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AUDRIA MEUTHIA BASYADI & BERLY MARTAWARDAYA

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By Audria Meuthia Basyadi & Berly Martawardaya

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No More Grieving Parents: Determinant of Neonatal Death in Indonesia

Audria Meuthia Basyadi[1] & Berly Martawardaya[1,2]

[1]Faculty of Economics & Business, Universitas Indonesia, Indonesia
[2]Institute for Development of Economics and Finance (INDEF), Indonesia

Abstract

Neonatal mortality contributes the highest portion in under-five mortality, globally. Similar pattern also occurred in Indonesia. Additionally, the decreasing rate of neonatal mortality in Indonesia is slower than infant mortality and under-five mortality. In addition to be used as a basis *Rencana Pembangunan Jangka Menengah Nasional* (RPJMN) 2020-2024, an understanding of the factors associated with neonatal mortality is important as they may differ from factors that affect infant and/or under-five mortality. The data used for this study was the 2017 Indonesia Demographic and Health Survey (IDHS). Respondents of this study include births from ever-married-women, who died during their neonatal period in the past five years preceding the survey. The results show that opposing trends can be seen in the factors proven to have significance in neonatal death. On one hand, second, third as well as fourth-and-so-on born, low birth weight, neonates with less than 24 months of birth interval compared with preceding birth, neonates with very small birth size, neonates with unemployed fathers had lower chance of surviving neonatal period. On the other hand, female neonates, neonates with unemployed mothers, neonates whose mothers working in agricultural sector, and neonates living in Sumatra, Sulawesi, Nusa Tenggara, Maluku, and Papua were more likely to survive neonatal period. To address these results, provision of reproductive health education, encouragement programs for pregnant women to keep pre-existing medical illness under control and maintain their weight during pregnancy, awareness programs for mothers to take postnatal care, provision of basic education for fathers, law enforcement of more flexible maternity leave, and efforts to strengthen health facilities are needed.

Keywords: neonatal mortality, child health, population health, Indonesia
JEL classification: I120, I140, I150

1. Background

Health status is an essential priority for most societies. It makes an important contribution to a nation's development and its economic progress, as healthy populations live longer are more productive (World Health Organization, 2008). According to World Health Organization (2006), there are a couple of factors that affect the health status of a country, such as neonatal mortality. Globally, under-five mortality is contributed the most by neonatal mortality (UN IGME, 2018), which is defined as the probability of dying within the first month of life (The DHS Program, n.d.). This indicates the importance of knowing the current trends of neonatal deaths. Figure 1 shows that Sub-Saharan has the highest number of neonatal deaths, followed by South Asia and Southeast Asia, respectively.

[1] Author can be contacted at basyadi.audria@gmail.com and bmartawardaya@indef.or.id

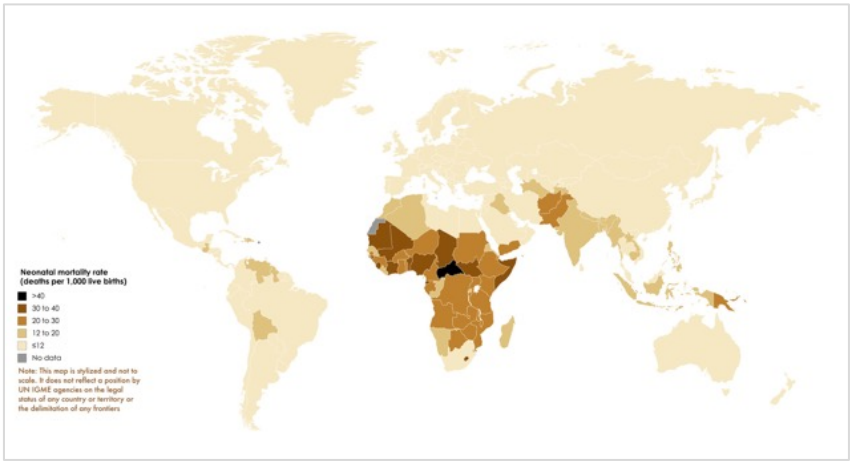

Figure 1 Neonatal Mortality Map
Source: United Nation Inter-Agency Group for Child Mortality Estimation (UN IGME) (2018).

Figure 2 shows the comparison of NMR between Southeast Asian countries from 1990 to 2017. Indonesia, initially, was the country with the third highest level of neonatal mortality amongst other Southeast Asia countries. In 2013, NMR in Indonesia has started to become lower than the Philippines, marking Indonesia apparent improvement in reduction of NMR. Still, Indonesia needs to improve its NMR as it is still higher compared to countries with better economic performance, such as Singapore, Malaysia, Vietnam, Brunei Darussalam, and Thailand (The World Bank, 2019).

