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Analysis of the Determinants of Preeclampsia in Samarinda City

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Abstract
Introduction: *Preeclampsia remains one of the leading causes of maternal morbidity and mortality worldwide and contributes substantially to adverse maternal and fetal outcomes.* ***Objective:*** *This study aimed to analyze determinants of preeclampsia among pregnant women in Samarinda City, Indonesia.* ***Method:*** *A quantitative analytical observational study with a retrospective case-control design was conducted using secondary maternal health data from 11 community health centers in Samarinda City during 2023-2024. The study included 246 respondents consisting of 82 cases of preeclampsia and 164 controls. Independent variables included maternal age, pre-pregnancy body mass index, parity, and pregnancy interval. Data were analyzed using univariate analysis, Chi-square tests for bivariate analysis, and binary logistic regression for multivariable analysis.* ***Result and Discussion:*** *Bivariate analysis showed that pre-pregnancy body mass index was significantly associated with preeclampsia, while maternal age, parity, and pregnancy interval were not statistically significant. Multivariable logistic regression demonstrated that pre-pregnancy body mass index was the strongest determinant of preeclampsia, with women who were overweight or obese before pregnancy having 3.621 times higher odds of developing preeclampsia than women with normal body mass index. Maternal age younger than 20 years or older than 35 years was also independently associated with an increased risk of preeclampsia, whereas parity and pregnancy interval were not significantly associated after adjustment. These findings show the importance of maternal nutritional status and reproductive age in the occurrence of preeclampsia.* ***Conclusions:*** *Pre-pregnancy body mass index was the most dominant determinant of preeclampsia among the variables examined, followed by maternal age, while parity and pregnancy interval were not significantly associated with preeclampsia among pregnant women in Samarinda City.*

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Introduction

Preeclampsia is a pregnancy complication characterized by hypertension occurring after 20 weeks of gestation accompanied by proteinuria or other organ dysfunctions (WHO, 2025). This condition remains one of the leading causes of maternal morbidity and mortality in many countries, including Indonesia. Preeclampsia contributes significantly to severe complications in both mothers and fetuses, such as eclampsia, hemorrhage, preterm birth, and maternal death (Chang *et al*., 2023; von Dadelszen *et al*., 2023). Globally, it is estimated that approximately 260,000 maternal deaths occurred in 2023, meaning that more than 700 women died every day due to pregnancy-related complications, including preeclampsia, which accounts for around 16% of maternal deaths worldwide. The highest burden of maternal mortality is found in low-and middle-income countries, accounting for approximately 92% of total maternal deaths globally.

In Indonesia, the maternal mortality rate remains relatively high at 189 per 100,000 live births based on the 2023 Indonesian Health Survey (Utomo *et al*., 2025; Wenang *et al*., 2024). Hypertension during pregnancy continues to be one of the major causes of maternal death alongside hemorrhage and infection. Preeclampsia is influenced not only by direct medical conditions but also by various maternal factors such as maternal age, nutritional status, parity, and pregnancy interval. Maternal age that is either too young or too advanced is known to increase the risk of pregnancy complications due to biological immaturity and decreased reproductive function. In addition, nutritional status, particularly overweight and obesity before pregnancy, has been associated with an increased risk of endothelial dysfunction and vascular disorders involved in the pathogenesis of preeclampsia (Abraham & Romani, 2022; Poniedziałek *et al*., 2023). Parity and pregnancy interval are also suspected to affect maternal physiological conditions during pregnancy, making these factors important to investigate further as a basis for early detection and prevention of pregnancy complications.

Samarinda City is one of the regions in East Kalimantan with relatively high coverage of antenatal care (ANC) services. Nevertheless, cases of preeclampsia are still reported in significant numbers each year. Preliminary data obtained from the Samarinda City Health Office recorded a total of 459 documented cases of preeclampsia or eclampsia during 2023-2024, consisting of 221 cases in 2023 and 238 cases in 2024. These cases represented the total population of available preeclampsia or eclampsia cases recorded in community health centers during the study period. These findings show that the high coverage of ANC services has not been fully effective in reducing the incidence of preeclampsia among pregnant women. The high prevalence of preeclampsia in Samarinda City may be influenced by various risk factors that have not been optimally identified in primary healthcare services. Therefore, research capable of identifying the determinants of preeclampsia more comprehensively is needed to strengthen prevention programs and pregnancy risk screening in healthcare facilities.

