

A Five-Year Study of Maternal and Neonatal Risk Factors Contributing to Early Neonatal Death at a Tertiary Referral Hospital

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Abstract

Objective: This study aims to explore maternal and neonatal risk factors associated with early neonatal death at a central referral hospital in West Java.

Methods: A cross-sectional study was conducted. Over five years, 310 early newborn mortality samples were collected from 9,240 births. Key characteristics associated with early infant death were identified using univariate and multivariate analysis.

Results: Among the mothers, 63.9% were from outside Bandung and aged 15–46. 64.5% (n=200) of neonates died within two days. Primiparous mothers accounted for 33.2% (103). Common maternal conditions included premature contractions (27.1%), premature rupture of membranes (22.9%), hypertension (14.2%), placenta previa (6.5%), and eclampsia (3.5%). 84.8% of neonates were premature, and 59.4% experienced early death. Bivariate analysis showed significant relationships with parity, maternal diseases, mode of delivery, and newborn hypoxia. Death after 48 hours was notably associated with mode of delivery (p=0.009; OR 1.54).

Conclusion: END is associated with parity, maternal conditions, delivery mode, and asphyxia. Improved prenatal care and stronger referral systems can reduce mortality rates.

Keywords: early neonatal death, maternal risk factors, mode of delivery, maternal complications

Analisis Faktor Risiko Ibu dan Neonatus terhadap Kematian Neonatal Dini di RS Rujukan Tersier: Studi Lima Tahun

Abstrak

Tujuan: Penelitian bertujuan untuk mengidentifikasi faktor risiko maternal dan neonatal yang terkait dengan kematian neonatal dini pusat rujukan di Jawa Barat.

Metode: Metode penelitian dilakukan dengan studi potong lintang selama lima tahun. 310 sampel kematian neonatal dini diambil dari 9,240 kelahiran. Analisis *multivariate dan univariate* dilakukan untuk melihat hubungan faktor-faktor penting yang berhubungan dengan kematian neonatal dini

Hasil: Hasil penelitian menunjukkan sebanyak 63,9% berasal dari luar Bandung dan berusia antara 15 dan 46 tahun. 64,5% (n=200) bayi meninggal dalam dua hari. 33,2% persalinan prematur (103). Kondisi patologis ibu yang ditemukan kontraksi prematur (27,1%), ketuban pecah dini (22,9%), hipertensi (14,2%), plasenta previa (6,5%) dan eklampsia (3,5%). 84,8% lahir prematur, dan 59,4% meninggal dini. Menurut analisis bivariat, ada hubungan yang signifikan antara cara persalinan, penyakit ibu, hipoksia bayi baru lahir, dan paritas (p=0.009; OR 1.54). Kematian bayi setelah 48 jam memiliki korelasi yang signifikan dengan metode persalinan.

Kesimpulan: KND dikaitkan dengan paritas, penyakit ibu, cara persalinan, dan asphyxia. Memperkuat sistem referral dan meningkatkan perawatan antenatal dapat mengurangi angka kematian.

Kata kunci: faktor risiko maternal; kematian neonatal dini; komplikasi maternal; metode persalinan

Introduction

Global data in 2021 showed 2.3 million infant deaths in the first month, averaging 6,400 per day.^{1,2} The global newborn mortality rate dropped 43.5 percent from 31.9 per 1,000 live births in 1990 to 18 in 2021.³ Indonesia's neonatal mortality rate decreased from 26 per 1,000 live births in 2010 to 16.85 in 2020. Indonesia ranks seventh among the top 10 countries with the highest newborn mortality rates in 2020.⁴

Neonatal death rate is decreasing annually; however, there is still a significant gap between one region and other nations. Most neonatal deaths occur in low- and middle-income countries.^{1,5} Neonatal death, as defined by the World Health Organization (WHO), refers to the death of a newborn baby within the first 28 days of life. This period is further divided into early neonatal death, which occurs between 0 and 7 days of life, and late neonatal death, which occurs between 7 and 28 days of life.⁵ Early neonatal death (END) remains a major contributor to child mortality worldwide. High-income countries have improved outcomes through evidence-based interventions, especially in managing pre-term infants; thus, reducing preterm birth is essential to decreasing END rates.^{6,7}