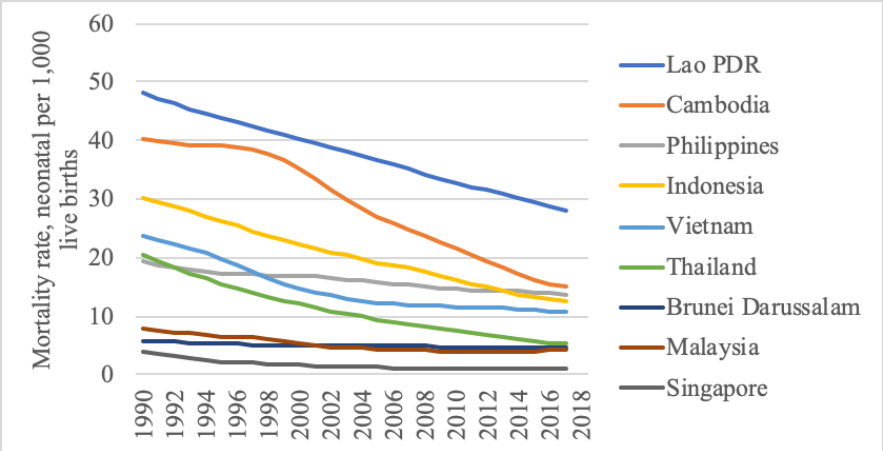

Figure 2. Neonatal Mortality Rate in Southeast Asia
Source: World Bank (2019).

Taking a closer look at Indonesia's current children mortality status, the global trend that was previously mentioned can also be seen in the said country. According to *Kementerian Kesehatan Republik Indonesia* (2019), children dying within the first month of life contributes approximately 47 percent to the total number of children dying between birth and the fifth birthday. Furthermore, improvement in the levels of childhood mortality rates can be seen in Figure 3, the decreasing rate of neonatal mortality in Indonesia is less than those of infant mortality and under-five mortality. On average, neonatal deaths decreased by 2.8 percent from 1987 to 2017. For the same time frame, infant and under-five deaths fell by 7.8 and 10.8 percent, respectively (*Badan Kependudukan dan Keluarga Berencana*, 2018).

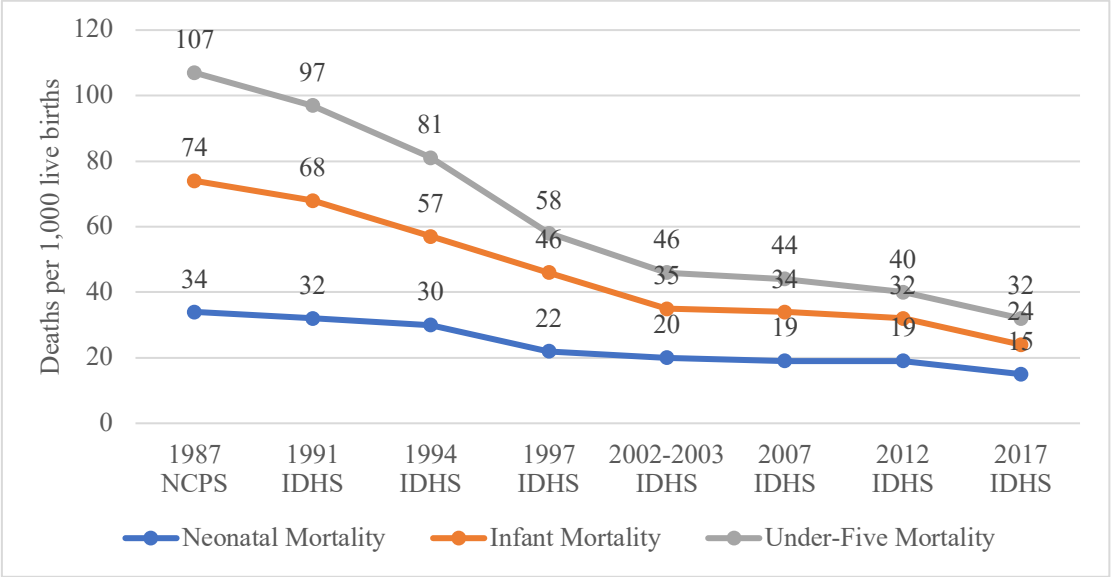

Figure 3. Trends of Indonesia Childhood Mortality
Source: *Badan Kependudukan dan Keluarga Berencana* (2018)

Improvement in the levels of childhood mortality rates can be caused by changes in the trends of factors found to be associated with these rates. However, these rates may have different determinants from one another. As previously mentioned, neonatal deaths contribute the highest percentage in under-five mortality; hence, a study and analysis of factors affecting neonatal deaths is needed. Moreover, a study regarding this topic is needed to be used as a basis for *Rencana Jangka Panjang Menengah Nasional* (RPJMN) 2020-2024 as results from RPJMN 2014-2019 show that neonatal death is still one of the problems Indonesia still faces (*Badan Perencanaan Pembangunan Nasional*, 2019). While there are previous studies identifying important factors that affect mortality of neonates in Indonesia (e.g. Titaley et al., 2008; Afifa, 2009), these studies did not explain the current phenomenon; thus, an updated study is needed to explain the current trends.

