% CI	
			Minimum	Maksimum
Wife's salary	0,672	0,457	0,012	17,096
History of PE/E	0,483	2,690	0,169	42,763
pregnancy interval	0,218	0,114	0,004	3,624
MAP at 27 weeks of gestation	0,997	0,002	0,057	36,857

Cont... **Table 3. The results of multivariate logistic regression analysis between wife's salary, history of PE / E, pregnancy interval, MAP at 27 weeks 'gestation, MAP at 28 weeks' gestation, MAP at 32 weeks 'gestation, ROT at 27 weeks' gestation, ROT at gestational age 28 weeks, ROT at 32 weeks gestation, BMI at 27 weeks gestation, BMI at 28 weeks gestation, and BMI at 32 weeks gestation, with the occurrence of hypertension at 32 weeks gestation**

MAP at 28 weeks of gestation	0,997	3,216	0,062	15,773
MAP at 32 weeks of gestation	0,998	6,311	0,120	20,213
ROT at 27 weeks of gestation	0,066	43,850	0,779	2,470
ROT at 28 weeks of gestation	0,225	6,057	0,329	111,439
ROT at 32 weeks of gestation	0,996	2,953	0,014	1,912
27 weeks of gestation with excess body weight	0,934	1,267	0,005	332.772
27 weeks of gestation with obesity	0,339	0,140	0,002	7,893
28 weeks of gestation with excess body weight	0,999	0,007	0,002	1,827
28 weeks of gestation with obesity	0,999	13,155	0,090	2,997
32 weeks of gestation with excess body weight	1,000	1,236	0,009	2,266
32 weeks of gestation with obesity	0,999	4,145	0,020	543,782
Binary logistic				

From the results of the analysis in the table above, it can be seen that the largest p value is the BMI variable at 32 weeks of gestation, so that in the next modeling, the BMI variable at 32 weeks of gestation is removed from the model.

Table 4. The results of multivariate logistic regression analysis between wife's salary, history of PE / E, pregnancy interval, ROT at 27 weeks of gestation, ROT at 28 weeks of gestation, ROT at 32 weeks of gestation, BMI at 27 weeks of gestation, and BMI at gestational age 28 weeks, with the occurance of hypertension at 32 weeks' gestation

Variable	P value	OR	95% CI	
			Minimum	Maksimum
Wife's salary	0,825	0,725	0,042	12,471
History of PE/E	0,332	3,653	0,267	49,956

Cont... **Table 4. The results of multivariate logistic regression analysis between wife's salary, history of PE / E, pregnancy interval, ROT at 27 weeks of gestation, ROT at 28 weeks of gestation, ROT at 32 weeks of gestation, BMI at 27 weeks of gestation, and BMI at gestational age 28 weeks, with the occurance of hypertension at 32 weeks' gestation**

pregnancy interval	0,259	0,210	0,014	3,151
MAP at 27 weeks of gestation	0,588	0,527	0,052	5,370
ROT at 27 weeks of gestation	0,037	9,693	1,148	81,839
ROT at 28 weeks of gestation	0,032	16,072	1,266	204,009
ROT at 32 weeks of gestation	0,002	64,260	10,616	943,950
27 weeks of gestation with excess body weight	0,476	0,197	0,002	17,076
27 weeks of gestation with obesity	0,218	0,152	0,008	3,057
28 weeks of gestation with excess body weight	0,978	1,081	0,004	303,956
28 weeks of gestation with obesity	0,085	24,717	0,645	947,226
Binary logistic				

From the results of the analysis in the table above, it can be seen that the largest p value is the wife's salary variable, so that in the next modeling the wife's salary variable is excluded from the model. This model has an AUC value of 0.970 (95% CI 0.935-1.005) with a p value of 0.000.

Discussion

Characteristics of the research sample: Based on table 5.2. In the table of characteristics of pregnant women, the variables of work status, education, age of household income, history of abortion, gravida, and pregnancy interval do not show any significant differences between the two groups, In the table on the characteristics of pregnant women, the variables of work status, education, age of household income, history of abortion, gravida, and pregnancy distance do not show any significant differences between the two groups, this is in accordance with the study. [14] which in His research also explained that age, education and parity did not significantly influence both mothers with normal tension and hypertension. Based on the research that has been done, the researcher concludes that the sample in this study is homogeneous because there is no difference in the proportion of hypertension based on characteristics.

The Relationship of Obstetric History with Hypertension in Pregnancy:A history of PE / E is a major risk factor where in this study there was a significant difference between the two groups which could lead to a 10 times greater likelihood of developing hypertension, this is in line with what was done by where the risk of developing hypertension in pregnancy increased 3 times higher in pregnant women who have a history of PE / E.[15] Based on the research that has been conducted, the researchers concluded that although the

history of abortion, parity, and pregnancy spacing has no effect or relationship to the incidence of hypertension in pregnancy, if pregnant women have a history of preeclampsia / eclampsia, it is likely that the mother will experience the same condition in the next pregnancy.

