Determinants of Early Neonatal Mortality in Indonesia

Irdam Ahmad, Nadia Qothrunnada and Yulintin Riana Dewi

Authors affiliations: Indonesia Defense University (Ahmad), BPS Statistics Indonesia (Qothrunnada and Dewi)

Corresponding author/address: Irdam Ahmad, Indonesian Defense University, Department of Defense Economics, irdam.ahmad@idu.ac.id

Abstract

This study aimed to analyze the factors that contributed to early neonatal mortality in Indonesia using the raw data from the 2017 Indonesian Demographic Health Survey. The analytical method used was the Rare Event Logistic Regression Model. The results showed that infants who were more likely to die at early neonatal or seven days of life were born to working mothers, mothers with aged <20 years old and >35 years old, infants born with low birth weight (<2500 grams), male infants, and parturition attendants who were not health officers. About 65.3% of early neonatal deaths were born to working women, 40% were born to women <20 years and >35 years of age, 44% were low birth weight, 69.3% were male and 56% were born by pregnant women whose parturition are not assisted by health officers.
Keywords: early neonatal mortality, Indonesia, logistic regression

Introduction

Neonatal Mortality Rate (NMR) is the number of infant deaths that occur in the first month after birth, namely infant at the age of 0 to 28 days per 1000 live births (Badan Pusat Statistik, BPS, 2018). Several factors that can influence neonatal mortality are birth spacing, quality of antenatal care, parturition attendants, postpartum infections, accessibility, and delays in deciding to seek assistance. (Alifariki et al., 2019). Data from the Statistics Indonesia (BPS, 2018) demonstrates that infant mortality rate in Indonesia decreased sharply from 68 deaths per 1000 live births in 1991 to 24 deaths per 1000 live births. However, NMR in Indonesia decreased slowly from 32 deaths per 1000 live births in 1991 to 15 deaths per 1000 live births in 2017. Compared to several ASEAN countries (Knoema, 2019), this NMR is higher than in the Philippines (13.8 deaths per 1000 live births), Malaysia (4.4 deaths per 1000 live births), Thailand (5.3 deaths per 1000 live births), and Singapore (1.1 deaths per 1000 live births). Although Indonesia's SDG's target of reducing NMR has almost been achieved, which is 12 deaths per 1000 live births in 2030, Indonesia's public health lags compared to other ASEAN countries.

Neonatal mortality can be divided into two components, early neonatal and late neonatal. Early neonatal mortality occurs within the first seven days of life and late neonatal mortality occurs when the infant is 7-28 days old (WHO, 2006). According to WHO (2006), early neonatal mortality is the largest contributor to neonatal mortality where more than 3 million deaths occur in the early neonatal period out of 4 million infants who die in the neonatal period each year.

Based on the published results of the 2017 Indonesian Demographic Health Survey (IDHS) (BPS, 2018), it can be seen that out of the 255 living infants who died before reaching the age of 28 days, 212 infants or 83.1% of them died at the

first seven days of life, with details of 30.6% died at birth (0 days), and the remaining 52.5% died at the age of 1-6 days. Furthermore, according to BPS (2018), early neonatal mortality contributes 54.8% of infant mortality, while neonatal mortality contributes 67% of total infant mortality. These results indicate that the contribution of early neonatal mortality to neonatal and infant mortality is still large. Therefore, it is important to examine the determinants of neonatal mortality.

This study aims to comprehend the factors that influence early neonatal mortality in Indonesia using the raw data of the 2017 IDHS. Early neonatal mortality is mostly related to maternal factors and the parturition process. However, due to limited data, only certain factors will be examined. The variables used in this study are maternal and infant characteristics, i.e. maternal age, maternal work status, infant weight at birth, the sex of the infant, and parturition attendant.

Literature Review

WHO (2006) states that neonatal mortality and stillbirth are influenced by poor maternal health, inadequate care during pregnancy, improper management of complications during pregnancy and parturition, poor hygiene during parturition, the first critical hour after parturition, and lack of newborn infant care. Meanwhile, early neonatal mortality is mostly connected to complications during pregnancy or parturition, premature birth, and malformations.