2. Literature Review

A theoretical framework to study the determinants of child survival in developing country was proposed by Mosley and Chen (1984). Social science and medical science models are linked in this framework. The medical science concept is represented by proximate determinants, which are the immediate causes of a possible increase in morbidity and mortality of children. These variables are grouped into: 1) maternal factors, 2) environmental contamination, 3) nutrient deficiency, which is the nutrient availability needed. 4) injury, and 5) personal illness control. These determinants have been previously mentioned and discussed in "Health Field Concept" developed by Lalonde (1974) and Blum (1981). Additionally, as socioeconomic factors indirectly affect child survival, they must operate through proximate determinants. These factors are grouped into: 1) individual-level variables, 2) household-level variables, and 3) community-level variables.

Previous studies have shown the significance and the effects of these factors on neonatal deaths. Factors significant in these studies include antenatal care (Debelew et al, 2014; Kolola et al., 2016; Kayode et al., 2014; Hong et al., 2017; Subramanian and Corsi, 2014), birth order (Debelew et al., 2014; Ezeh et al., 2014; Nisar and Dibley, 2014; Neal et al.,

2018), provincial region (Nisar and Dibley, 2014; Titaley et al., 2008; Huda et al., 2016; Hong et al., 2017), delivery complication (Debelew et al., 2014; Nisar and Dibley, 2014; Titaley et al., 2008; Al Kibria et al., 2018), birth size (Debelew et al., 2014; Ezeh et al., 2014; Nisar and Dibley, 2014; Kolola et al., 2016; Titaley et al., 2008), health-seeking behaviour (Kayode et al., 2014; Huda et al., 2016; Subramanian and Corsi, 2014), gestational age at birth (Debelew et al., 2014; Al Kibria et al., 2018; Goyande et al., 2015), wealth index (Nisar and Dibley, 2014; Hong et.al., 2017; Goyande et al., 2015), and postnatal care (Kolola et al., 2016; Titaley et al., 2008; Kayode et al., 2014.

Other studies also show additional factors that are found significant to neonatal mortality. Twin birth (Debelew et al., 2014; Kayode et al., 2014; Al Kibria et al., 2018), maternal age (Ezeh et al., 2014; Al Kibria et al., 2018; Neal et al., 2018; Huda et al., 2016), cluster area (Ezeh et al., 2014; Huda et al., 2016; Hong et al., 2017), sex of neonate (Ezeh et al., 2014; Kolola et al., 2016; Titaley et al., 2008; Al Kibria et al., 2018), birth interval (Ezeh et al., 2014; Titaley et al., 2008; Hong et al., 2017), maternal, newborn, and child health intervention (Subramanian and Corsi, 2014), delivery place (Debelew et al., 2014; Kolola et al., 2016), delivery mode (Ezeh et al., 2014; Goyande et al., 2015), birth weight (Kayode et al., 2014; Goyande et al., 2015), neighborhood deprivation index (Kayode et al., 2014; Huda et al., 2016), exclusive breastfeed (Kolola et al., 2016; Kayode et al., 2014), number of children in the family (Yirgu et al., 2017), and maternal education (Huda et al., 2016; Goyande et al., 2015) are also found to have effects on neonatal mortality.

In addition to the factors previously mentioned, neonatal mortality is also found to be affected by tetanus toxoid injection (TTI) (Kolola et al., 2016), history of child death (Yirgu et al., 2017; Al Kibria et al., 2018), and delivery assistance (Titaley et al., 2008; Kayode et al., 2014), maternal employment status (Titaley et al., 2008), premature rupture of membrane (Debelew et al., 2014), paternal employment status (Titaley et al., 2008), vaccination (Subramanian and Corsi, 2014), contraceptive use (Subramanian and Corsi, 2014), improved sanitary facilities (Subramanian and Corsi, 2014), bednets (Subramanian and Corsi, 2014), family planning need satisfaction (Subramanian and Corsi, 2014), safe water (Subramanian and Corsi, 2014), family size (Yirgu et.al., 2017), road (Huda et al., 2016), and neonatal care (Debelew et al., 2014).

3. Data and Methodology

The data used for this study is the 2017 Indonesia Demographic and Health Survey (IDHS). IDHS provides information on various subjects (e.g. socioeconomic background, breastfeeding practices, childhood and adult mortality, etc). IDHS is jointly executed by Badan Pusat Statistik (BPS), Badan Kependudukan dan Keluarga Berencana Nasional (BKKBN), and Kementrian Kesehatan (Kemenkes) due to the President's policy of "Satu Data Indonesia". In its execution, BPS, BKKBN, and Kemenkes are assisted by the Inner-City Fund (ICF) International through the Demographic and Health Surveillance (DHS) Program by the United States Agency for International Development (USAID). Futhermore, IDHS has been conducted in 1987, 1991, 1994, 1997, 2002-2003, 2007, 2012, and 2017 – a total of 8 waves of IDHS. The dataset used in the study are taken from the child database that contains information on the birth histories of children who were born up to five years preceding the survey from mothers aged 15 to 49 years during the interview.