One of the main risk factors for neonatal mortality has been shown to be availability and access to prenatal care, which is believed to have a strong ecological relationship.⁸ Another study reveals that premature delivery, intrapartum complications (such as asphyxia and respiratory failure), infections, and malformations are the most common factors contributing to newborn deaths. It is also linked to a lack of quality care and proper handling at birth and during the first day of life.^{6,9} The World Health Organization (WHO) recommends measures to lower neonatal mortality, including improving the quality of care for pregnant women and

newborns during pregnancy and after birth, such as strengthening midwifery care.^{4,6} Identifying maternal and obstetric issues is essential for early intervention and reducing neonatal mortality. Improving antenatal care through standardized guidelines, early risk detection, and skilled delivery support across all facilities—including referral centers—is a key policy strategy.^{10,11} While many studies in Indonesia examine maternal health and neonatal outcomes, few focus on maternal factors related to early neonatal mortality, particularly in national referral hospitals. This study aims to explore maternal and neonatal risk factors associated with early neonatal death at a central referral hospital in West Java.

Method

The research examines early neonatal mortality through a cross-sectional study that investigates maternal characteristics, such as demographics (age, education level, residence), obstetric history, maternal health issues, parity, referrals, and mode of delivery. To assess neonatal risk, factors like APGAR scores, birth weight, fetal number, and gestational age are evaluated. The study included mothers who gave birth at Hasan Sadikin Hospital and experienced early neonatal death (<7 days). Exclusion criteria included stillbirths and neonates born outside the hospital but treated at its NICU/Perinatology Department.

Data were collected from all mothers giving birth at Hasan Sadikin Hospital between January 1, 2019, and December 2023, focusing on neonatal deaths within the first 7 days. Early neonatal death was categorized into deaths within the first 48 hours and those between 48 hours and 7 days. The total sample size was 310, using total sampling. Data collection was conducted through patient registries and medical records. Neonatal data were obtained from

perinatology records to document outcomes of newborns who died within 7 days. The data were tabulated and analyzed using SPSS with both univariate and multivariate analysis to identify contributing variables.

Results

The research study (Table 1) presents data on residency, maternal education, and age. Of the patients, 36.1% (n=112) lived in Bandung, while 63.9% (n=198) lived outside the city. Their educational levels were elementary at 25.2% (n=78), junior high at 26.1% (n=81), senior high school at 46.5% (n=144), and higher education at 2.3% (n=7). The distributions of maternal age were <19 years 8.3% (n=26), 20–24 years 26.4% (n=82), 25–29 years 23.8% (n=74), 30–34 years 20% (n=62), 35–39 years 15.2% (n=47), and >40 years 6.1% (n=19), with ages ranging from 15 to 46 years.

Early neonatal death with a mortality rate of less than 48 hours is 64.5% (n=200), while death after 48 hours is 35.5% (n=110). Neonatal deaths from singletons accounted for 87.1% (n=270), with 11.9% (n=37) in gemelli and 1.0% (n=3) in triplets. Fetal emergency infant pathology was responsible for 21% (n=65), congenital abnormalities for 10.3% (n=32), and small for gestational age for 2.3% (n=7). Meanwhile, moderate asphyxia accounted for 38.7% (n=120) and severe asphyxia for 15.5% (n=48).

Early neonatal deaths occurred in primiparas (33.2%, n=103), multiparas (59.4%, n=184), and grand multiparas (7.4%, n=23). The leading maternal conditions were premature contractions (27.1%, n=84), PROM (22.9%, n=71), hypertension (14.2%, n=44), placenta previa (6.5%, n=20), and eclampsia (3.5%, n=11). Preterm births made up 84.8% (n=263): early preterm 59.4% (n=184), late preterm 25.5% (n=79), and full-term delivery 15.2% (n=47). Referrals accounted for 60.6% (n=188): from hospitals 65.4%, primary care

13.3%, midwives 11.7%, and obstetricians 9.6%. Non-referrals were 39.4% (n=122).

Table 1 Maternal and neonatal characteristics

Variable	N=310
Residency	
Bandung	112 (36.1%)
Outside Bandung	198 (63.9%)
Education	
Elementary School	78 (25.2%)
Junior high school	81 (26.1%)
Senior high school	144 (46.5%)
Higher education	7 (2.3%)
Maternal Age	
Mean±Std	28.24±6.821
Median	28.00
Neonatal characteristics	
Died <48 hours	200 (64.5%)
Died >48 hours	110 (35.5%)
Multiple Birth	
Singleton	270 (87.1%)
Gemelli	37 (11.9%)
Triplet	3 (1.0%)

Analysis of the outcomes from Table 1 showed that neonatal deaths < 48 hours and > 48 hours were carried out. Analysis of Mann-Whitney test data on the maternal age variable, P value > 0.05 (P = 0.988), there was no significant difference in maternal age between early neonatal death < 48 hours and > 48 hours. The Chi Square test was carried out on the residency variable (p=0.667), and the Kolmogorov-Smirnov alternative test on maternal education (P=0.626) was not significant; there was no difference between the residency variable and maternal education on the outcome of early neonatal death.

