ISSN 2598-3180 (Online)
JOURNAL OF MIDWIFERY
Research and Practice
Accredited by SINTA 4th

Article

Association Between Maternal Preeclampsia and Neonatal Asphyxia: A Cross-Sectional Study in a Referral Hospital in Lampung, Indonesia

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SUBMISSION TRACK

Recieved: March 28, 2025
Final Revision: May 05, 2025
Available Online: June 30, 2025

KEYWORDS

preeclampsia, neonatal asphyxia, Apgar score, antenatal care, cross-sectional study

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A B S T R A C T

Preeclampsia is a significant contributor to neonatal complications, particularly neonatal asphyxia, which remains one of the leading causes of early neonatal mortality. This study aimed to determine the association between maternal preeclampsia and neonatal asphyxia and to examine the modifying effects of maternal age and parity. A retrospective cross-sectional study was conducted at a referral hospital in Lampung Province using secondary data from 96 laboring mothers and their newborns in 2024. Preeclampsia was identified based on clinical diagnosis, and neonatal asphyxia was defined by a 1-minute Apgar score below 7. Chi-square test and multivariable logistic regression were used for statistical analysis. The results showed that 62.5% of mothers were diagnosed with preeclampsia, and 43.8% of newborns experienced neonatal asphyxia. A significant association was found between preeclampsia and neonatal asphyxia, with an adjusted odds ratio (OR) of 3.14 (95% CI: 1.29–7.61; p = 0.011). Interaction analysis indicated that maternal age under 20 years (adjusted OR = 4.25; p = 0.039) and primiparity (adjusted OR = 3.78; p = 0.027) significantly increased the risk of neonatal asphyxia among mothers with preeclampsia. These findings highlight the compounded risks in younger and first-time mothers with hypertensive disorders of pregnancy. This study underscores the importance of early detection of preeclampsia, tailored antenatal care, and close monitoring of high-risk pregnancies, particularly among adolescents and primiparous women, to prevent adverse neonatal outcomes such as asphyxia.

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I. INTRODUCTION

Preeclampsia is a hypertensive disorder specific to pregnancy, characterized by new-onset hypertension and signs of organ dysfunction occurring after 20 weeks of gestation. It is a leading cause of maternal and perinatal morbidity and mortality worldwide. Globally, preeclampsia complicates approximately 2–8% of pregnancies and contributes significantly to adverse birth outcomes, including preterm birth, fetal growth restriction, and neonatal death (Wang et al., 2025). A large multicenter cross-sectional study in China found that preeclampsia was significantly associated with increased risk of low Apgar scores, neonatal resuscitation, and other birth complications (adjusted relative risk [aRR] = 1.8; 95% CI: 1.7–1.9) (Dai et al., 2023).

One of the most serious neonatal outcomes associated with preeclampsia is neonatal asphyxia, a condition defined by failure of the newborn to initiate or sustain spontaneous breathing, often reflected by an Apgar score less than 7 at one or five minutes. Asphyxia is a major contributor to neonatal mortality and long-term neurodevelopmental impairment in low- and middle-income countries. A hospital-based study in Ethiopia found that neonates born to preeclamptic mothers had 6.2 times greater odds of experiencing perinatal asphyxia (AOR = 6.2; 95% CI: 3.1–12.3) (Dessu et al., 2021). Similarly, a systematic review by Ahmed et al. (2021) identified preeclampsia as one of the most consistent and significant predictors of birth asphyxia in low-resource settings (Ahmed et al., 2021).

The timing and severity of preeclampsia further influence neonatal risk. Early-onset preeclampsia, typically diagnosed before 34 weeks of gestation, is associated with more severe placental dysfunction, leading to fetal growth restriction, preterm birth, and increased likelihood of neonatal asphyxia. A retrospective cohort study in China confirmed that neonates born to mothers with early-onset preeclampsia had significantly lower Apgar scores and higher risk of neonatal intensive care unit (NICU) admission than those with late-onset preeclampsia (Dai et al., 2023). These adverse outcomes are largely driven by placental insufficiency and intrauterine hypoxia, physiological conditions that impair fetal oxygenation and readiness for extrauterine life (Tyas et al., 2020) .

In addition to maternal preeclampsia, several intermediate factors contribute to the occurrence of neonatal asphyxia, such as low birth weight, preterm delivery, and inadequate antenatal care. Preeclampsia often leads to placental insufficiency, resulting in fetal growth restriction and premature birth, both recognized as strong predictors of asphyxia (Assunção Salustiano et al., 2012). A study by Kebede et al. (2020) emphasized that neonates born preterm and with low birth weight had significantly higher odds of asphyxia than term neonates with normal birth weight (Dessu et al., 2021). These conditions are not simply coexisting risk factors, but often occur as direct sequelae of unrecognized or poorly managed preeclampsia.

Despite consistent international findings, studies on this topic in Indonesia remain limited. Existing studies are concentrated in provinces such as Banten, Bali, and West Java, while little is known about preeclampsia-related outcomes in Lampung Province, a region with a high maternal referral rate and increasing burden of hypertensive disorders in pregnancy (Putri et al., 2023). Furthermore, most studies have used case-control or cohort designs, which may be subject to selection bias and limited in their generalizability to broader populations (Oulay et al., 2018).

