

## Path Analysis on the Determinants of Severe Preeclampsia in Surakarta, Central Java

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### ABSTRACT

**Background:** Preeclampsia is a major cause of maternal morbidity and mortality that occurs at gestational age >20 weeks. It is characterized by hypertension and proteinuria. Shortly, severe preeclampsia may develop into eclampsia accompanied by seizures or coma. This study aimed to examine the determinants of severe preeclampsia in Surakarta, Central Java.

**Subjects and Method:** This was a case control study conducted in Gajahan health center, Dr. Moewardi hospital, and Surakarta hospital, Surakarta, Central Java, from October 2018 to December 2018. A sample of 200 pregnant women was selected by fixed disease sampling. The dependent variable was severe preeclampsia. The independent variables were age, education, stress, parity, history of hypertension, history of diabetes mellitus (DM), ANC visit, and family history of hypertension. Data on preeclampsia were obtained from medical record. The other data were collected by questionnaire. The data were analyzed by path analysis.

**Results:** Severe preeclampsia was directly and positively associated with age <20 or ≥35 years (b= 1.23; 95% CI= 0.31 to 2.14; p= 0.008), history of hypertension (b= 1.54; 95% CI= 0.58 to 2.51; p= 0.002), history of DM (b= 1.12; 95% CI= 0.21 to 2.03; p= 0.016), and stress (b= 1.58; 95% CI = 0.60 to 2.56; p = 0.002). It was negatively associated with parity (b= -0.96; 95% CI= -1.90 to -0.01; p = 0.046) and ANC visit (b= -1.98; 95% CI= -2.91 to -1.05; p<0.001). Severe preeclampsia was indirectly associated with education, ANC visit, and family history of hypertension.

**Conclusion:** Severe preeclampsia is directly and positively associated with age, history of hypertension, history of DM, and stress. It is negatively associated with parity and ANC visit. Severe preeclampsia is indirectly associated with education, ANC visit, and family history of hypertension.

**Keywords:** severe preeclampsia, determinants, path analysis

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### BACKGROUND

The Maternal Mortality Rate (MMR) in Indonesia is still very high. The 2015 Inter-censal Population Survey (SUPAS) showed that the Maternal Mortality Rate (MMR) in Indonesia was 305 per 100,000 live births. The target to be achieved by the SDGs (Sustainable Development Goals) is less than 70 maternal deaths per 100,000 live births globally in 2030, the figure is still high, while the AKI in Central Java Pro-

vince in 2017 is 88.58 per 100,000 live births or 475 cases. The maternal Mortality Rate (MMR) in Surakarta in 2017 amounted to 71 cases (14.95%) (Republic of Indonesia Ministry of Health, 2017; Central Java Provincial Health Office, 2018).

Preeclampsia is one of the main causes of maternal and perinatal morbidity and mortality worldwide which affects 2 to 8% of all pregnancies. Causes of preeclampsia include age, education, parity, ANC visits, family history of hypertension,

history of hypertension, history of diabetes mellitus, and stress (Jeyabalan, 2013; Grum et al., 2017; Moon and Odibo, 2014; Quan et al., 2018; Tessema et al., 2015; Ramesh et al., 2014; Yu et al., 2013).

Preeclampsia in Indonesia is the second leading cause of maternal death after bleeding, whereas in Central Java the incidence of preeclampsia is the first cause of maternal death. The incidence of preeclampsia in Indonesia in 2013 was 27.1%, while preeclampsia in Central Java Province in 2017 amounted to 32.97% (Republic of Indonesia Ministry of Health, 2014; Central Java Provincial Health Office, 2018). Based on the results of the preliminary study that has been carried out at Dr Moewardi hospital, Surakarta on April 2, 2018 through secondary data from medical records, the results showed that the number of occurrences of preeclampsia in Dr. Moewardi hospital in 2016 was 248 patients while in 2017, there were 282 patients.

Preeclampsia is diagnosed when pregnant women experience hypertension and urine protein after 20 weeks of pregnancy. The main predisposing theory of preeclampsia is abnormal placental implantation, resulting in adverse uterine and placental perfusion resulting in hypoxic conditions, increased oxidative stress and the release of anti-angiogenic proteins into maternal plasma (Villa et al., 2017; Grum et al., 2017).