The DHS Program (n.d) define neonatal mortality as the probability of children dying within the first month of life (0 to 28 days). Based on the definition, this study only includes children who died during their neonatal period in order to capture neonatal mortality. Children who died after their first month of life (1 month or older) are categorized into survived children

together with the ones who are still alive during the interview. The sample size for this study is 15,986 due to missing values in certain variables used. The said variables include unrecorded birth weight as there are some babies with unknown birth weight, whether from official records or the mother's memory. Most of these babies were born at home, so adequate tools to measure record the new-borns' weight may not be available.

This study is going to use binary logistic regression model, mainly adapted from study by Kayode et al. (2014), with additional variables from previous studies listed in Section 2.3. This model is chosen because the dependent variable used is in a binary form: (1) died before attaining the age of one month during the process of collecting the data, and (2) alive during the process of data collection. This logistic model can be used to see the probability of the occurrence of an event by considering combination of independent variables or predictor variables. Processing and data analysis are done by using Stata 14.1. The model of regression analysis used or the regression equation is expressed in the form of logit mode as follows:

$$L_i = \beta_0 + \beta_1 neonatal + \beta_2 antenatal + \beta_3 delivery + \beta_4 postnatal + \beta_5 maternal + \beta_6 paternal + \beta_7 household + \beta_8 region + \beta_9 residence + e_{ijk}$$

Where:

neonatal: Neonatal Factors
antenatal: Antenatal Factors
delivery: Delivery Factors
postnatal: Postnatal Factors
maternal: Maternal Factors
paternal: Paternal Factors
household: Household Factors
region: Region
residence: Place of Residence

4. Empirical Results

Table 1 shows the incidence of neonatal mortality in Indonesia, In the 2017 IDHS, the number of neonates who died in the five years preceding 2017 was 15 per 1,000 live births.

Table 1 Incidence of Neonatal Mortality per 1,000 live births

Neonatal Mortality	Standard Deviation	No. of Observations
15	0.1214612	15,464

Additionally, cross tabulations were conducted to examine the impact of all potential predictors on neonatal mortality without adjusting for other covariates (see Table 2). Looking at each of the categorical variables, the categories with the highest proportion in neonatal survival are first born, neonates with more than 2500 grams of birth weight, neonates that have more than 48 months of birth interval compared with preceding birth, male neonates, neonates with average birth size, singletons, neonates born in private facility, neonates whose mothers did not go through caesarean section procedure during delivery, neonates born with the help of semi trained assistants, neonates receiving postnatal care, neonates whose mothers were between 20 to 29 years old when they gave birth, neonates whose mothers obtained secondary level education, neonates with unemployed mothers, neonates whose mothers have autonomy over her own health, neonates who were no breastfed by their mothers, neonates whose mothers receive tetanus toxoid injection, neonates with fathers who obtained secondary level education, neonates whose fathers working in services sector, neonates whose family is classified into “richer”, neonates living in Java and Bali, and neonates living in urban area.

Table 2 The 2017 IDHS Contingency Table

Variables	Neonate Health Status		
	Alive	Died	Total
Birth Order			
1	98.54%	1.46%	100%
2	98.73%	1.27%	100%
3	98.44%	1.56%	100%
4+	97.85%	2.15%	100%
Birth Weight			
< 2500 grams	94.37%	5.63%	100%
2500 grams or more	99.06%	0.94%	100%
Birth Interval			
< 24 months	98.35%	1.65%	100%
25-36 months	98.90%	1.10%	100%
37-48 months	98.19%	1.81%	100%
49+ months	98.63%	1.37%	100%

Variables	Neonate Health Status		
	Alive	Died	Total
Maternal Education			
No education	97.42%	2.58%	100%
Primary level	98.41%	1.59%	100%
Secondary level	98.67%	1.33%	100%
Tertiary level	98.07%	1.93%	100%
Maternal Occupation			
Unemployed	98.78%	1.22%	100%
Services	98.06%	1.94%	100%
Agricultural	98.20%	1.80%	100%
Industrial	99.02%	0.98%	100%
Maternal Autonomy on Her Own Health			
Do not participate	98.30%	1.70%	100%
Participate	98.53%	1.47%	100%