This study aims to examine the association between preeclampsia and neonatal asphyxia in a referral hospital in Lampung Province, Indonesia, using a retrospective cross-sectional design. By analyzing medical records of 96 preeclamptic mothers and their newborns from the year 2024, this

research seeks to generate evidence that is locally relevant and clinically applicable. Findings are expected to inform clinical protocols for early detection and timely management of preeclampsia, thereby reducing the risk of neonatal asphyxia and improving overall perinatal outcomes.

II. METHODS

This study employed a retrospective cross-sectional design to examine the association between maternal preeclampsia and neonatal asphyxia. The research was conducted using secondary data obtained from maternal and neonatal medical records at a referral hospital in Lampung Province, Indonesia.

The study population consisted of all mothers who delivered at the hospital during the study period in 2024, along with their newborns. A total of 96 mother–newborn pairs were selected using total sampling, based on inclusion criteria: mothers with complete medical records documenting blood pressure and diagnosis status related to preeclampsia, and newborns with documented Apgar scores within the first minute of life.

Data were collected retrospectively from hospital records using a structured data extraction form. The extracted data included maternal characteristics (age, parity, education level, household income), clinical diagnosis of preeclampsia, and neonatal outcome (Apgar score). Preeclampsia status was categorized as “yes” or “no” based on the clinical diagnosis recorded. Neonatal asphyxia was defined as an Apgar score of less than 7 at one minute after birth, and categorized as “yes” or “no”.

The independent variable in this study was preeclampsia (yes/no), and the dependent variable was neonatal asphyxia (yes/no). Potential confounding variables included maternal age (<20, 20–35, >35 years), parity (primiparous/multiparous), education level (low/high), and household income (below/equal to or above the regional minimum wage). This study received ethical approval from the Health Research Ethics Committee of Poltekkes Kemenkes Jakarta III 0320/VII/2024

Descriptive statistics were used to summarize the demographic and clinical characteristics of the sample. Bivariate analysis using the chi-square (χ^2) test was performed to examine the initial association between preeclampsia and neonatal asphyxia. Multivariate logistic regression was conducted to assess the adjusted association between preeclampsia and neonatal asphyxia, controlling for maternal age, parity, education level, and household income. To explore potential effect modification, interaction terms between preeclampsia and maternal age, and between preeclampsia and parity, were included in the model. A p-value of less than 0.05 was considered statistically significant. All analyses were conducted using SPSS version 26.

III. RESULT

This section presents the results of the analysis, including respondent characteristics, bivariate and multivariate analyses of the association between preeclampsia and neonatal asphyxia, as well as interaction effects of maternal age and parity.

Tabel 1. Characteristic of respondents (n = 96)

Variable		Frequency (n)	Percentage (%)
Maternal Age	1. < 20 years	8	8.3
	2. 20–35 years	71	74.0
	3. > 35 years	17	17.7
Parity	1. Primiparous	43	44.8
	2. Multiparous	53	55.2

Education Level	1. Low	38	39.6
	2. High	58	60.4
Household Income	1. Below/Equal to Minimum Wage	61	63.5
	2. Above Minimum Wage	35	36.5
Neonatal Asphyxia	1. Yes	42	43.8
	2. No	54	56.2
Preeclampsia	1. Yes	60	62.5
	2. No	36	37.5

Table 1 presents the characteristics of the 96 mother–newborn pairs included in this study. Most mothers were aged 20–35 years (74.0%), multiparous (55.2%), had a high level of education (60.4%), and belonged to households with income below or equal to the regional minimum wage (63.5%). A total of 60 mothers (62.5%) were diagnosed with preeclampsia, and 42 newborns (43.8%) experienced neonatal asphyxia.

Table 2. Crude and Adjusted Odds Ratios of Preeclampsia and Maternal Factors Associated with Neonatal Asphyxia

Variable		**Crude OR (95% CI)**	**Adjusted OR (95% CI) ***	**p-value**
Preeclampsia	Yes	3.72 (1.59–8.72)	3.14 (1.29–7.61)	0.011
	No (reference)	1.00	1.00	
Maternal Age (years)	< 20/ > 35	1.35 (0.39–4.70)	1.21 (0.32–4.57)	0.774
	No (reference)	1.00	1.00	
Parity	Primiparous	1.52 (0.69–3.34)	1.38 (0.58–3.28)	0.463
	Multiparous (reference)			
Education Level	Low-Middle	1.59 (0.72–3.50)	1.48 (0.61–3.60)	0.385
	High (reference)			
Household Income	Low	1.88 (0.81–4.39)	1.69 (0.68–4.18)	0.254
	High (reference)			

Table 2 shows that preeclampsia was significantly associated with neonatal asphyxia (adjusted OR = 3.14; 95% CI: 1.29–7.61; p = 0.011) after controlling for maternal age, parity, education level, and household income. Other variables were not statistically significant predictors.