Pregnancy factors that influence the occurrence of preeclampsia include parity. Primiparous mothers have risk factors for preeclampsia 2-3 times greater compared to multiparous mothers. Preeclampsia in primiparous mothers has a significantly higher risk of hypertensive morbidity in subsequent pregnancies. Antenatal Care (ANC) visits affect preeclampsia because each ANC visit of a mother will get coun-

seling during pregnancy that can detect early preeclampsia (Bdolah et al., 2014; Grum et al., 2017).

Factors that influence the occurrence of preeclampsia associated with maternal health history include family history of hypertension, history of hypertension, and a history of diabetes mellitus. Based on research conducted by Grum et al. (2017), it is found that mothers with a family history of hypertension also affected preeclampsia with a risk opportunity 7 times greater than women who did not have a history of hypertension. Research conducted by Quan et al. (2018) shows that maternal comorbidities such as hypertension, diabetes mellitus are high risk factors for preeclampsia. The incidence of preeclampsia among people with diabetes mellitus ranges from 10% to 20% (Gutaj et al., 2017).

Apart from the factors above, several studies show that age, education and stress also affect the occurrence of preeclampsia. The increase of maternal age is an important risk because the increase in villous reactions causes preeclampsia in mothers aged  $\geq 35$  years and is four times more likely to experience preeclampsia than mothers aged 25-29 years. Pregnant women  $< 20$  years old are also at risk of developing preeclampsia because of the incomplete maturation of the reproductive system (Tessema et al., 2015; Benli et al., 2014; Cohen et al., 2014). The level of education also affects the occurrence of preeclampsia. Education indirectly represents low socio-economic status and socio-economic determinants (Ramesh et al., 2014). Based on research conducted by Yu et al. (2013), it is found that mothers who experienced psychosocial stress had a 20 times higher risk of developing preeclampsia. The results of this study indicate the importance of prevention efforts to reduce psychosocial stress.

The determinants referred to in this study were age, education, parity, ANC visits, family history of hypertension, history of hypertension, history of diabetes mellitus, and stress. Based on this background and the high incidence of severe preeclampsia, the authors are interested in examining further factors that influence the incidence of severe preeclampsia.

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## SUBJECTS AND METHOD

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### 1. Study Design

This study is quantitative non-experimental one. The design was an observational analytic study with a case control approach comparison of 1: 3. The study was conducted at Gajahan community health center, Surakarta Hospital, and Dr. Moewardi hospital, Surakarta, Central Java, Indonesia, from October to December 2018.

### 2. Population and Samples

The target population of this study was all mothers with severe preeclampsia. A sample of 200 pregnant women was selected by fixed disease sampling.

### 3. Study Variables

The dependent variable was severe preeclampsia. The independent variables were age, education, parity, ANC visit, family history of hypertension, history of hypertension, history of diabetes mellitus, and stress.

### 4. Operational definition of variables

Severe preeclampsia was defined as an increase in blood pressure of at least 160 mmHg systolic or 110 mmHg diastolic with urine protein 5 to 10 g/L in 24 hours or  $\geq +2$  proteins with a dipstick. The data collection was carried out using medical record. The measuring scale for women who did not experience severe preeclampsia is 0 and 1 for mothers who had severe preeclampsia.

Age is how long the mother is alive with a life span calculated from birth until data collection is done. The data collection

was done with a questionnaire. The measuring scale of 0 is for mothers aged 20-34 years and 1 is for mothers aged  $\geq 35$  years.

Education was defined as the highest formal school level achieved by mothers starting from elementary, junior high school, senior high school and college. The data were obtained using questionnaires. The measuring scale of 0 is for mothers with education <senior high school education and 1 is for mother with education  $\geq$  senior high school.

Parity means a mother with a number of children born both alive and dead. The data collection was conducted using questionnaire. The measurement scale was 0 for parity 1 and 1 for parity  $>1$ .

ANC visit was defined as mothers who have ANC examinations during pregnancy. The data collection was conducted using questionnaires. The measuring scale of 0 is for mothers who visited ANC  $<4$  times and 1 is for mothers who visited ANC  $\geq 4$  times.

Family history of hypertension means a mother with a history of hypertension from her father/biological mother, biological grandparents. The data collection is done by questionnaire. The measuring instrument used is a questionnaire. Measuring scale of 0 is for mothers who do not have a family history of hypertension and 1 is for mothers who have a family history of hypertension.

History of hypertension refers to mothers with a history of hypertension before pregnancy. The data collection was done using questionnaires. Measuring scale of 0 is for mothers who do not have a history of hypertension and 1 is for mothers who have a history of hypertension.