Several previous studies have investigated factors associated with the incidence of preeclampsia; however, the findings remain inconsistent. Aziz *et al*. (2022) reported that maternal age, body mass index, gravida, and parity were associated with the incidence of preeclampsia. Rakhmawati and Wulandari (2021) also found that pre-pregnancy nutritional status influenced the increased risk of preeclampsia among pregnant women. However, Kristanti and Suharto (2023) reported that not all maternal factors showed significant associations with the occurrence of preeclampsia. Most previous studies still used cross-sectional designs with limited sample sizes and did not simultaneously integrate factors such as maternal age, nutritional status, parity, and pregnancy interval.

Therefore, this study was conducted to analyze the determinants of preeclampsia among pregnant women in Samarinda City in 2025 using secondary healthcare data, with the expectation of providing a more representative overview and serving as a basis for strengthening preeclampsia risk screening in primary healthcare services.

Method

This study employed a quantitative analytical observational design using a retrospective case-control approach. The case-control design was selected because it is appropriate for identifying and analyzing factors associated with the occurrence of preeclampsia among pregnant women by comparing subjects who experienced the condition with those who did not. The study utilized secondary data obtained from maternal and child health service records maintained by community health centers in Samarinda City, East Kalimantan, Indonesia. Data were collected from routine maternal healthcare documentation and antenatal care (ANC) reports covering the period from January 2023 to December 2024. The retrospective approach enabled the researchers to assess exposure variables that had occurred before the diagnosis of preeclampsia. This design was considered efficient for evaluating multiple risk factors simultaneously and for identifying the most influential determinants associated with preeclampsia among pregnant women.

The study population consisted of all pregnant women recorded in the maternal health information system of community health centers in Samarinda City during 2023-2024. Based on records from the Samarinda City Health Office, there were 459 documented cases of preeclampsia or eclampsia during the study period, including 221 cases in 2023 and 238 cases in 2024. The study sample comprised two groups, namely the case group and the control group. The case group consisted of pregnant women diagnosed with preeclampsia, whereas the control group consisted of pregnant women who did not experience preeclampsia during pregnancy. The minimum sample size for the case group was determined using the Slovin formula with a margin of error of 10%. Based on a population of 459 cases, the calculation resulted in a minimum sample requirement of 82 respondents for the case group. A case-control ratio of 1:2 was applied to increase statistical power, resulting in 164 respondents in the control group and a total sample size of 246 respondents.

The sampling technique for the case group was fixed disease sampling, in which all selected respondents had a confirmed diagnosis of preeclampsia based on medical records. Meanwhile, the control group was selected using simple random sampling from pregnant women without a diagnosis of preeclampsia. To reduce potential selection bias, frequency matching was performed between case and control groups based on gestational age categories. Matching was conducted to ensure comparability between groups and to minimize the influence of gestational age as a potential confounding factor. Eligible participants were identified through maternal health records maintained by community health centers. Only records that fulfilled the predetermined inclusion criteria and contained complete information for all study variables were included in the final analysis.

The study was conducted in eleven community health centers representing several districts of Samarinda City, namely Harapan Baru, Palaran, Mangkupalas, Baqa, Samarinda Kota, Sidomulyo, Lempake, Sungai Siring, Sungai Kapih, Loa Bakung, and Temindung Community Health Centers. These health centers were selected because they routinely provide maternal healthcare services and maintain complete maternal health records required for this study. Samarinda City is the capital of East Kalimantan Province

and serves as an important referral area for maternal healthcare services. The selected health centers represent different geographical and administrative areas of the city, thereby improving the representativeness of the study sample. Data collection and management were conducted between August 2025 and April 2026. The study period included administrative preparation, data acquisition, data cleaning, statistical analysis, and report preparation.

The dependent variable in this study was the incidence of preeclampsia. Preeclampsia was defined as a condition characterized by blood pressure of at least 140/90 mmHg occurring after 20 weeks of gestation accompanied by proteinuria, as documented in medical records or antenatal care reports. The independent variables included maternal age, pre-pregnancy nutritional status based on Body Mass Index (BMI), parity, and pregnancy interval. Maternal age was classified as high-risk when the mother was younger than 20 years or older than 35 years and non-risk when aged 20-35 years. Nutritional status was assessed using pre-pregnancy BMI and categorized as normal (< 25 kg/m²) or overweight/obese (≥ 25 kg/m²). Parity was classified as high-risk when the mother had experienced more than five previous births and non-risk when she had one to four previous births. Pregnancy interval was categorized as risky when the interval between the last childbirth and the current pregnancy was ≤ 18 months or ≥60 months and non-risk when the interval ranged from 19 to 59 months.