Several studies which link early neonatal mortality with maternal age, in which a high risk of death occurs in mothers who are under 20 years of age and more than 35 years, have been conducted by Budiati (2016), Astri et al. (2014), Rejeki and Aji (2008), and Mahmudah (2011). Another research by Meisuri et al. (2018) show that women aged less than 20 years old and over 35 years old have a 2.8 times higher risk of experiencing stillborn infants than women aged 20-35 years old. At this risky age (< 20 years old > 35 years old), women have a low awareness of their health. At a young age (adolescent), women tend to have a lack of knowledge, inaccurate information without prior consultation with health officers so that the actions taken are relatively inappropriate. Whereas in old age, women tend to be busier (Departemen Kesehatan, 2010).

An infant born to working pregnant women also has a greater risk of dying before the age of 7 days, based on the results of research conducted by Budiati (2016), Nugraheni et al. (2016), Gaizauskiene et al. (2007), and Umah (2014). The research result of Titaley et al. (2008) indicates that the infants of working pregnant women have a 1.84 times higher risk of neonatal mortality or can encounter adverse effects on the fetus due to heavy physical work during pregnancy (Reid, 2001). Thus, it is recommended for pregnant women to avoid severe work such as nonstop working from morning until the afternoon because it can cause fatigue that can endanger their health and their foetus (Umah, 2014). As for child weight at birth, several studies have shown that infants born weighing less than 2500 grams or Low Birth Weight (LBW) have a greater risk of early neonatal mortality (Kusumawati et al., 2019, Dianawati et al., 2016, Budiati 2016, Astri et al., 2014, and Abdullah et al., 2012).

The research results of Dianawati et al. (2016) states that infants with a birth weight of <2500 grams are at risk of early neonatal mortality 6.98 times greater than infants born with a weight of ≥2500 grams because they have a higher risk of suffering from the disease. Infant organs with Low Birth Weight generally do not

function perfectly so they have many difficulties surviving after birth. According to Musrifa et al. (2014), infants with Low Birth Weight can increase the risk of early neonatal mortality by 204 times compared to infants with Normal Birth Weight. Meanwhile, according to Sadono et al. (2005), infants with Low Birth Weight are a risk factor for acute respiratory infections (ISPA) in infants, and infants with Low Birth Weight tend to suffer from ISPA frequently. Infants with Low Birth Weight have the risk of suffering ISPA 3 times compared to infants with normal birth weight.

In addition, several research results show that the sex of the infant also affects early neonatal mortality, in which male infants have a greater risk of dying than female infants, for instance, research conducted by Pertiwi (2010), WHO (2006), and Filho and Laurenti (2012). The physiology of males in early life is weaker than females so that males tend to experience greater morbidity and mortality (Wells, 2000). Female infants are also more resistant to infection and malnutrition.

Birth attendant type is also one of the factors that influence infant mortality. Several research results indicate that birth attendants who are not health workers have a significant effect on early neonatal mortality (Djaja et al., 2009; Suraya et al., 2016, Tarigan et al., 2017, and Mahampang et al., 2011).

According to Tarigan, Afifah, and Simbolon (2017), infants born to mothers who do not undergo antenatal care and parturition with health officers during pregnancy to parturition have a 2.19 times higher risk of experiencing death. In addition, a study by Pertiwi (2010) shows that a high rate of infant mortality by parturition attendants who are not health officers is most likely caused by a lack of knowledge and skills in handling maternal parturition and newborn infants.

Data

The data used in this study was the raw data from the 2017 IDHS results conducted by BPS in collaboration with the Ministry of Health and the National Population and Family Planning Board (BKKBN). The 2017 IDHS was conducted between 24 July to 30 September 2017. The aim of the survey was obtaining data and information on demographics and health in Indonesia, such as maternal and child health, birth rates, mortality, immunization prevalence, reproductive health, family planning prevalence, as well as knowledge about Human Immune Deficiency Virus (HIV), Acquired Immunodeficiency Syndrome (AIDS), and Sexually Transmitted Infections (STI).