Sex of Neonate			
Male	98.12%	1.88%	100%
Female	98.90%	1.10%	100%
Birth Size			
Very small	98.90%	1.10%	100%
Small	99.28%	0.72%	100%
Average	98.80%	1.20%	100%
Large	97.09%	2.91%	100%
Very large	85.77%	14.23 %	100%
Twin Birth			
Singleton	98.60%	1.40%	100%
Twin	91.49%	8.51%	100%
Delivery Place			
Home	98.90%	1.10%	100%
Public facility	98.01%	1.99%	100%
Private facility	98.68%	1.32%	100%
Other	98.82%	1.18%	100%
Delivery Mode			
Non-caesarean section	98.60%	1.40%	100%
Caesarean section	98.05%	1.95%	100%
Delivery Assistant			
Trained	98.02%	1.98%	100%
Semi trained	98.88%	1.12%	100%
Other	98.58%	1.42%	100%
PCV			
No visit	96.64%	3.36%	100%
Visit	99.58%	0.42%	100%
Maternal Age			
< 20 years	98.65%	1.35%	100%
20-29 years	98.53%	1.47%	100%
30+ years	97.62%	2.38%	100%

Breastfeed			
Do not breastfeed	97.97%	2.03%	100%
Breastfeed	99.23%	0.77%	100%
TTI			
Do not receive	98.65%	1.35%	100%
Receive	98.46%	1.54%	100%
Paternal Education			
No education	94.38%	5.62%	100%
Primary Level	98.80%	1.20%	100%
Secondary Level	98.54%	1.46%	100%
Tertiary Level	98.00%	2.00%	100%
Paternal Occupation			
Unemployed	98.69%	1.31%	100%
Services	98.60%	1.40%	100%
Agricultural	98.39%	1.61%	100%
Industrial	98.41%	1.59%	100%
Household Wealth			
Poorest	98.46%	1.54%	100%
Poorer	98.61%	1.39%	100%
Average	98.81%	1.19%	100%
Richer	98.21%	1.79%	100%
Richest	98.43%	1.57%	100%
Region			
Sumatra	98.32%	1.68%	100%
Java & Bali	98.68%	1.32%	100%
Kalimantan	98.40%	1.60%	100%
Sulawesi	98.37%	1.63%	100%
Nusa	97.81%	2.19%	100%
Place of Residence			
Rural	98.73%	1.27%	100%
Urban	98.29%	1.71%	100%

Conversely, neonatal deaths are contributed the highest by first born neonates with more than 2500 or more grams of birth weight, neonates that have less than 24 months of birth interval compared with preceding birth, male neonates, neonates with average birth size, singleton neonates, neonates born in private facility, neonates whose mother did not go through caesarean-section procedure during delivery, neonates born with the help of trained

assistants, neonates who did not receive postnatal care, neonates whose mothers were between 20 to 29 years old when they gave birth, neonates whose mothers obtained secondary level education, neonates with mothers working in services sectors, neonates whose mothers have autonomy over her own health, neonates who were not breastfed by their mothers, neonates whose mothers receive tetanus toxoid injection, neonates with fathers who obtained secondary level education, neonates whose fathers working in services sector, neonates whose family is classified into "richer", neonates living in Java and Bali, and neonates living in urban area.

As part of the multivariate analysis, possible associated factors were examined for evidence of multicollinearity using variance inflation factor (VIF) (see Appendix 3). Using a cut-off point of 5.0 (Ringle et al., 2015), no variables were excluded from the model.

Table 3 shows the regression results for neonatal mortality. Using these results, it can be seen that there are variables that proven significant to the model, indicating the rejection of null hypotheses. These variables include birth order, birth weight, birth interval, sex of neonate, birth size, delivery assistant, maternal occupation, and region.

Table 3 Regression Results for Neonatal Mortality

NMR	Odds Ratio	P>|t|
Birth Order (ref=1st order)		
2nd order	6.1071**	0.002
3rd order	7.1814**	0.004
4th+ order	10.7653***	0.001
Birth Weight (ref=2500+ gram)		
< 2500 gram	2.9495**	0.015
Birth Interval (ref=48+ months)		
< 24 months	2.5975*	0.057
36-47 months	1.5708	0.455
48+ months	1.1092	0.878
Sex of Neonate (ref=male)		
Female	0.3376**	0.004
Birth Size (ref=average)		
Very small	13.7139***	0.000
Small	1.3773	0.513
Large	0.5531	0.278
Very large	1.1633	0.8910
Twin Birth (ref=singletons)		

Twin	0.3254	0.154
ACV		
Number of visit	0.7549	0.418
Delivery Place (ref=private)		
Home	0.4490	0.219
Public	1.6583	0.160
Other	0.9799	0.988
Delivery Mode (ref=non-caesarean section)		
Caesarean section	1.1680	0.739
Delivery Assistant (ref=trained)		
Semi Trained	1.0297	0.950
Other	0.4281	0.165
PCV (ref=no visit)		
Visit	0.08536***	0.000
Maternal Age (ref=20-29 years)		
< 20 years old	0.6314	0.232
30+ years old	1.1061	0.845
Maternal Education (ref=secondary)		
Uneducated	0.4518	0.441
Primary Level	1.0480	0.917
Tertiary Level	1.1423	0.780
Maternal Occupation (ref=service)		
Unemployed	0.3175***	0.001
Agricultural	0.13363*	0.073
Industrial	1.1290	0.773
Maternal Autonomy on Own Health (ref=do not participate)		
Participate	0.7221	0.531
Breastfeed (ref=do not breastfeed)		
Breastfeed	0.9856	0.970
TTI (ref=do not receive)		
Receive	1.6440	0.288