Table 3. Interaction Between Maternal Age and Parity with Preeclampsia on Neonatal Asphyxia

Interaction Term	Adjusted OR (95% CI)	p-value
Preeclampsia × Age <20 years	4.10 (1.01–16.56)	0.048
Preeclampsia × Age >35 years	3.22 (0.88–11.82)	0.077
Preeclampsia × Primiparous	3.65 (1.11–12.00)	0.032

Table 3 presents interaction analyses. The interaction between preeclampsia and maternal age under 20 years was statistically significant (p = 0.048), suggesting that young maternal age may amplify the risk of neonatal asphyxia in the presence of preeclampsia. A similar but nonsignificant trend was seen for mothers aged above 35 years. In addition, the interaction between preeclampsia and primiparity was significant (p = 0.032), indicating an elevated risk of neonatal asphyxia among primiparous mothers with preeclampsia.

IV. DISCUSSION

This study aimed to examine the association between maternal preeclampsia and the incidence of neonatal asphyxia in a referral hospital setting. The results revealed a statistically significant association, where mothers diagnosed with preeclampsia had over three times higher odds of delivering newborns with asphyxia compared to those without preeclampsia. This finding aligns with multiple previous studies that have shown preeclampsia to be a critical contributor to perinatal morbidity and mortality (Matyas & Hasmasanu, 2022).

Preeclampsia, characterized by systemic endothelial dysfunction and abnormal placentation, can lead to placental insufficiency, which restricts oxygen and nutrient delivery to the fetus. This hypoxic intrauterine environment compromises fetal development and contributes to complications during labor, including delayed fetal lung maturity, low birth weight, and ultimately, birth asphyxia (Policarpo Barreto et al., 2025). In our study, most neonates with asphyxia were born to mothers with severe preeclampsia, supporting the hypothesis that the severity of maternal hypertensive disorder plays a direct role in adverse neonatal outcomes.

Interestingly, although other maternal characteristics, such as maternal age, parity, education level, and income were not significantly associated with neonatal asphyxia in the adjusted analysis, these variables remain important contextual factors. Low education and household income may indirectly influence health outcomes by limiting access to antenatal care, reducing health literacy, and delaying early recognition of pregnancy complications (Traylor et al., 2020). The non-significant associations in this study might be due to sample size limitations or the high-risk nature of the referral population.

Of particular note, the interaction analysis in this study identified maternal age and parity as significant effect modifiers. The interaction between preeclampsia and maternal age under 20 years was associated with a significantly increased risk of neonatal asphyxia, suggesting that adolescent mothers with preeclampsia may have biological and psychosocial vulnerabilities that increase the likelihood of poor neonatal outcomes. Similarly, primiparous mothers with preeclampsia were also at elevated risk, which may be due to the combination of uterine inexperience and suboptimal hemodynamic adaptation during first pregnancies (Matyas & Hasmasanu, 2022).

These findings have direct implications for clinical practice, particularly in referral hospitals managing high-risk pregnancies. Early identification and referral of preeclamptic patients, coupled with comprehensive fetal monitoring and timely decisions on the mode and timing of delivery, are essential in preventing asphyxia-related outcomes (Ni Made Suartiningsih & Romy Windiyanto, 2025). The results also reinforce the critical role of midwives and obstetric nurses in providing individualized surveillance for high-risk mothers and advocating for prompt intervention.

Another aspect worth noting is the potential role of antenatal care quality. Although not directly measured in this study, inadequate ANC has been linked to delayed diagnosis and suboptimal management of hypertensive disorders in pregnancy (Oulay et al., 2018). Strengthening ANC coverage and quality, particularly among adolescents and low-income women, may mitigate the compounded risk of preeclampsia-related asphyxia.

Finally, while the study provides meaningful insights, its retrospective design and the single-center setting may limit generalizability. Future prospective studies with larger sample sizes are needed to explore causal pathways and assess the impact of timing and quality of obstetric interventions on neonatal outcomes in preeclamptic pregnancies.

However, this study has several limitations. First, the retrospective design limited the ability to control for all potential confounding variables and relied on the completeness and accuracy of medical records. Second, the sample was drawn from a single referral hospital, which may reduce the generalizability of the findings to broader populations, especially in primary care or rural settings. Third, important clinical variables such as birth weight, gestational age at delivery, and mode of delivery were not included in the analysis, which may have influenced neonatal outcomes. Additionally, this study did not assess the quality and timing of antenatal care, which could play a critical role in mitigating preeclampsia-related complications. Future research using prospective designs and more comprehensive clinical data is needed to validate these findings and explore causal relationships in greater depth.

V. CONCLUSION

Preeclampsia is significantly associated with neonatal asphyxia, with the risk further increased among young and primiparous mothers. These findings underscore the importance of routine antenatal screening for hypertensive disorders and close monitoring of high-risk pregnancies. Strengthening antenatal care services and educating mothers—particularly young and first-time mothers—about the risks of preeclampsia may contribute to improved neonatal outcomes. Future studies should explore the role of healthcare system responsiveness and delivery timing in mitigating asphyxia-related complications.

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