The sampling method used in the 2017 IDHS was two-stage sampling. First stage was selecting a number of census blocks by systematic PPS (probability proportional to size) with the size was the number of households from the listing results of 2010 Indonesia Population Census. Second stage was selecting household as many as 25 households in each census block that have been systematically selected from the results of the latest household updates. The total sample of this survey were 49,250 households. The population in this study were all infants born to Fertile Age Women (FAW) aged 15-49 in the period 2012 to 2017. The samples in this study were the last infants born to women of childbearing age 15-49 years from 2012 to 2017, with the total sample of infants obtained was 14,254 children. This study only used the last infants born to women because some

of independent variables were only available for the last-born baby. The dependent variable in this study was early neonatal death. According to WHO (2006) early neonatal death is infant mortality that occurs before the first seven days of life (0-6 days). The independent variables included: The independent variables thought to affect the probability of early neonatal death used in this study were the mother's employment status, the mother's age at delivery, the infant's weight at birth, the sex of the infant, and the childbirth attendant.

Method of Analysis

The analytical method used in this study was binary rare-event logistic regression, because early neonatal mortality cases are rare-event cases. They occur only dozens to thousands of times less often than survival past the early neonatal mortality window of opportunity.

King and Zeng (2001) did not limit the rare events that must be fulfilled to use the proposed model. However, research by Wistara (2015) used a percentage of the successful category or rare events of 6.88%. Meanwhile, the research conducted by Veazey et al. (2016) used the Relogit model with rare events of 4%. The number of categories that are rare is something that needs to be considered. According to King and Zeng (2001), if the rare events cases is being analyzed using binary logistic regression, it will increase the bias of the parameter estimation results of the maximum likelihood method and the probability is far from balanced. In rare event data, the binary dependent variable has tens to thousands of data with a value of zero compared to data with a value of one. This condition will cause P(Y=1) to be underestimates while P(Y=0) to be overestimates.

The logistic regression method on rare event data or Rare Event Logistic Regression (ReLogit) is the result of correction from the ordinary logistic regression method. This method corrects the bias on the coefficients and corrects the probability of P(Y=1). The binary logistics regression model of rare events used in this research is as follows:

$$\tilde{g}(D) = \tilde{\beta}_0 + \tilde{\beta}_1 D_1 + \tilde{\beta}_2 D_2 + \tilde{\beta}_3 D_3 + \tilde{\beta}_4 D_4 + \tilde{\beta}_5 D_5$$

where:

$\tilde{\beta}_0$ = the regression intercept/constant parameter estimator
$\tilde{\beta}_1, \ldots, \tilde{\beta}_5$ = Coefficient value of variable regression
D_1 = Dummy variable for maternal employment status
D_2 = Variable dummy for maternal age at childbirth
D_3 = Variable dummy for infants' weight at birth
D_4 = Dummy variable for infant sex
D_5 = Dummy variable for birth attendant

Table 1.
Operational Definition of Variable Logistic Regression Model

No	Variable	Variable Name	Category	Dummy
(1)	(2)	(3)	(4)	(5)
1	Y	Early Neonatal Mortality	1 = Early Neonatal Mortality	1
			2 = Non-Early Neonatal Mortality	0
2	D_1	Maternal Employment Status	1 = Working	1
			2 = Not working[R]	0
3	D_2	Maternal Age at Childbirth	1 = 15-19 years and 36-49 years	1
			2 = 20-35 years[R]	0
4	D_3	Infant's weight at birth	1 = Low Birth Weight	1
			2 = Non Low Birth Weight[R]	0
5	D_4	Sex of Infants	1 = Male	1
			2 = Female[R]	0
6	D_5	Parturition Attendants	1 = Not a Health Officer	1
			2 = Health Officer[R]	0

Note: R = reference category

Results and Discussion

Logistic regression analysis was used to determine which independent variables affect early neonatal mortality, with the following hypotheses:

$H_0: \beta_j = 0$ (the j-independent variable does not affect early neonatal mortality)

$H_1: \beta_j \neq 0$ (the j-independent variable affects early neonatal mortality) for j = 1, 2, … 5.

