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The Association Between Gestational Hypertension and the Incidence of Neonatal Asphyxia in Kalibaru

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Abstract

Maternal hypertension is one of the leading contributors to adverse neonatal outcomes, particularly neonatal asphyxia. However, evidence regarding this association in primary healthcare settings in Indonesia remains limited. This study aimed to analyze the relationship between gestational hypertension and the incidence of neonatal asphyxia in Kalibaru. A retrospective cross-sectional design was used involving 216 postpartum women selected through simple random sampling from a population of 469. Data were collected through medical record review and analyzed using the Chi-Square test with SPSS version 25. Results showed a highly significant association between gestational hypertension and neonatal asphyxia (p-value = 0.000; χ^2 = 210.699). All mothers with gestational hypertension (100%; n = 53) gave birth to neonates experiencing asphyxia, whereas only 0.6% (n = 1) of neonates from mothers without gestational hypertension developed asphyxia. Gestational hypertension impairs uteroplacental perfusion through vasospasm, endothelial dysfunction, oxidative stress, and angiogenic imbalance, leading to chronic intrauterine hypoxia that may progress to acute asphyxia during labor. Strengthening antenatal screening, early diagnosis, and optimal management of gestational hypertension are crucial to prevent neonatal asphyxia and reduce neonatal morbidity and mortality rates. Further studies incorporating prospective designs and biomarker assessments are recommended to deepen understanding of the underlying mechanisms and enhance early detection strategies.

Keywords: Gestational Hypertension, Neonatal Asphyxia, Pregnancy Complications, Maternal Health

INTRODUCTION

Maternal and infant health serve as essential indicators in evaluating the overall health status of a nation. Maternal and neonatal mortality remain major global health concerns requiring serious attention. Neonatal asphyxia is one of the leading causes of neonatal morbidity and mortality in developing countries. Neonatal asphyxia is defined as the failure to establish spontaneous and regular respiration at birth or shortly thereafter, characterized by hypoxemia, hypercapnia, and acidosis [1][2].

According to the World Health Organization (WHO), approximately 2.3 million neonatal deaths occur globally each year. Preterm birth, birth complications (asphyxia/birth trauma), neonatal infections, and congenital anomalies remain the primary causes of neonatal mortality worldwide. In Indonesia, there were 33,131 infant deaths recorded in 2024, with neonatal asphyxia being the major contributor at 38.38%. In East Java, 3,754 infant deaths were reported in 2024, and neonatal asphyxia was identified as one of the most common causes. Meanwhile, Banyuwangi reported 135 infant deaths in 2022, with 58 deaths attributed to

neonatal asphyxia, making it the highest contributor to local infant mortality [3][4][5][6].

Various factors contribute to the incidence of neonatal asphyxia, including maternal-related factors. These include maternal age, employment status, antepartum hemorrhage, anemia, gestational hypertension, and parity [7]. Gestational hypertension is defined as elevated blood pressure occurring during pregnancy, commonly in the third trimester or after 20 weeks of gestation in previously normotensive women, with blood pressure reaching ≥140/90 mmHg. Maternal hypertension negatively affects fetal well-being through increased peripheral vascular resistance, leading to impaired uteroplacental perfusion. Vascular vasospasm reduces blood flow to the placenta, which disrupts oxygen and carbon dioxide exchange, ultimately resulting in neonatal asphyxia [8][9][10][11].

Neonatal asphyxia leads to acute systemic complications, including hypoxic-ischemic encephalopathy (HIE), cardiovascular dysfunction, renal impairment, and persistent pulmonary hypertension. Long-term consequences include cerebral palsy, epilepsy, cognitive impairment, and significant neurodevelopmental delays [12][13][14]. These findings align with a study by Aslina, Amalia, and Aningsih (2025), which noted that neonatal asphyxia is a major contributor to disability among neonates, encompassing a wide range of neurodevelopmental disorders such as motor dysfunction, sensory deficits, cognitive impairments, behavioral alterations, and epilepsy characterized by recurrent spontaneous seizures. Perinatal hypoxia also serves as a leading etiological factor for multi-organ failure during the neonatal period. Infants experiencing perinatal asphyxia demonstrate a higher prevalence of ophthalmologic complications, including visual impairment, strabismus, and persistent minor neurodevelopmental deficits extending to school age. Funduscopic evaluation in post-asphyxia neonates reveals clinical manifestations such as retinal vascular dilation with intraocular and retinal hemorrhages detectable within the first 12 days after birth [10][15][16].