History of diabetes mellitus refers to mothers with a history of diabetes mellitus during pregnancy. The data collection was done using questionnaires. The measuring scale of 0 is for mothers who have no

history of diabetes mellitus and 1 is for mothers who have a history of diabetes mellitus.

Stress refers to a condition when mothers experience a negative emotional condition where a person experiences feelings of anxiety, irritability and overreacting to stressful situations. Data collection is done using questionnaires. The measuring scale of 0 is for low stress mothers and 1 is for high stress mothers.

### 5. Study Instrument

The data were collected by questionnaire. The validity tests were in the forms of content validity and face validity. The reliability testing in this study was carried out on 20 patients undergoing treatment at Surakarta City Hospital, both in the case population (10) and controls (10). Reliability testing was done by measuring variables using the SPSS 22 statistical program which can calculate total item correlations (200.20) and Cronbach alpha ( $\geq 0.70$ ).

### 6. Data Analysis

The data analysis was carried out using path analysis to determine the magnitude of the influence of determinants that influence, both direct or indirect ones. Path analysis steps in this study included model specifications, model identification, suitability of the model, parameter estimation and model specification.

### 7. Research Ethics

The research ethics include informed consent, anonymity, confidentiality and ethical clearance. The research ethics was obtained from Research Ethics Committee, Universitas Sebelas Maret, Surakarta, Central Java, with number 298.UN27.6.KEPK/2019.

## RESULTS

### 1. Univariate Analysis

Table 1 showed the univariate analysis. Table 1 showed that mothers who have low

education were 97 (48.5%), primiparous was 87 (43.5%). Mothers who visited ANC  $\geq 4$  times were 128 (64%). Mothers who did not have a family history of hypertension were 128 (64%). Mothers who did not have a history of hypertension were 97 mothers (48.5%). Mothers who did not have a history of diabetes mellitus were 120 mothers (60%). Low-stress mothers were 108 (54%).

**Table 1. Univariate Analysis**

Variables	n	%
<b>Severe Preeclampsia</b>		
Non-severe Preclampsia	150	75.0
Severe Preclampsia	50	25.0
<b>Age</b>		
20-34 years	127	63.5
<20 and $\geq 35$ years	73	36.5
<b>Education</b>		
Low	97	48.5
High	103	51.5
<b>Parity</b>		
1	87	43.5
>1	113	56.5
<b>ANC Visit</b>		
<4 times	72	36.0
$\geq 4$ times	128	64.0
<b>History of Hypertension</b>		
No	97	48.5
Yes	103	51.5
<b>History of Diabetes Mellitus</b>		
No	120	60.0
Yes	80	40.0
<b>Stress</b>		
Low	108	54.0
High	92	46.0

### 2. Bivariate Analysis

Table 2 showed the result of bivariate analysis. Table 2 showed that age  $< 20$  or  $\geq 35$  years (OR= 3.32; 95% CI=1.71 to 6.45;  $p < 0.001$ ), had family history of hypertension (OR= 2.44; 95% CI= 1.27 to 4.71;  $p = 0.010$ ), had history of hypertension (OR= 4.14; 95% CI= 2.00 to 8.54;  $p < 0.001$ ), had history of DM (OR= 5.44; 95% CI= 2.70 to 10.94;  $p < 0.001$ ), and high stress (OR= 7.53; 95% CI= 3.49 to 16.28;

p<0.001) increased the risk of severe preeclampsia.

**Table 2. The results of bivariate analysis**

Variables	Non-Severe Preeclampsia		Severe Preeclampsia		OR	95% CI	p
	n= 150	%	n=50	%			
<b>Age</b>						1.71 to 6.45	
20-34 years	106	83.5	21	16.5	3.32		<0.001
<20 or ≥35 years	44	60.3	29	39.7			
<b>Education</b>						0.09 to 0.42	<0.001
Low	59	60.8	38	39.2	0.20		
High	91	88.3	12	11.7			
<b>Parity</b>						0.08 to 0.36	<0.001
1	50	57.5	37	42.5	0.17		
>1	100	88.5	13	11.5			
<b>ANC</b>						0.04 to 0.19	<0.001
<4	34	47.2	38	52.8	0.09		
≥4	116	90.6	12	9.4			
<b>Family history of hypertension</b>							
No	104	81.3	24	18.8	2.44	1.27 to 4.71	0.010
Yes	46	63.9	26	36.1			
<b>History of hypertension</b>						2.00 to 8.54	<0.001
No	85	87.6	12	12.4	4.14		
Yes	65	63.1	38	36.9			
<b>History of DM</b>						2.70 to 10.94	<0.001
No	105	87.5	15	12.5	5.44		
Yes	45	56.3	35	43.8			
<b>Stress</b>						3.49 to 16.28	<0.001
Low	98	90.7	10	9.3	7.53		
High	52	56.5	40	43.5			