Table 2 Maternal and neonatal risk factor

Variable	N=310
Parity	
Primipara	103 (33.2%)
Multipara	184 (59.4%)
Grandemultipara	23 (7.4%)
Maternal Pathology	
Premature contractions	84 (27.1%)
Premature rupture of membranes	71 (22.9%)
Hypertension in pregnancy	44 (14.2%)
Placenta Previa	20 (6.5%)
Eclampsia	8 (2.6%)
Previous SC	10 (3.2%)
Other	11 (3.5%)
None	62 (20.0%)
Infant Pathology	
Fetal distress	65 (21.0%)
Congenital anomaly	32 (10.3%)
SGA	7 (2.3%)
Anonymous	29 (9.4%)
Triplet 8 (2.6%)	
Fresh/Stellar	18 (5.8%)
None	151 (48.7%)
Referral	
Not referred	122 (39.4%)
Referred	188 (60.6%)
Origin of Referral	
Midwife	22 (7.1%)
Byself	122 (39.4%)
Primary health care	25 (8.1%)
Secondary hospital	123 (39.7%)
Obstetrician	18 (5.8%)
Types of delivery	
Induction	49 (15.8%)
Spontaneous	114 (36.8%)
SC	136 (43.9%)
Other	11 (3.5%)
Weeks of pregnancy	
Early Preterm	184 (59.4%)
Late Preterm	79 (25.5%)
Term	47 (15.2%)

Chi-square tests were performed to assess the association between early neonatal death and several variables, including parity, maternal and neonatal pathology, referral status, and origin, as well as the type and category of delivery. Variables such as neonatal pathology, referral status, referral origin, and premature delivery. The results show that P values > 0.05, indicating significance. In contrast, parity (P = 0.005), maternal pathology (P = 0.015), and mode of delivery (P = 0.02) were significantly associated with early neonatal death (P < 0.05).

Table 4 shows that the Mann-Whitney test was performed on data that were not normally distributed, specifically baby weight, APGAR score at 1 minute, and APGAR score at 5 minutes. The results indicated that the P value for baby weight and baby length was greater than 0.05 (P>0.05). However, the P values for the APGAR score at 1 minute (P=0.006) and at 5 minutes (P=0.004) were less than 0.05 (P<0.05), indicating a statistically significant association with neonatal premature death.

Multivariate analysis in Table 5 examined the relationship between parity (P=0.402, CI=0.73, OR=1.19), mode of delivery (P=0.009, CI=1.16, OR=1.54), and referral origin (P=0.807, CI=0.828, OR=1.02) with early neonatal death. The results showed that only mode of delivery was significantly associated, while parity and referral origin had no significant effect.

Discussion

In this study, the youngest participant was 15 years old and the oldest was 46 years old, with an average age of 26.4 years, and 20-24 years being the most common age group at 26.4%. Extreme maternal ages (both adolescent and advanced) are linked to a higher risk of neonatal complications death.¹² In this study, premature neonatal death was more common among multipara mothers (59.4%, n=184)

Table 3 Bivariate analysis of neonatal mortality outcomes

Variable	Returning Condition		P value
	Died <48 hours N=200	Died >48 hours N=110	
Parity			0.005*
Primipara	65 (32.5%)	38 (34.5%)	
Multipara	127 (63.5%)	57 (51.8%)	
Grandemultipara	8 (4.0%)	15 (13.6%)	
Maternal Pathology			0.015*
Premature contractions	46 (23.0%)	38 (34.5%)	
Premature rupture of membranes	55 (27.5%)	16 (14.5%)	
Hypertension in pregnancy	26 (13.0%)	18 (16.3%)	
Placenta Previa	11 (5.5%)	9 (8.2%)	
Eclampsia	4 (2.0%)	4 (3.6%)	
Previous SC	4 (2.0%)	6 (5.5%)	
Other	7 (3.5%)	4 (3.6%)	
None	47 (23.5%)	15 (13.6%)	
Infant Pathology			0.464
Fetal Crisis	40 (20.0%)	25 (22.7%)	
Congenital anomaly	25 (12.5%)	7 (6.4%)	
SGA	5 (2.5%)	2 (1.8%)	
Anonymous	19 (9.5%)	10 (9.1%)	
Triplet	3 (1.5%)	5 (4.5%)	
Fresh/Stellar	11 (5.5%)	7 (6.4%)	
None	97 (48.5%)	54 (49.1%)	
Referral			0.252
NR	74 (37.0%)	48 (43.6%)	
R	126 (63.0%)	62 (56.4%)	
Origin of Reference			0.611
Midwife	15 (7.5%)	7 (6.4%)	
Come Alone	74 (37.0%)	48 (43.6%)	
Primary health care	16 (8.0%)	9 (8.2%)	
Hospital secondary	85 (42.5%)	38 (34.5%)	
Obstetrician	10 (5.0%)	8 (7.3%)	
Mode delivery			0.020*
Induction	41 (20.5%)	8 (7.3%)	
Spontaneous	72 (36.0%)	42 (38.2%)	
SC	81 (40.5%)	55 (50.0%)	
Other	6 (3.0%)	5 (4.5%)	
Prematurity			0.640
Early Preterm	118 (59.0%)	66 (60.0%)	
Late Preterm	49 (24.5%)	30 (27.3%)	
Term	33 (16.5%)	14 (12.7%)	