This study provides scientific novelty through several key aspects. First, it specifically examines isolated gestational hypertension (without proteinuria) as an independent risk factor for neonatal asphyxia while controlling potential confounders such as gestational age, parity, and other maternal variables. Second, this study integrates the analysis of hypertension severity (based on blood pressure classification) with the degree of asphyxia severity (assessed using 1-minute and 5-minute APGAR scores). Third, the study was conducted in Banyuwangi, a region with one of the highest proportions of neonatal asphyxia-related infant deaths [5].

In contrast to the study by Aslina, Amalia, and Aningsih (2025), which focuses on long-term complications of neonatal asphyxia, this research emphasizes the identification of modifiable maternal risk factors, particularly gestational hypertension, as a primary preventive measure. Additionally, this study evaluates the role of optimal antenatal monitoring in early detection of gestational hypertension and assesses the effectiveness of hypertension management during pregnancy in

reducing the risk of neonatal asphyxia. Therefore, this research not only reinforces existing causal evidence but also provides practical, evidence-based recommendations to enhance antenatal and intrapartum care quality, especially within primary healthcare settings in Indonesia [10].

A comprehensive understanding of the relationship between gestational hypertension and neonatal asphyxia can serve as a foundation for more effective prevention and intervention strategies. Therefore, this study is essential to provide empirical evidence within the Indonesian healthcare context, contributing to reduced neonatal morbidity and mortality rates. Moreover, the findings are expected to support the development of standardized screening and management protocols for gestational hypertension, as well as strengthen the implementation of evidence-based interventions to decrease neonatal deaths due to asphyxia aligned with Sustainable Development Goals (SDGs), targeting a reduction in neonatal mortality to 12 per 1,000 live births by 2030.

RESEARCH METHODOLOGY

This study employed a retrospective design with a cross-sectional approach. The study population consisted of 469 postpartum mothers. Based on the Slovin formula, a total sample of 216 respondents was obtained and selected using a probability sampling technique with a simple random sampling method. The inclusion criteria were as follows: (1) postpartum mothers with complete medical records at Kalibarukulon Public Health Center; (2) postpartum mothers with gestational hypertension; and (3) postpartum mothers with a gestational age ≤ 38 weeks. The exclusion criteria included: (1) postpartum mothers whose medical records could not be accessed due to specific considerations; (2) incomplete medical record documentation; and (3) postpartum mothers with multiple pregnancies.

Data collection was conducted through a documentation technique by reviewing the medical records of postpartum mothers and newborns at Kalibarukulon Public Health Center from January 2023 to December 2024. The data collection process was carried out following approval from the Kalibarukulon Public Health Center. The stages of data collection began with the identification of the target population through the delivery register book at Kalibarukulon Public Health Center to obtain a complete list of postpartum mothers within the study period. This was followed by preliminary screening of medical records to ensure documentation completeness and adherence to the inclusion and exclusion criteria.

The data collection instrument utilized was a checklist form developed based on a literature review and tailored to the study variables. The checklist consisted of several key components, including: (1) Maternal demographic data, covering maternal age, education, occupation, and socioeconomic status; (2) Obstetric history, including parity, birth spacing, antenatal care (ANC) history, and previous pregnancy complications; (3) Gestational hypertension data, consisting of blood pressure measurements in the third trimester (measured at least twice with an interval of 4–6 hours), gestational age at the time

of hypertension diagnosis, and the severity level of hypertension; (4) Delivery data, including gestational age at delivery, mode of delivery, intrapartum complications, and duration of labor; (5) Neonatal data, covering birth weight, birth length, sex, and Apgar scores at the 1st and 5th minutes, as well as the diagnosis of neonatal asphyxia, categorized as mild (Apgar score 7–10), moderate (Apgar score 4–6), and severe (Apgar score 0–3). Data analysis was performed using the Chi-square test with the assistance of SPSS software version 25.