### 3. Path Analysis

Figure 1 depicted path model with estimation. Table 3 showed that there was a significant effect of parity, ANC, history of diabetes mellitus, history of hypertension, age, stress, education, and family history of hypertension. There was a relationship between severe preeclampsia and parity (b= -0.96; CI 95%= -1.90 to - 0.01; p= 0.046), ANC (b= - 1.98 ; CI 95%= -2.91 to - 1.05; p<0.001), history of DM (b= 1.12; CI 95%= 0.21 to 2.03; p= 0.016), history of

hypertension (b= 1.54 ; CI 95%= 0.58 to 2.51; p= 0.002), age (b= 1.23; CI 95%= 0.31 to 2.14; p= 0.008, stress (b= 1.58; CI 95%= 0.60 to 2.56; p= 0.002), ANC through DM (b= -1.29; CI 95%= -1.90 to - 0.68; p<0.001), education through ANC (b= 1.17; CI 95%= 0.56 to 1.77; p<0.001), family history of hypertension through history of hypertension (b= 0.60; CI 95%= 0.02 to 1.19 ; p= 0.042).

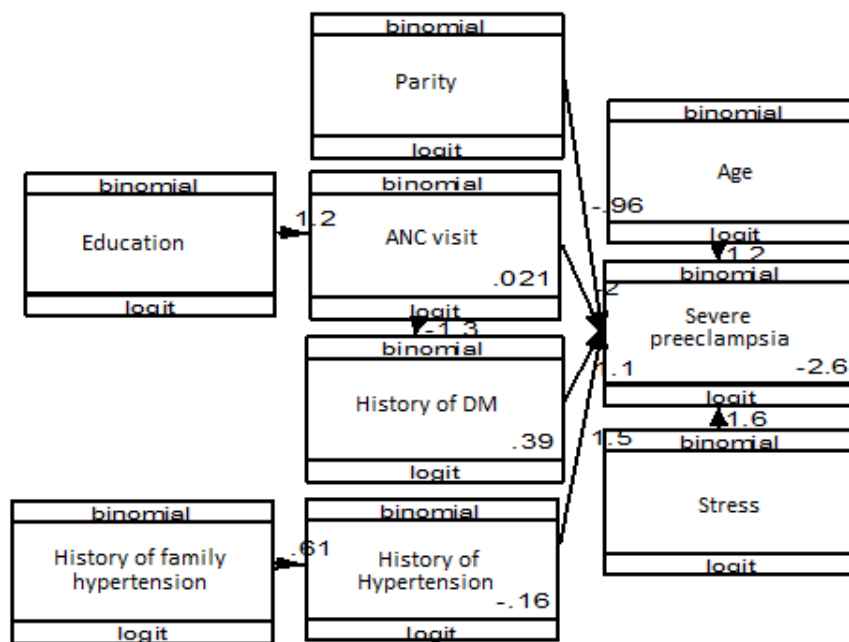


Figure 1. Path model with estimation

Table 3. The results of path analysis

Dependent Variable	Independent Variable	Path Coefficient (b)	95% CI		p
			Lower Limit	Upper Limit	
<b>Direct Effect</b>					
Severe Preeclampsia	← Parity	0.96	-1.90	-0.01	0.046
	← ANC	-1.98	-2.91	-1.05	<0.001
	← History of diabetes mellitus	1.12	0.21	2.03	0.016
	← History of hypertension	1.54	0.58	2.51	0.002
	← Age	1.23	0.31	2.14	0.008
	← Stress	1.58	0.60	2.56	0.002
	<b>Indirect Effect</b>				
History of diabetes mellitus	← ANC	-1.29	-1.90	-0.68	<0.001
ANC	← Education	1.17	0.56	1.77	<0.001
History of hypertension	← Family history of hypertension	0.60	0.02	1.19	0.042

**DISCUSSIONS**

**1. The relationship between age and severe preeclampsia**

The result of analysis showed that there was an effect of age on severe preeclampsia. This study showed that maternal age <20

or ≥35 years old were 1.23 times more likely to had severe preeclampsia.