The Relationship between Mean Arterial Pressure and hypertension in pregnancy: The results showed that positive MAP (> 90 mmHg) was significantly different in the normal tension group with the hypertension group at 27 weeks and 32 weeks of gestation. The chance of pregnant women with positive MAP to suffer from hypertension at 27 weeks' gestation was 3,381 times (95% CI: 2,361 - 4,841) compared to negative MAP. The chance of developing hypertension at 32 weeks' gestation on positive MAP at 27 weeks of gestation was 2.088 (95% CI: 1.182 - 3.688), positive MAP at 28 weeks of gestation was 2.658 (95% CI: 1.215 - 5.818) and positive MAP at 32 weeks of gestation was 0.360 (95% CI: 0.272) - 0.478). In line with the findings in the 2nd trimester with MAP ≥ 90 mm Hg indicates 4 times higher in the probability of developing hypertension in pregnancy.[16] ROT was significantly different in the normal tension group with the hypertension group in pregnancy. A positive ROT at 27 weeks had 20 times the risk of developing hypertension compared with the negative ROT group. At 32 weeks of gestation the risk of hypertension increases in pregnant women with positive ROT at 27 weeks of gestation by 2 times, positive ROT at2 weeks of gestation by 2 times and the greatest risk if ROT at 32 weeks of gestation is positive by 98 times compared to pregnant women with negative ROT. In this study, the ROT variable is strongly related to the incidence of hypertension in pregnancy. It is in line with (Walia MD et al., 2015) that women who have a positive ROT at 28-32 weeks of gestation have a 2.2 times greater risk of developing preeclampsia.

The Relationship between body mass index (BMI) and hypertension in pregnancy: Body mass index was significantly different in the normal tension group with the hypertension group in pregnancy. At 27 weeks of gestation, BMI with excess body weight had 4 times higher in the risk of developing hypertension compared to the normal BMI group and BMI with obesity had 5 times higher in the risk of developing hypertension compared to the normal BMI group. At 32 weeks 'gestation, the risk of developing hypertension increases in pregnant women at 28 weeks' gestation with BMI of obesity by 8 times. The obesity at 32 weeks of gestation has a four times chance of causing hypertension in pregnancy. This is in line with research conducted by that pregnant women with the overweight category have 2 times higher in the risk of experiencing hypertension in pregnancy and BMI in the Obesity category will experience 3 times higher in the risk of hypertension, the greater the BMI of pregnant women, the greater also the possibility of developing hypertension.[18]

Analysis of MAP, ROT, and BMI, as predictor factors of hypertension in pregnancy: From the **results** of the multivariable analysis of hypertension at 27 weeks' gestation, 3 models were obtained, namely Model 1 consisting of MAP and BMI, Model 2 consisting of a history of PE / E and BMI, well calibrated and having a strong interpretation value (83.5%), it is lower than model 1 and higher than model 2 with a sensitivity of 72%, specificity of 96%, a positive predictive value of 87.5% and a negative predictive value of 57.1%. The comparison test did not show any difference in AUC values> 15%, which means that each model has the same level of interpretation of hypertension in pregnancy. Models 1 and 2 can be implemented in all health care facilities for pregnant women. From all the models, only model 3 has an easy level of efficacy, by simply calculating the BMI value from body weight and height and knowing the existence of a history of PE / E in a previous pregnancy. Besides its simplicity, model 3 still has a good interpretation value.[17] In addition to the predictors of hypertension at 27 weeks 'gestation, the results of the study also found one final model as a predictor of hypertension at 32 weeks' gestation. Model 1 is the relationship between ROT at 27 weeks of gestation, ROT at 28 weeks of gestation and ROT at 32 weeks of gestation as predictors of hypertension at 32 weeks' gestation. Model 1 is well calibrated and has a good interpretation value (85.1%) with a sensitivity of 83.6%, a specificity of 93.3%, a positive predictive value of 93.9% and a negative predictive value of 82.4%.[19] This model can be implemented in all health care facilities for pregnant women. Model 1 has an easy level of practicality, namely by only assessing the difference

in diastolic pressure between oblique and supine lying, although it is easy to do, this model still has a good interpretation value.[20]

Conclusions

The conclusion of this study is that MAP, ROT, and BMI are predictor factors of hypertension in pregnancy. Based on the research results obtained, the following suggestions are given:

1. For maternal and child health service facilities.

To prevent the occurrence of preeclampsia and eclampsia, early prevention, especially in high-risk groups, aims to identify the possibility of hypertension in pregnant women since the beginning of pregnancy, so early detection is needed.

2. For next researchers

The next researchers can carry out a better research design, with a larger sample with a more expanded research location.

Ethical Clearance : The original protocol for this study proposal has received approval from STIKes Insan Cendekia Medika Jombang Ethics Committee with ethical number 012/KEPK/ICME/I/2019

Source of Funding : This study is self-funded research project.

Conflict of Interest : None

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