The results of this research showed that maternal employment status, maternal age at childbirth, infant weight at birth, the sex of the infants, and parturition attendants have a significant effect on early neonatal mortality in Indonesia by 2017 (Table 2).

The logistic regression model formed based on Table 2 is as follows:

$$\tilde{g}(D) = -6{,}8045 + 0{,}5373D_1 + 0{,}8313D_2 + 2{,}1646D_3 + 0{,}6940D_4 + 0{,}6112D_5$$

D_1 = Dummy variable for maternal employment status
D_2 = Dummy variable for maternal age at childbirth
D_3 = Dummy variable for infant weight at birth
D_4 = Dummy variable for the sex of the infant
D_5 = Dummy variable for parturition attendants

Table 2
Hypothesis Testing Results

Variable	$\tilde{\beta}$	Lower 95% Confidence Limit	Upper 95% Confidence Limit	P-value	$exp(\tilde{\beta})$
Constant	-6.8045	-7.3827	-6.2263	0.0000	0.0011
Maternal Employment Status	0.5373	0.0796	0.9950	0.0214*	1.7114
Work					
Does not work[R]					
Maternal Age at Childbirth	0.8313	0.3783	1.2843	0.0003***	2.2963
<20 years and >35 years					
20-35 years[R]					
Infant Weight at birth	2.1646	1.7067	2.6225	0.0000***	8.7111
Low Birth Weight (<2500 grams)					
Not Low Birth Weight[R]					
Sex of Infant	0.6940	0.2200	1.1680	0.0041**	2.0017
Male					
Female[R]					
Childbirth Attendants	0.6112	0.1625	1.0599	0.0076*	1.8426
Not a health officer					
Health officer[R]					

Source: 2017 IDHS (processed data)
N = 14254
R categories used as reference
***p<0.001; **p<0.01; *p<0.05

The odds ratio of maternal employment status was 1.7, which means that the infants born to working pregnant women had a 1.7 times greater tendency of encountering early neonatal mortality than the infants born to non-working pregnant women. This is in accordance with the research by Nugraheni et al. (2016) which shows that the infants of working pregnant women have a 1.75 times greater tendency to encounter early neonatal mortality. Moreover, according to Titaley et al (2008), the infants of working pregnant women have a 1.84 times greater tendency to encounter early neonatal mortality than non-working pregnant women.

This research also showed that maternal age at childbirth has significant effect on early neonatal mortality. With the odds ratio was 2.3, means that the infants born to <20 years and >35 years old pregnant women have a 2.3 times greater tendency to die before the age of 6 days compared to the infants born to 20-35 years old pregnant women. The result of this research is in accordance with the research of Astri et al. (2014) which states that the maternal age of < 20 years and > 35 years have a 3.5 times greater chance of encountering early neonatal mortality than the infants born to 20-35 years old mothers.

The weight of infant's birth can also influence early neonatal mortality. Table 1 in Annex 1 shows that infants born with a weight of <2500 grams or included into the category of Low Birth Weight (LBW) had a greater percentage of

early neonatal mortality (3.4%) than early neonatal mortality of infants with a weight of >2500 grams (0.4%). An odds ratio of 8.7 means that the infants born with a weight of <2500 grams tend to die 8.7 times greater than the infants born with a weight of >2500 grams.

Kusumawati et al. (2019) state that LBW has a relationship with early neonatal mortality. The causative factors of LBW are poor socioeconomic conditions, extremely young maternal age, inadequate caloric intake, smoking, and maternal infectious diseases (Tayade and Kumar, 2012). Meanwhile, according to Manuaba (1998), the causative factors of LBW are malnutrition during pregnancy and maternal age less than 20 years or more than 35 years.

This research also exhibits that sex of infant has significant effect on early neonatal mortality. The odds ratio of 2.0 means that male infants have 2.0 times the tendency of early neonatal mortality compared to female infants. This result is in accordance with the research of Astri et al. (2014) which stated that of the 140 early neonatal mortality, 60% of them were male infants while the rest were female infants. Filho and Laurenti's (2012) research also stated that infant mortality is more common in male infants than female infants in which the ratio of male infant mortality was 1,188 per 1,000 female infant mortalities. According to Wells (2000) the male physiological functions in early life are weaker than female. Female infants are more protected because they have a better level of lung maturity than the male infants (Torday et al., 1981). In addition, male infants are more susceptible to get affected by a bad environment than female infants. This is in line with the research of Kusumawati et al. (2010) which states that female infants is more biologically advantaged after birth than the male infants. Female infants are more resistant to health problems such as infections and nutritional problems.