Table 4 Comparison of Infant Weight, Infant Length, 1-minute APGAR Score, and 5-minute APGAR Score based on Discharge

Variable	Returning Condition		P value
	Died <48 hours N=200	Died >48 hours N=110	
Baby weight			0.948
Mean±Std	1638.55±753.047	1583.02±629.750	
Median	1400.00	1415.00	
Range (min-max)	465.00-3650.00	470.00-3500.00	
Baby Length			0.922
Mean±Std	38.71±5.652	38.77±4.842	
Median	38.00	39.00	
Range (min-max)	26.00-53.00	23.00-50.00	
1-minute APGAR Score			0.006*
Mean±Std	3.69±1.986	4.33±1.877	
Median	3.00	5.00	
Range (min-max)	0.00-8.00	0.00-7.00	
5-minute APGAR Score			0.004*
Mean±Std	5.58±2.225	6.30±2.061	
Median	6.00	7.00	
Range (min-max)	0.00-9.00	0.00-9.00	

Table 5 Multivariate Analysis

	B	P value	OR	CI 95%	
				Lower	Upper
Parity	0.174	0.402	1.190	0.793	1.786
Mode delivery	0.433	0.009*	1.541	1.116	2.130
Origin of references	0.027	0.807	1.027	0.828	1.274

Remarks: For numerical data, the p value is tested with an unpaired T test if the data is normally distributed, and with *Mann-Whitney test* if the data is not normally distributed. The categorical data of p-value was calculated using *the Chi-Square* test with the alternative test of *Kolmogorov-Smirnov* and *Exact Fisher* if the conditions of *Chi-Square* were not met. The significance value is based on the value of $p < 0.05$.

than in primipara (33.2%, n=103) and grand multipara (7.4%, n=23). This data aligns with recent research showing that multiparity is a significant risk factor for premature neonatal death. Research in Ghana indicates that mothers with high parity are more susceptible to pregnancy complications that contribute to neonatal death.¹³

Maternal conditions commonly associated with premature neonatal death include premature contractions (27.1%, n=84), premature rupture of membranes (22.9%, n=71), hypertension during pregnancy (14.2%, n=44), placenta previa (6.5%, n=20), and eclampsia (3.5%, n=11). Recent research indicates that maternal complications such as premature contractions, premature rupture of membranes, and hypertension in pregnancy are key risk factors for early neonatal death. A study also found that preterm labor, especially when caused by complications like premature rupture of membranes and hypertension, significantly raises the risk of neonatal mortality.^{14,15}

Most cases of early neonatal death are due to premature labor, accounting for 84.8% (n=263). Among these, early preterm labor makes up 59.4% (n=184), late preterm 25.5% (n=79), and term labor 15.2% (n=47). Another study indicated that babies born at a very early preterm gestational age face a higher risk of severe complications, such as respiratory distress syndrome (RDS) and neonatal sepsis, which significantly increase the risk of mortality within the first 48 hours of life.^{2,16} adverse birth outcomes (small-for-gestational-age (SGA

Several pathological conditions significantly contribute to early neonatal mortality. Moderate asphyxia accounts for 38.7% (n = 120), while severe asphyxia accounts for 15.5% (n = 48). Other contributing factors include congenital anomalies (10.3%, n = 32) and small for gestational age neonates (2.3%, n = 7). Prematurity emerges as a major cause of

neonatal death, mainly due to the immaturity of vital organs and biological systems. Low birth weight worsens vulnerability by raising the risks of infection and death. Structural or genetic birth defects also form a notable part of neonatal fatalities. A particularly critical issue is birth asphyxia, which involves oxygen deprivation around delivery. This condition is especially dangerous within the first 48 hours after birth. Statistically, low APGAR scores at one and five minutes were significantly linked to early neonatal death, with P values of 0.006 and 0.004 respectively (P < 0.05), underscoring the importance of immediate postnatal assessment and intervention.