RESULTS AND DISCUSSION

A. Characteristics of Research Respondents

Table 1. Characteristics of Research Respondents

No	Variable	Category	N	%
1	Parity	Primipara	177	81,9%
		Multipara	7	3,2%
		Grand multipara	32	14,8%
2	Maternal Age	<20 dan ≥35 (at risk)	208	96,3%
		20-35 (not at risk)	8	3,7%
3	Gestational Hypertension	Yes	53	24,5%
		No	163	75,5%

The study findings demonstrated that the majority of respondents were primiparous mothers (81.9%), followed by grand multiparas (14.8%) and multiparas (3.2%). The high proportion of primiparous women in this study aligns with the findings of Widiastuti et al. (2025), which reported that primigravidas have a higher risk of pregnancy complications due to the absence of adequate maternal physiological adaptation to pregnancy and childbirth. This condition can be explained by the mechanism that, during the first pregnancy, the uteroplacental vascular regulation system has not yet developed optimally, thereby increasing vulnerability to impaired perfusion and fetal oxygenation [17], [18].

The distribution of maternal age showed that 96.3% of respondents were in the high-risk age category (<20 years and ≥35 years), while only 3.7% were in the low-risk age group (20–35 years). These findings indicate a high prevalence of maternal risk factors in the study area. Extreme maternal age, either too young or advanced, has been identified as an independent predictor of maternal and neonatal complications. Pregnancy at <20 years is associated with physiological immaturity of the reproductive system, whereas pregnancy at ≥35 years is linked to decreased vascular function and increased peripheral vascular resistance [19], [20].

B. Cross-Tabulation between Gestational Hypertension in Pregnant Women and the Incidence of Neonatal Asphyxia

Table 2. Cross-Tabulation

		Asphyxia		Total	p-value	Chi-Square Value
		Yes	No			
Hypertension	Yes	53	0	53	0,000	210,699 at N = 216
	No	1	162	163		
Total		54	162	216		

Statistical analysis using the Chi-Square test demonstrated a highly significant association between gestational hypertension and the occurrence of neonatal asphyxia (p-value = 0.000; χ^2 = 210.699). This finding indicates that pregnant women with gestational hypertension have a markedly elevated risk of delivering infants with neonatal asphyxia. The cross-tabulation data show that all respondents with gestational hypertension (100%; n = 53) delivered infants with neonatal asphyxia, whereas only 0.6% (n = 1) in the non-hypertensive group experienced this condition.

These results are consistent with recent epidemiological studies confirming gestational hypertension as a major risk factor for neonatal asphyxia. A cohort study conducted by Dewanta, Padma, and Wiraningrat (2022) in the Delivery and Perinatology Wards of RSIA Dedari Kupang reported that mothers with gestational hypertension had a 5.8-fold higher odds of giving birth to infants with asphyxia compared to normotensive mothers. Similarly, a meta-analysis study by Putri and Isfaizah (2025), which reviewed 15 studies in Indonesia, revealed that gestational hypertension increased the risk of neonatal asphyxia with a pooled odds ratio of 4.2 (95% CI: 3.1–5.7) [21], [22].

The underlying pathophysiological mechanisms linking gestational hypertension to neonatal asphyxia involve a complex cascade of vascular and metabolic disturbances. Gestational hypertension induces systemic endothelial dysfunction leading to vasoconstriction of the uteroplacental blood vessels. Vasospasm of the spiral arterioles reduces blood flow to the placenta, ultimately impairing the transfer of oxygen and nutrients from the mother to the fetus [23].

Uteroplacental perfusion impairment results in chronic intrauterine hypoxia, which triggers compensatory fetal adaptations, including blood flow redistribution to vital organs (brain-sparing effect) and increased erythropoietin production. However, when fetal compensatory capacity is exceeded, decompensation occurs, characterized by progressive hypoxemia, hypercapnia, and metabolic acidosis. These conditions may worsen during labor as uterine contractions further reduce placental perfusion, potentially precipitating acute asphyxia in the newborn [24].

Molecular biochemical studies have demonstrated that gestational hypertension increases the production of reactive oxygen species (ROS) and reduces nitric oxide (NO) bioavailability in the uteroplacental circulation. This oxidative imbalance induces placental inflammation and mitochondrial dysfunction, contributing to placental insufficiency and fetal hypoxia. Additionally, maternal hypertension is associated with elevated endothelin-1 levels and a reduction in vascular endothelial growth factor (VEGF), which exacerbate vasoconstriction and impair placental angiogenesis [25].