Table 1
Operational Definitions of Study Variables

Variable	Operational Definition	Source of Data	Category
Preeclampsia	Blood pressure ≥ 140/90 mmHg after 20 weeks of gestation accompanied by proteinuria	Medical records and ANC reports	Yes (1), No (0)
Maternal age	Maternal age at the time of pregnancy	Medical records	High-risk (< 20 or > 35 years), Non-risk (20-35 years)
Pre-pregnancy BMI	Body Mass Index before pregnancy calculated from weight and height records	Maternal health records	Overweight/Obese (≥ 25 kg/m²), Normal (< 25 kg/m²)
Parity	Number of previous live births before current pregnancy	Obstetric records	High-risk (> 5 births), Non-risk (1-4 births)
Pregnancy interval	Interval between previous childbirth and current pregnancy	Obstetric records	Risky (≤ 18 months or ≥ 60 months), Non-risk (19-59 months)

Data were collected using a structured data extraction form developed specifically for this study. The extraction form was designed to systematically record all variables from medical records and maternal healthcare databases. Before analysis, all records underwent a screening process to ensure compliance with the inclusion and exclusion criteria. The inclusion criteria were pregnant women recorded in community health center medical records, gestational age above 20 weeks, and complete information for all study variables. Exclusion criteria included incomplete records, missing values for key variables, and duplicated entries. To maintain confidentiality, all personal identifiers were removed and replaced with numerical codes prior to data processing and statistical analysis.

Data analysis was performed using the Statistical Package for the Social Sciences (SPSS). Univariate analysis was conducted to describe the distribution of all study variables and was presented as frequencies and percentages. Bivariate analysis was performed using the Chi-square test to examine the association between each independent

variable and the incidence of preeclampsia. The magnitude of association was estimated using Odds Ratios (ORs) and 95% Confidence Intervals (95% CIs). Variables with a p-value less than 0.25 in the bivariate analysis, as well as variables considered epidemiologically relevant, were included in the multivariate model. Multivariate analysis was conducted using binary logistic regression with the backward likelihood ratio method to identify the most dominant determinants of preeclampsia. Statistical significance was determined at a p-value of less than 0.05, and adjusted Odds Ratios with 95% Confidence Intervals were reported for the final model.

This study adhered to ethical principles governing health research involving human data. Ethical approval was obtained from the Health Research Ethics Committee of STIKES Guna Bangsa Yogyakarta under approval number 022/KEPK/I/2026. Although the study used secondary data, confidentiality and privacy were strictly maintained throughout the research process. Personal identities contained in medical records were anonymized before data extraction and analysis. Data were used solely for research purposes and were accessible only to authorized researchers. The study was conducted in accordance with the principles of beneficence, confidentiality, anonymity, and responsible data management to ensure the protection of research participants and healthcare institutions involved in the study.

Result and Discussion

1. Result

A total of 246 respondents were included in the study, consisting of 82 pregnant women diagnosed with preeclampsia (case group) and 164 pregnant women without preeclampsia (control group). The distribution of maternal characteristics according to maternal age, parity, pregnancy interval, and pre-pregnancy body mass index (BMI) is presented in Table 2. Among all respondents, 93 women (37.8%) were categorized as having high-risk maternal age (< 20 years or > 35 years), while 153 women (62.2%) were aged 20-35 years. Most respondents had high-risk parity according to the study definition (> 5 deliveries), accounting for 151 women (61.4%). Regarding pregnancy interval, 134 women (54.5%) had a high-risk interval (< 18 months or ≥ 60 months). In terms of nutritional status, 135 respondents (54.9%) were classified as overweight/obese (BMI ≥ 25 kg/m²), while 111 respondents (45.1%) had a BMI below 25 kg/m².

Table 2

Distribution of Maternal Characteristics and Risk Factors for Preeclampsia in Samarinda City (2023-2024)

Risk Factors	Cases (n=82)		Controls (n=164)		Total (n=246)	
	n	%	n	%	n	%
Maternal Age						
High-risk (< 20 or > 35 years)	38	46.3	55	33.5	93	37.8
Non-risk (20-35 years)	44	53.7	109	66.5	153	62.2
Parity						
High-risk (> 5 deliveries)	48	58.5	103	62.8	151	61.4
Non-risk (1-4 deliveries)	34	41.5	61	37.2	95	38.6
Pregnancy Interval						
High-risk (< 18 months or ≥ 60 months)	50	61.0	84	51.2	134	54.5
Non-risk (18-59 months)	32	39.0	80	48.8	112	45.5
Pre-pregnancy BMI						
BMI ≥ 25 kg/m²	61	74.4	74	45.1	135	54.9
BMI < 25 kg/m²	21	25.6	90	54.9	111	45.1

