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Neonatal survival analysis: the relationship between neonatal mortality and the number of antenatal care visits (2017 Indonesia Demographic and Health Survey)

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Abstract

Purpose: In 2021, the number of under-five child deaths in Indonesia reached 27.566, with 28.158 (73,1%) of these being neonatal deaths. Indonesia implemented a minimum of four prenatal visits (K4) in 2019. The number of antenatal care (ANC) visits according to WHO standards has not been fully implemented nationwide in Indonesia. This study aims to analyze neonatal survival related to the number of ANC visits and neonatal death incidents based on the 2017 IDHS data. **Methods:** This study used a cross-sectional method with data from the 2017 IDHS. The sample included women of childbearing age (15-49 years) who had given birth within five years before the survey and had recorded ANC visits during their last pregnancy. Data analysis was performed using descriptive life-table and Kaplan-Meier Curve, bivariate analysis using Log Rank Test, and multivariate analysis using Cox Regression. **Results:** The study involved 13.826 women of childbearing age who were survey respondents. Univariate analysis showed that most respondents were at low risk during pregnancy (73.55%), belonged to the lowest wealth quintile (22.18%), and had a high education level (52.91%). Most babies were born with normal birth weight (92,89%) and were male (51,43%). The majority of ANC visits fell into the K6 category (47,59%). Kaplan-Meier survival analysis showed significant neonatal deaths within the first five days, with the survival probability dropping to 99,50% by the fifth day. Multivariate analysis identified maternal age, birth weight, baby's sex, and place of delivery as significant factors affecting neonatal mortality. Higher maternal age, lower birth weight, and male sex increased the risk of neonatal death, while delivering in a health facility was associated with higher neonatal mortality. **Conclusion:** The study found that ANC visits were significant in the K6 and K8 categories. However, when multivariate analysis was performed, the significance was lost when the birth weight variable was included. Most ANC visits were in the K6 category, which is Indonesia's standard for at least six antenatal visits. Maternal age, baby's sex, birth weight, and the number of babies significantly affected neonatal survival. The neonatal mortality rate was 6,4 per 1.000 live births.

Keywords: antenatal care visits; neonatal mortality; 2017 IDHS

INTRODUCTION

Neonatal mortality remains a critical global health issue, with approximately 2.3 million neonatal deaths reported in 2021, equating to around 6,400 deaths daily. Despite global reductions in neonatal deaths, significant disparities persist across regions and countries. The highest rates of neonatal mortality are found in Sub-Saharan Africa and South Asia. Neonates in Sub-Saharan Africa are ten times more likely to die in their first month compared to those in wealthier nations, while in South Asia, the risk is nine times higher. In countries with the highest neonatal mortality rates, the risk of death in the first month of life is approximately 53 times higher than in countries with the lowest rates [1].

In Indonesia, data from the Directorate of Nutrition and Maternal and Child Health indicate that the number of under-five deaths in 2021 was 27,566, a decrease from 28,158 in 2020. Of these, 73.1% occurred during the neonatal period, with 20,154 neonatal deaths. Among these neonatal deaths, 79.1% occurred within the first six days of life, and 20.9% occurred between seven and 28 days. Post-neonatal mortality (ages 29 days to 11 months) accounted for 18.5% of under-five deaths, and mortality in children aged 12-59 months was 8.4%. The primary causes of neonatal deaths in 2021 were low birth weight (34.5%) and asphyxia (27.8%), with other causes including congenital anomalies, COVID-19 infections, neonatal tetanus, and more [2].

Neonatal health is closely linked to the first 1,000 days of life, beginning at conception and including the intrauterine period (230 days). Neonatal mortality can be attributed to various factors, categorized as direct causes related to complications at birth and indirect causes associated with maternal conditions such as hypertension, anemia, the quality of antenatal care (ANC), delivery practices, and maternal characteristics like being too young, too old, having closely spaced pregnancies, or having many children, and delayed recognition of danger signs, decision-making, and seeking help [3].

Based on the explanation above, the researcher proposes the research question: Is neonatal survival related to the number of antenatal visits as a factor causing neonatal mortality, based on the 2017 IDHS data. This research aims to analyze the relationship between neonatal survival and the number of antenatal visits, as well as the incidence of neonatal mortality, based on 2017 IDHS data. Researchers also aim to calculate the rate of neonatal mortality based on The 2017 IDHS data. They will determine the proportion of pregnant women according to the number of antenatal visits and identify the factors related to neonatal mortality.