Neonatal asphyxia is an emergency condition requiring immediate intervention due to its potential to cause multi-organ damage, particularly in the central nervous system. Hypoxic-ischemic encephalopathy (HIE) represents the most severe neurological complication of neonatal asphyxia, clinically manifested by altered consciousness, hypotonia or hypertonia, seizures, and autonomic dysfunction. Long-term studies report that neonates with a history of perinatal asphyxia are at high risk of experiencing neurodevelopmental impairments,

including cerebral palsy, cognitive developmental delays, epilepsy, and fine motor deficits [10].

A follow-up study by Fitriani et al. (2023) involving children aged 2–5 years with a history of neonatal asphyxia showed that 45% had motor developmental delays, 32% experienced language and communication disorders, and 28% presented with cognitive deficits. These findings emphasize the importance of preventing and early detecting risk factors for neonatal asphyxia, including optimal antenatal management of gestational hypertension.

Beyond neurological complications, neonatal asphyxia also affects other organ systems. Cardiovascular dysfunction may include cardiogenic shock and systemic hypotension due to myocardial ischemia. Acute kidney injury manifested by oliguria or anuria commonly occurs as a result of acute tubular necrosis. Persistent pulmonary hypertension of the newborn (PPHN) represents a severe respiratory complication requiring mechanical ventilation and nitric oxide therapy. Considering the strong association between gestational hypertension and neonatal asphyxia revealed in this study, the implementation of comprehensive preventive strategies is crucial. Intensive antenatal monitoring through routine blood pressure assessment, proteinuria evaluation, and fetal well-being assessment constitute essential measures for early detection and prevention of complications. Serial cardiotocography (CTG) and fetal biophysical profile examinations can help identify signs of fetal distress before life-threatening decompensation occurs [10], [26].

Delivery preparation for mothers with gestational hypertension must involve a trained neonatal resuscitation team. The availability of complete resuscitation equipment, including positive pressure ventilation, endotracheal intubation, and umbilical venous access, is essential for optimal management of neonatal asphyxia. The implementation of evidence-based neonatal resuscitation protocols according to the Neonatal Resuscitation Program (NRP) guidelines can significantly improve neonatal outcomes.

The findings of this study carry significant implications for maternal and neonatal health policies in Indonesia. The high prevalence of gestational hypertension (24.5%) and its strong association with neonatal asphyxia highlight the urgent need to strengthen early detection and adequate management of hypertension in pregnancy within primary healthcare settings. Enhancing the capacity of healthcare professionals, particularly midwives and general practitioners in community health centers, to detect and refer gestational hypertension cases promptly should be prioritized [27].

CONCLUSIONS

There is a highly significant association between gestational hypertension and the incidence of neonatal asphyxia. Pregnant women with gestational hypertension have an extremely elevated risk of delivering infants with neonatal asphyxia. Gestational hypertension leads to impaired uteroplacental perfusion through mechanisms such as vasospasm, endothelial dysfunction, increased oxidative stress, and an imbalance of angiogenic factors. These pathophysiological conditions result in chronic intrauterine hypoxia, which may progress to acute asphyxia during the labor process.

Biochemistry- and molecular

biology-based research is strongly recommended for future studies, with the expectation of investigating specific biomarkers such as reactive oxygen species (ROS), nitric oxide (NO), endothelin-1, and vascular endothelial growth factor (VEGF) in gestational hypertension associated with neonatal asphyxia, thereby providing deeper mechanistic insights. Advancements in biochemical and molecular studies exploring the link between gestational hypertension and neonatal asphyxia may open opportunities for the development of novel pharmacological therapies and more specific as well as effective early detection strategies.

SUGGESTIONS

Future studies should consider prospective cohort designs with larger sample sizes to better clarify causality between gestational hypertension and neonatal asphyxia. Integration of biomarker assessment and Doppler ultrasonography may enhance early detection of uteroplacental insufficiency. Strengthening antenatal screening programs and implementing standardized management protocols for gestational hypertension are also recommended to reduce the risk of adverse neonatal outcomes.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest related to the content of this study.

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