Bivariate analysis was performed using the Chi-square test, and the magnitude of association was estimated using odds ratios (ORs) with 95% confidence intervals (95% CI). The results are presented in Table 3. Maternal age showed a borderline association with preeclampsia (OR=1.712; 95% CI=0.996-2.942; p=0.051). Although women with high-risk age had 1.7 times greater odds of developing preeclampsia than those aged 20-35 years, the association did not reach statistical significance because the p-value exceeded 0.05 and the confidence interval included values close to unity. Parity was not significantly associated with preeclampsia (OR=0.836; 95% CI=0.486-1.437; p=0.517). Similarly, pregnancy interval was not significantly associated with preeclampsia (OR=1.488; 95% CI=0.868-2.551; p=0.147), although women with a high-risk pregnancy interval tended to have higher odds of preeclampsia. In contrast, pre-pregnancy BMI demonstrated a statistically significant association with preeclampsia (OR=3.553; 95% CI=1.971-6.332; p=0.001), indicating that overweight or obese women had more than three times higher odds of developing preeclampsia compared with women with BMI < 25 kg/m².

Table 3
Bivariate Analysis of Risk Factors Associated with Preeclampsia in Samarinda City

Variables	Cases (n=82)		Controls (n=164)		p-value	OR	95% CI
	n	%	n	%			
Maternal Age							
High-risk (< 20 or > 35 years)	38	46.3	55	33.5	0.051	1.712	0.996-2.942
20-35 years	44	53.7	109	66.5			
Parity							
> 5 deliveries	48	58.5	103	62.8	0.517	0.836	0.486-1.437
1-4 deliveries	34	41.5	61	37.2			
Pregnancy Interval							
< 18 months or ≥ 60 months	50	61.0	84	51.2	0.147	1.488	0.868-2.551
18-59 months	32	39.0	80	48.8			
Pre-pregnancy BMI							
BMI ≥ 25 kg/m²	61	74.4	74	45.1	0.001	3.553	1.971-6.332
BMI < 25 kg/m²	21	25.6	90	54.9			

Variables with p-values < 0.25 in the bivariate analysis were entered into the multivariable logistic regression model using the backward likelihood ratio method. Parity was excluded from the final model because it did not meet the selection criterion. The final model included maternal age, pregnancy interval, and pre-pregnancy BMI. The results of the multivariable logistic regression analysis are shown in Table 4.

Table 4
Multivariable Logistic Regression of Risk Factors for Preeclampsia

Variables	B	S.E.	Wald	p-value	Adjusted OR (Exp(B))	95% CI
						Lower - Upper
Pre-pregnancy BMI (BMI ≥ 25 kg/m²)	1.287	0.302	18.115	<0.001	3.621	2.002-6.549
Maternal Age (< 20 or > 35 years)	0.599	0.293	4.178	0.041	1.820	1.025-3.232
Pregnancy Interval (< 18 months or ≥ 60 months)	0.528	0.292	3.279	0.070	1.696	0.957-3.005

The multivariable analysis showed that pre-pregnancy BMI was the strongest determinant of preeclampsia among the variables examined in this study. Women with BMI ≥ 25 kg/m² had 3.62 times greater odds of developing preeclampsia compared with women with BMI < 25 kg/m² (AOR=3.621; 95% CI=2.002-6.549; p<0.001). Maternal age was also independently associated with preeclampsia, as women aged < 20 years or > 35 years had 1.82 times higher odds of developing preeclampsia than those aged 20-35 years (AOR=1.820; 95% CI=1.025-3.232; p=0.041). In contrast, pregnancy interval was not significantly associated with preeclampsia after adjustment for other variables (AOR=1.696; 95% CI=0.957-3.005; p=0.070). Although the odds ratio suggested a tendency toward increased risk among women with high-risk pregnancy intervals, the confidence interval included 1 and the p-value exceeded 0.05, showing that the association was not statistically significant. Therefore, among the variables included in the final regression model, pre-pregnancy BMI emerged as the most influential determinant of preeclampsia, followed by maternal age, whereas pregnancy interval did not retain statistical significance after adjustment.

2. Discussion

The study identified pre-pregnancy Body Mass Index (BMI) as the strongest determinant associated with preeclampsia among the variables examined. Multivariable logistic regression analysis showed that women with a pre-pregnancy BMI of ≥ 25 kg/m² had 3.621 times higher odds of developing preeclampsia compared with women whose BMI was < 25 kg/m² (95% CI: 2.002-6.549; p < 0.001). This finding shows that excess body weight before pregnancy substantially increases the likelihood of preeclampsia and remains significant even after adjustment for maternal age and pregnancy interval. The result is consistent with previous studies reporting that overweight and obesity are important risk factors for hypertensive disorders during pregnancy. Rakhmawati and Wulandari (2021) similarly reported a significant relationship between maternal BMI and preeclampsia incidence. From a biological perspective, excessive adipose tissue contributes to chronic low-grade inflammation, oxidative stress, endothelial dysfunction, and metabolic disturbances that may impair placental development and vascular adaptation during pregnancy. These mechanisms increase susceptibility to abnormal placentation and hypertension, which are central features of preeclampsia.