Paternal Education (ref=secondary)		
Uneducated	9.59437***	0.001
Primary Level	0.9607	0.927
Tertiary Level	1.2134	0.689
Paternal Occupation (ref=service)		
Unemployed	0.3602	0.350
Agricultural	1.7916	0.214
Industrial	0.7605	0.566
Household Wealth (ref=rich)		
Poorest	0.7107	0.570
Poor	0.7917	0.690
Middle	0.7657	0.611
Richest	0.5782	0.284
Region (ref=Java & Bali)		
Sumatra	0.4752*	0.092
Kalimantan	0.6877	0.531
Sulawesi	0.2793**	0.027
Nusa	0.3296**	0.025
Place of Residence (ref=urban)		
Rural	0.9216	0.846
_cons	0.0124	0.003

*** p < 0.001; ** p < 0.05; * p < 0.1

The significance of birth order may be caused by several reasons. First and early born are most likely to receive parental resources, including time and material, than later born. Later born usually have to compete with elder siblings over resources right after they are born (Elliot, 1992). Additionally, a large number of children may cause increases the risk of communicable diseases towards younger siblings (Elliott, 1992; Holman et al. 2003).

Conde-Agudelo et al. (2012) and Dewey and Cohen (2007) found that short birth interval is related to “maternal depletion syndrome”, which suggest that mothers may not have fully recover from her previous pregnancy, and therefore, cannot support the next child. Moreover, Hart et al. (2004) and Batty et al. (2007) have shown that having normal birth weight or birth size will cause improvement in the health of the babies later on in life. Conversely, babies born with low birth weight or birth size have a high risk of getting chronic illness or

development problems, which may lead to the increase risk of early death (Tinker and Ransom, 2002; Zylbersztejn, 2018). These reasons could be used in explaining the significance of birth weight and birth size.

The significance of sex of neonate could be explained by the nature of genetic endowment. If both parents carry the trait for a genetically determined disease, the baby has at least 25 percent chance of inheriting that condition, increasing the risk of dying at a young age (Sick Kids, n.d.). Moreover, several studies show that male are more prone to be exposed to chronic illness than female (Harvard Men's Health Watch, 2010; Vlassof, 2007, "X-linked inheritance", n.d.).

According to the World Health Organization (2013), postnatal visits give opportunities for health personnel to facilitate healthy breastfeeding practices as well as monitor the newborn's growth and overall health status, which is crucial for neonates, especially those who are only one week old as they are found more likely to be exposed to illness than other children in their neonatal period (Kementerian Kesehatan Republik Indonesia, 2018).

Previous studies by Basu et al. (1991), Baum (2003), Berger et al. (2005), and Dagher et al. (2013) shows the link of maternal occupation and children health status through maternity leave duration. They found that a high flexibility of maternity leave duration can increase the amount of time mothers spent with their babies. Children time's with parents is a crucial factor in children's health and development. It gives parents the opportunity to monitor their children's activities and deter health risk behaviours (Dishion and McMahon, 1998) and arrange health care appointments (Clemans-Cope et al., 2008; Heymann and Earle, 1999), decreasing the risk of mortality.

According to Chen and Li (2009), paternal education is proven to have significance over various things as in developing countries, fathers tend to have higher education than mothers. Fathers with higher education tend to have more knowledge on maintaining baby-father bond and adequate ways to care for their babies. This indicates that these fathers have better judgement in deciding things related to their child's health conditions (Chen et al., 2017; Khashu et al., 2018; Martínez et al., 2007), and thus, improving the health status of their children.

The significance of regional variables may be due to the number of health providers and facilities. Jakarta has a well-developed health services available, followed by Yogyakarta and Bali; however, most other provinces fall far below, especially those in Eastern Indonesia. The regional imbalance in health care delivery can be explained not only in terms of facility distribution among provinces and districts, but also by geography. Most regions in Eastern Indonesia are larger in size, compared to Jakarta. Despite of the comparable number of health services per capita, these services are sparsely distributed, causing the possible difficulty for people, including neonates, to reach adequate facilities (National Research Council of the National Academies and Indonesian Academy of Sciences, 2013). Additionally, the significance of this variable may be explained by the different regional level of air pollution. According to Schwartz et al. (1994), the air quality of a region could increase the likelihood of chronic ill diseases, such as asthma. Thakare and Vijaya (2011) also found that children living in areas with low level of air pollution have better lungs than those living in areas with high concentration of air pollution, which leads to a longer span of life.