In this study, out of 310 neonatal deaths, 64.5% (200 cases) occurred within the first 48 hours after birth, while 35.5% (110 cases) happened after 48 hours. This suggests that most neonatal deaths happen very early after birth. Previous research shows that the early neonatal period, especially in the first 48 hours, is a critical time with a high risk of infant mortality. According to studies, nearly three-quarters of neonatal deaths occur in the first week of life, with the highest risk on the first day.¹⁷

Early neonatal death mostly occurred in singleton infants by 87.1% (n=270), while mortality in twins (gemelli) was 11.9% (n=37) and triplet mortality was 1.0% (n=3). Recent studies have shown that neonatal deaths are more common in single infants than in twins or triplets, studies conducted in several centers show that although twins and triplets have a higher risk for neonatal morbidities such as respiratory distress syndrome (RDS) and sepsis, the rate of premature neonatal death in single infants remains higher due to the lower proportion of premature births among single births compared to multiple births.¹⁸

Early neonatal mortality was also examined according to the mode of delivery, with vaginal delivery accounting for 56.1% (174 cases) and cesarean section for 43.9%

(136 cases). Most mothers arrived at the hospital via referrals (60.6%, 188 cases), mainly from hospitals (65.4%), primary health facilities (13.3%), independent practice midwives (11.7%), and obstetric specialists (9.6%). In contrast, 39.4% (122 cases) of mothers arrived at the hospital without a referral. These findings emphasize the role of the type of childbirth and referral in shaping neonatal health outcomes. Chien *et al.* (2017) show that cesarean section, although it can save lives in emergencies, is often linked to a higher risk of postpartum complications for mothers and babies, including infections and respiratory issues in newborns. However, in certain cases, cesarean section remains the best choice to lower the risk of neonatal death, especially in high-risk pregnancies.

Timely access to quality healthcare services remains a key factor in lowering neonatal mortality. In our study, 39.4% of mothers arrived at the hospital without a referral, highlighting significant gaps in the referral system. This is especially important when considering the varying origins of referrals, which showed no statistically significant link to the outcome ($p = 0.807$; OR = 1.027; 95% CI: 0.828–1.274). Although the statistical analysis indicates that the origin of referral may not independently predict adverse outcomes, the clinical significance remains important. The lack of association may indicate broader systemic issues, such as inconsistent referral practices or limited access to primary care, rather than the irrelevance of referral pathways themselves.

Supporting this, Ngoc *et al.* (2020) demonstrated that timely referrals to higher-level healthcare facilities significantly improved perinatal outcomes. Our findings align with this, especially given the large proportion of non-referred cases, which highlights the ongoing need for better public education and a streamlined referral system to ensure prompt and adequate care.

Furthermore, the mode of delivery

proved to be a significant factor ($p = 0.009$; OR = 1.541; 95% CI: 1.116–2.130), showing that the method of childbirth is closely connected to neonatal outcomes. This link may reflect underlying clinical conditions, emergency obstetric interventions, or late-stage complications—possibly worsened by delayed or missing referrals. The importance of antenatal care, as emphasized by Moyer *et al.* (2018), supports this: educating mothers about danger signs and ensuring regular check-ups can encourage timely care-seeking and proper planning for delivery, which may reduce emergency procedures and enhance neonatal survival.

Although parity was not significantly linked to the outcome ($p = 0.174$; OR = 1.190; 95% CI: 0.793–1.786), it remains an important demographic factor in maternal risk assessments. Its lack of statistical significance in this model might be due to interactions with other, stronger predictors such as delivery method or referral status.

Conclusion

Early neonatal death is strongly linked to maternal factors such as preterm labor, hypertension, placenta previa, and eclampsia; neonatal conditions including prematurity, asphyxia, congenital anomalies, and small for gestational age; and delivery characteristics. Most deaths happen within 48 hours and in singleton births. Multiparity and poor referral systems further raise the risk.

Enhanced monitoring and management of maternal conditions such as preterm labor, PROM, hypertension, placenta previa, and eclampsia are essential to reduce early neonatal death. Strengthening antenatal care, early identification of high-risk pregnancies, timely referrals, and proper management at tertiary centers are essential to reduce early neonatal mortality. Continued research and integrated health programs are needed to improve neonatal outcomes.

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