The study also showed that maternal age was independently associated with preeclampsia in the final multivariable model. Pregnant women aged below 20 years or above 35 years had 1.820 times greater odds of developing preeclampsia compared with those aged 20-35 years (95% CI: 1.025-3.232; p=0.041). Although the association between maternal age and preeclampsia was not statistically significant in the bivariate

analysis (p=0.051), the effect became significant after adjustment for other variables in the multivariable model. This finding suggests that maternal age may act as an independent risk factor whose effect becomes more evident when potential confounding variables are considered. The result is in line with studies reporting that pregnancies occurring at extreme reproductive ages are associated with increased obstetric complications, including hypertensive disorders. Younger mothers may have biological immaturity and limited reproductive adaptation, whereas advanced maternal age is frequently associated with vascular changes, reduced endothelial function, and a higher prevalence of chronic medical conditions that may contribute to the development of preeclampsia.

In contrast, pregnancy interval was not significantly associated with preeclampsia after adjustment for other variables (AOR=1.696; 95% CI: 0.957-3.005; p=0.070). Although the odds ratio suggested a tendency toward increased risk among women with pregnancy intervals shorter than 18 months or longer than 59 months, the confidence interval included unity and therefore did not demonstrate statistical significance. These findings indicate that pregnancy interval alone may not be a strong predictor of preeclampsia in this study population. Nevertheless, the direction of the association remains consistent with previous literature suggesting that both short and long interpregnancy intervals may adversely affect maternal physiological adaptation. The absence of statistical significance may be related to sample size limitations, variability in maternal characteristics, or the influence of other unmeasured factors that were not included in the current model. In addition, the non-significant finding may also reflect a potential underpowered study for this specific exposure category, which may limit the ability to detect a modest but clinically relevant association. Misclassification bias in the measurement of pregnancy interval based on retrospective medical records may have occurred, particularly due to incomplete documentation or recall inaccuracies in obstetric history recording, which could have attenuated the observed association toward the null.

Parity was not associated with preeclampsia in either the bivariate or multivariable analyses. The odds ratio below one (OR=0.836; 95% CI: 0.486-1.437) suggests no meaningful association between parity and preeclampsia in this study population. Differences between the present findings and previous studies may be attributable to variations in parity classification, study design, sample characteristics, and population demographics. In addition, parity may interact with other maternal characteristics that were not measured in this study, thereby reducing its independent contribution to preeclampsia risk. Consequently, parity should be interpreted cautiously and not considered a protective factor solely based on the observed odds ratio, given the lack of statistical significance.

Several limitations should be considered when interpreting these findings. This study utilized secondary data from maternal health records, which restricted the availability of several clinically important variables. Factors known to influence preeclampsia risk, including chronic hypertension, diabetes mellitus, previous history of preeclampsia, family history of hypertension, educational level, socioeconomic status, and adequacy of antenatal care, were not available for analysis. Consequently, residual confounding may still exist and could affect the estimated associations. Therefore, the identification of BMI as the strongest determinant should be interpreted as the strongest determinant among the variables included in the present study rather than the strongest determinant of preeclampsia.

Conclusion

This study identified pre-pregnancy Body Mass Index (BMI) and maternal age as factors significantly associated with the incidence of preeclampsia among pregnant women in Samarinda City. Multivariable logistic regression analysis showed that women with a pre-pregnancy BMI $\geq$ 25 kg/m² had 3.621 times higher odds of developing preeclampsia, while women aged < 20 years or > 35 years had 1.820 times higher odds compared with their respective reference groups. Pregnancy interval and parity were not significantly associated with preeclampsia in this study. Among the variables examined, pre-pregnancy BMI emerged as the strongest determinant of preeclampsia. These findings show the importance of preconception nutritional management and early identification of pregnancies occurring at high-risk maternal ages as part of strategies to reduce the burden of preeclampsia. However, because several established risk factors such as chronic hypertension, diabetes mellitus, previous history of preeclampsia, and socioeconomic characteristics were not available in the dataset, further studies incorporating a broader range of maternal risk factors are recommended to provide a more comprehensive understanding of preeclampsia determinants.

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