The average marginal effects for all covariates can be seen in Table 4. The probability of neonatal death increases by 1.18 and 1.29 percentage points in neonates born as the second and third child, respectively, than in first born. Additionally, neonates who are the fourth, fifth, sixth, and so on, are 1.56 percentage points more likely to die during their neonatal period than first born. This might be caused by less parental resources that these neonates received compared to their older siblings (Elliot, 1992).

Table 4 Marginal Effects of Regression Result for Neonatal Mortality

Variable	dy/dx	P>|z|
Birth Order (ref=1st order)		
2nd order	0.0118**	0.003
3rd order	0.0129**	0.006
4th+ order	0.0156**	0.002
Birth Weight (ref=2500+ gram)		
< 2500 gram	0.0071**	0.022
Birth Interval (ref=48+ months)		
< 24 months	0.0062*	0.058
36-47 months	0.0030	0.460
48+ months	0.0007	0.878
Sex of Neonate (ref=male)		
Female	-0.0071**	0.005
Birth Size (ref=average)		
Very small	0.0171***	0.000
Small	0.0021	0.510
Large	-0.0039	0.280
Very large	0.0010	0.891
Twin Neonates (ref=singletons)		
Twin	-0.0073	0.163
ACV		
Number of visits	-0.0018	0.418
Delivery Place (ref=private)		

Home	-0.0052	0.229
Public	0.0033	0.166
Other	-0.0001	0.988
Delivery Mode (ref=non-caesarean section)		
Caesarean section	0.0010	0.738
Delivery Assistant (ref=trained)		
Semi Trained	0.0002	0.950
Other	-0.0056	0.164
PCV (ref=no visit)		
Visit	-0.0161***	0.000
Maternal Age (ref=20-29 years)		
< 20 years old	-0.0030	0.249
30+ years old	0.0007	0.845
Maternal Education (ref=secondary)		
Uneducated	-0.0052	0.442
Primary Level	0.0003	0.917
Tertiary Level	0.0009	0.779
Maternal Occupation (ref=service)		
Unemployed	-0.0075***	0.003
Agricultural	-0.0132**	0.087
Industrial	0.0008	0.774
Maternal Autonomy on Own Health (ref=do not participate)		
Participate	-0.0021	0.535
Breastfeed (ref=do not breastfeed)		
Breastfeed	-0.0001	0.971
TTI (ref=do not receive)		
Receive	0.0033	0.291
Paternal Education (ref=secondary)		
Uneducated	0.0148***	0.002
Primary Level	-0.0003	0.928
Tertiary Level	0.0013	0.688

Paternal Occupation (ref=service)		
Unemployed	-0.0067	0.360
Agricultural	0.0038	0.218
Industrial	-0.0018	0.566
Household Wealth (ref=rich)		
Poorest	-0.0022	0.572
Poor	-0.0015	0.690
Middle	-0.0017	0.613
Richest	-0.0036	0.283
Region (ref=Java & Bali)		
Sumatra	-0.0049*	0.104
Kalimantan	-0.0023561	0.535
Sulawesi	-0.0084**	0.038
Nusa	-0.0073**	0.039
Place of Residence (ref=urban)		
Rural	-0.0005	0.846

*** p < 0.001; ** p < 0.05; * p < 0.1

Highlighted yellow: significant

Neonates with low birth weights (i.e. born at less than 2500 grams) are 0.71 percentage points more likely to die before attaining the age of one month old. Additionally, neonates with very small birth size are 1.71 percentage points more likely to die within their first month of life. These findings are consistent with studies done by Debelew et al. (2014), Ezeh et al. (2014), Nisar and Dibley (2014), Kolola et al. (2016), and Titaley et al. (2008).

Neonates who were born less than 24 months after preceding birth are 0.62 percentage points more likely to die within their first month of life, which may be caused by "maternal depletion syndrome" (Conde-Agudelo et al., 2012; Dewey and Cohen, 2007). The probability of neonatal death decreases by 0.71 percentage points in female neonates than in male neonates, which could be explained by several reasons. According to World Health Organization (2007), male nutritional status during childhood is consistently worse than of female, which could lead to faltering health status of children, and thus, increasing the risk of mortality.

The probability of children dying during their neonatal period falls by 1.61 percentage points when they receive postnatal care services, compared to those who do not. Titaley et al. (2008) also found similar finding in their study that use the 2002-2003 IDHS data set.

Additionally, this finding is in line with those found in studies by Kolola et al. (2016) and Kayode et al. (2014).