The 2017 IDHS data showed that around 31.7% of pregnant women whose parturition are not assisted by health officers. An odds ratio of 1.8 means that infants of pregnant women with parturition attendant who are not health officers (traditional midwives, friends, and family) have a 1.8 times greater tendency to experience early neonatal mortality than infants of mothers who are assisted by health officers (doctors, trained midwives, and nurses). This is in accordance with the research of Prabamurti et al. (2008) which states that babies born to mothers whose parturition are assisted by non-medical officers have a risk of neonatal mortality 6.07 times greater than infants born to medical officers. This is because parturition attendants with medical officers can detect risk factors for infant mortality and have the knowledge, skills, and tools to provide safe and clean assistance as well as to provide postpartum services to mothers and their infants (Departemen Kesehatan, 2002).

Conclusion

The results of 2017 Indonesian Demographic and Health Survey showed that 0.5% of newborns died at the first seven days of life. Infants who were more likely to deaths at the first seven days of life were born to working mothers, mothers with aged <20 years and >35 years, born with low birth weight (<2500 grams), male infants, and parturition attendants who were not the health officers. About 65.3% of early neonatal deaths were born to working women, 40% were born to <20 years and >35 years of women, 44% were low birth weight, 69.3% were male and 56% were born by pregnant women whose parturition are not assisted by health officers.

Compared to India, neonatal mortality rate in Indonesia is lower. A research by Mehkarkar (2018) states that out of the 2073 total births, there were 75 early neonatal deaths (END) which is nearly 36.18 per 1000 live births. About 50% of deaths were observed in mothers with age <20 years, 25% deaths observed in mothers of age group 20-29 years, and similar percentage is with age >30 years, 70% were among low birth weight babies.

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Annex: Descriptive Statistics

Table 1
Number and Percentage of Early Neonatal Mortality by Selected Independent Variables

Independent Variable	Dependent Variable Early Neonatal Mortality		Total
Working Status	**Died at 0-6 days**	**Survived at aged 6 days**	
Working	49 (0.8)[65.3]	6442 (99.2)[45.3]	6491 (100.0)
Not working	26 (0.3)[44.7]	7768 (99.7)[54.7]	7794 (100.0)
Total	75 (0.5)[100.0]	14210 (99.5)[100.0]	14285 (100.0)
Maternal Age at Childbirth			
<20 and >35 years	30 (0.9)[40.0]	3282 (99.1)[23.1]	3312 (100.0)
20-35 years	45 (0.4)[60.0]	10928 (99.6)[76.9]	10973 (100.0)
Total	75 (0.5)[100.0]	14210 (99.5)[100.0]	14285 (100.0)
Infant Weight at Birth			
<2500 grams	33 (3.4)[44.0]	934 (96.6)[6.6]	967 (100.0)
≥2500 grams	42 (0.3)[56.0]	13276 (99.7)[93.4]	13318 (100.0)
Total	75 (0.5)[100.0]	14210 (99.5)[100.0]	14285 (100.0)
Sex of the Infants			
Male	52 (0.7)[69.3]	7234 (99.3)[50.9]	7286 (100.0)
Female	23 (0.3)[30.7]	6976 (99.7)[49.1]	6999 (100.0)
Total	75 (0.5)[100.0]	14210 (99.5)[100.0]	14285 (100.0)
Parturition Attendants			
Not Health Officers	42 (0.9)[56.0]	4487 (99.1)[31.6]	4529 (100.0)
Health Officers	34 (0.3)[44.0]	9722 (99.7)[68.4]	9756 (100.0)
Total	75 (0.5)[100.0]	14210 (99.5)[100.0]	14285 (100.0)

Source : 2017 IDHS Raw Data
Note : numbers in parentheses are percentages