This study was in line with a study by Morikawa et al., (2013) which showed that ≥35 years old mothers was the risk factor of severe preeclampsia. Maternal age ≥35 years would increase the risk of preeclampsia.

sia by 1.8 times. The result of a study done by Kumari et al., (2016) stated that there was a relationship between age and preeclampsia. Mothers aged <20 years old were at risk of developing preeclampsia. Failure of normal trophoblast cell invasion could lead to mal adaptation of spiral arterioles, this was related to the causes of preeclampsia.

### **2. The relationship between education and severe preeclampsia**

The result of analysis showed that there was an effect of education through ANC on the incidence of severe preeclampsia. Mother who had high education were 1.17 times more likely to conduct ANC visit.

This study was in line with a study by Muyunda et al., (2016) which showed that high maternal education level was a very significant and important factor in determining optimal use of ANC. The results of this study indicated that mothers who have a high level of education were more likely to have sufficient knowledge of ANC services and understand the importance of ANC and attend four recommended visits. Therefore, mothers who have higher education tend to use ANC services compared to mothers with low education. Maternal education has an indirect relationship with the incidence of severe preeclampsia, the higher the maternal education, the lower the risk of severe preeclampsia.

### **3. The relationship between parity and severe preeclampsia**

The result of analysis showed that there was an effect of parity on the incidence of severe preeclampsia. Primiparous mother were 0.96 more likely to had severe preeclampsia.

This study was in line with a study by Pogacnik et al., (2018) which stated that there was a relationship between parity and severe preeclampsia. Primigravida mothers

have 1.6 times higher risk than mothers with multigravida.

### **4. The relationship between ANC visit and severe preeclampsia**

The result of analysis showed that there was an effect of ANC visit on severe preeclampsia. This showed that mothers who conduct ANC visits for <4 times were 1.98 times more likely to have severe preeclampsia.

This study was in line with a study by Ghi et al., (2018) which stated that there was a relationship between ANC visit and preeclampsia. Mothers who visit ANC in inadequate number have 12 times higher risk which was significantly higher than mothers who conduct ANC visit in sufficient numbers.

### **5. The relationship between family history of hypertension and severe preeclampsia**

The result of analysis showed that there was an effect of family history of hypertension through history of hypertension on the incidence of severe preeclampsia. Mother with family history of hypertension were 0.60 time more likely to had history of hypertension.

This study was in accordance with a study by Ranasinghe et al., (2015) which stated that there was a relationship between family history of hypertension with a history of hypertension. The results of this study could be interpreted that family history of hypertension from parents would increase the risk to experience a history of hypertension in mothers by 1.28 times, while a family history of hypertension from grandparents would increase the risk to experience a history of hypertension in mothers by 1.34 times. Family history of hypertension has an indirect relationship with the incidence of severe preeclampsia, mothers who have a family

history of hypertension would have a higher risk to have severe preeclampsia.

### **6. The relationship between history of hypertension and severe preeclampsia**

The result of analysis showed that there was an effect of history of hypertension on the incidence of severe preeclampsia. Mother with history of hypertension was 1.54 times more likely to have severe preeclampsia.

This study was in line with a study by English et al., (2015) which stated that there was a significant relationship between history of hypertension and the incidence of preeclampsia. Mothers with history of hypertension were 1.38 times more likely to have severe preeclampsia.

### **7. The relationship between history of diabetes mellitus and severe preeclampsia**

The result of analysis showed that there was an effect of history of diabetes mellitus on the incidence of severe preeclampsia. Mother who with history of DM was 1.12 times more likely to had severe preeclampsia.

This study was in accordance with a study done by Weissgerber and Mudd (2016) which stated that there was a relationship between history of diabetes mellitus and the incidence of preeclampsia. Mothers with history of diabetes mellitus were 2-4 times more likely to have preeclampsia than mothers who did not have history of diabetes mellitus.

### **8. The relationship between stress and severe preeclampsia**

The result of analysis showed that there was an effect of stress on the incidence of severe preeclampsia. This showed that mothers who experienced severe stress were 1.58 times more likely to have severe preeclampsia.

This study was in line with a study done by Yu et al., (2013) which stated that there was a relationship between stress and the incidence of preeclampsia. Stress during pregnancy was a risk factor for the occurrence of preeclampsia in pregnancy up to 20 times. These findings underscore the importance of efforts to prevent, filter, and manage chronic hypertension, to reduce psychosocial stress, especially among women with chronic hypertension.

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