Unemployed mothers are 0.75 percentage points less likely to lose their neonates during their babies' first month of life than mothers working in services sector, which might be caused by less time employed mothers spend with their neonates (Duckett and Richards, 1989; Hill and Stafford, 1980). Similarly, mothers working in agricultural sector are 1.32 percentage points less likely to lose their babies during neonatal period than those working in service sector. Baidya et al. (2002) argued that women working in agricultural sector have more flexible time than those working in service sector. For mothers, this means that they are more likely to have flexible work time in agricultural sector and use their spare time to take care of their babies.

In comparison with fathers who obtained secondary education level, the probability of losing their neonates increase by 1.48 percentage points for uneducated fathers. As previously mentioned, fathers who completed higher education level are more knowledgeable and thus, can make adequate decisions to maintain their children's health (Chen et al., 2017; Khashu et al., 2018; Martínex et al., 2007). This could indicate that uneducated fathers have less knowledge on child-health related things than fathers who completed secondary education level, which may increase the chance of neonatal deaths.

The probability of children dying during their neonatal period are 0.49, 0.84, and 0.73 less likely for neonates living in Sumatra; Sulawesi; and Nusa Tenggara, Maluku, and Papua, respectively, when compared to those living in Java and Bali. While Sulawesi as well as Nusa Tenggara, Maluku, and Papua have adequate amount of health services available, the distribution of these health facility are sparsely distributed in comparison with those in Java and Bali (National Academy of Sciences, 2013). Moreover, the level of air pollution in Java and Bali are higher than in Sumatra, Sulawesi, Nusa Tenggara, Maluku, and Papua (IQ Air, 2019). The worse air pollution could reduce the lifespans of neonates (Thakare and Vijaya, 2011).

Comparing the amount of marginal effects these variables have on neonatal deaths, the variable with the most impact is birth size, followed by postnatal care visits, birth weight, sex of neonates, maternal occupation, region, and paternal education level.

5. Conclusions and Recommendations

The objective of this research is to study the common characteristics seen in neonates dying within their first month of life and to factors affecting neonatal deaths. The 2017 Indonesia Demographic and Health Survey data was used. Binary logistic regression model was used to examine the effects of pre-determined variables on neonatal mortality. These variables themselves are chosen based on findings from various previous studies and some were found to be significant in affecting neonatal deaths. Neonates that are fourth born, fifth born, and so on, are more likely to experience neonatal death than first born. Additionally, neonates with low birth weights (i.e., children with less than 2500 grams) are more likely to die within their first month of life than normal birth weights. Female neonates are less likely to die before attaining the age of one month old that male neonates. Moreover, neonates with very small birth size are more likely to die during their neonatal period than those with average birth size. Mothers who take their neonates to postnatal care are less likely to lose their neonates than those who do not. Furthermore, unemployed and mothers working in agricultural sector

are less likely to lose their neonates than those working service sector. Uneducated fathers are more likely to lose their neonates than fathers who obtained secondary education level. Neonates living in Sumatra, Sulawesi, Nusa Tenggara, Maluku, and Papua are less likely to die than those living in Java and Bali.

To address these results, implementation of public health intervention should be directed at various factors. Firstly, provision of reproductive health education should be done, specifically emphasizing on the importance of birth order of children and controlling family size. This is done to ensure that younger children in the family will have adequate parental resources spend on them. Secondly, pregnant women should be encouraged to keep pre-existing medical illness (e.g., anaemia) under control and maintain their weight during pregnancy as according to *Kementerian Kesehatan Republik Indonesia* (2018), anaemia and underweight as well as overweight pregnant women may cause low birth weight and very small birth size of their children.

In addition, mothers should be encouraged to take postnatal care to monitor their new-born's growth and overall health status. This should be emphasized even further when the neonates are only one week old as they are more prone to getting sick than other neonates (*Kementerian Kesehatan Republik Indonesia*, 2018). Law enforcement of more flexible maternity leave should also be done, especially for mothers working service sector. More flexible maternity leave can reduce the level of maternal stress during pregnancy and increase the time mothers spend with their neonates.

Furthermore, provision of basic education for fathers should be done as educated fathers are more able to make adequate decisions related to their children's health decisions. Lastly, efforts to strengthen health facilities, specifically in Java and Bali should be done. In spite of the large number of health facilities available in these regions, the air pollution in cities within these regions are higher compared to other cities outside the said regions.

Future studies may address the adequate policies to increase the survival level of neonates. It is also interesting to see comparison of neonatal mortality determinants among Southeast Asia countries. Another intriguing topic to be discussed in a follow-up study is the effects of genetic endowment/hereditary factors on neonatal mortality as the said factors are not available with the data used in this study.

This study had several limitations. First, there is a possibility that neonatal mortality might have been underestimated as only surviving mothers had the opportunity to be interviewed. For example, mothers that died during labour with their yet-to-be-born babies would be omitted in the analysis. Second, variables such as environmental and genetic factors were not available in the survey. Lastly, there are variables which are not neonates-specific due to the nature of them being the reflection of the most recent condition. For example, maternal and paternal occupation were representation of employment status within the last twelve months preceding the survey.

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