Neonatal mortality refers to deaths occurring within the first 28 days of life. This period is highly vulnerable, with approximately 2,3 million neonatal deaths globally in 2021. Despite global efforts, the decline in neonatal mortality has not met targets, with a reduction rate of 24% from 1990 to 2021, compared to a 33% reduction in mortality among children aged 1-59 months. The Sustainable Development Goal 3.2 aims to reduce neonatal mortality to less than 12 per 1000 live births. Practical actions focused on the primary causes of neonatal deaths are needed, as nearly 80% of these deaths can be prevented with appropriate care during pregnancy and the neonatal period [1].

According to Mosley and Chen (1984), neonatal mortality is influenced by maternal biological factors, environment, nutrition, and health behaviors. Significant changes occur in a baby's life during the neonatal period, with organ maturation and adaptation to life outside the womb. The primary causes of neonatal mortality include congenital abnormalities, prematurity complications, birth asphyxia, trauma, and neonatal infections [4]. ANC is crucial for improving pregnancy outcomes and reducing neonatal mortality. Regular ANC visits help in monitoring the health of both mother and baby, allowing for timely interventions [5]. The World Health Organization (WHO) recommends a minimum of eight ANC visits to ensure better health outcomes. Indonesia currently mandates at least four ANC visits during pregnancy, following a schedule of one visit in the first trimester, one in the second, and two in the third [5].

Essential variables in child mortality include birth weight, birth interval, sex of the child, type of birth (singleton or multiple), and birth order. Male fetuses have a higher risk of neonatal mortality compared to female fetuses. This is potentially due to differences in proteins, genes, and extracellular microRNA regulation between male and female fetuses. As a result, female fetuses have a better survival rate than male fetuses [6]. This study contributes to the existing body of knowledge by utilizing the latest available data from the IDHS 2017, providing a contemporary analysis of the impact of ANC on neonatal survival rates in Indonesia, which mandates ANC 4 times during pregnancy. Gradually, Indonesia is adopting the WHO's recommendation for at least eight visits, but transitioning to a minimum of 6 visits [7].

METHODS

This study employs a cross-sectional method using data from the 2017 Indonesia Demographic and Health Survey (IDHS). The IDHS is a quantitative study conducted every five years, using a retrospective cohort approach to collect data on women's birth histories over the previous five years. The IDHS gathers data cross-sectionally, with a focus on the reproductive histories of women of childbearing age.

The data collection for the 2017 IDHS took place from July 24 to September 30, 2017, across all 34 provinces in Indonesia. The researcher requested the necessary dataset for analysis. Data processing and analysis were conducted following the issuance of an Exemption Letter (No. KE/FK/0724/EC/2024) on May 21, 2024.

WUS with live births within the last five years, meeting the following inclusion criteria: mothers who delivered live births within the past five years, the birth was the most recent at the time of the survey, the mother had antenatal care (ANC) records, and the birth was a singleton. The study addresses potential biases by ensuring the use of a well-defined sampling frame and standardized data collection methods. Biases related to recall and reporting were mitigated through careful survey design and interviewer training.

Data were collected using standardized questionnaires developed for the IDHS, which include modules on reproductive health, antenatal care, and child health. Data processing involved cleaning, coding, and analyzing the dataset using statistical software. This ensured accuracy and consistency in the analysis. Data analysis was conducted using univariate, bivariate, and multivariate statistical techniques to examine the relationships between ANC visits and neonatal mortality, controlling for confounding variables. The researcher conducted univariate, bivariate, and multivariate analyses on neonatal mortality, ANC visits, and related factors. Kaplan-Meier curves and Multiple Cox Regression were used for survival analysis. Mediation analysis examined birth weight's effect on the relationship between ANC visits and neonatal mortality, using ldecomp syntax in STATA [8].

RESULTS

This chapter presents the research results based on the 2017 Indonesia Demographic and Health Survey (SDKI). The study focused on 13,826 respondents concerning their last pregnancy's antenatal care (ANC) visits. The neonatal mortality rate observed was 6.4 per 1,000 live births (Table 1). Most respondents had six ANC visits, aligning with Indonesia's minimum standard. Positive influences on neonatal survival included maternal age, baby's gender, birth weight, and the number of babies. The number of ANC visits significantly impacted neonatal survival, particularly for those with eight or more visits.

The study found significant variables affecting neonatal mortality, including ANC visits, maternal age, birth weight, baby's sex, and number of babies. Positive impact on survival includes higher ANC visits, non-risk maternal age, higher birth weight, and female sex. Twins had a higher mortality risk than single births. Birth at health facilities showed a higher mortality risk. Taking more than 90 iron tablets improved survival by 4% (Table 2).

Multivariable analysis showed maternal age, birth weight, baby's sex, and place of delivery significantly impacted neonatal mortality (Tables 3 and 4). Non-risk maternal age reduced mortality by 55%, birth weight >2500g by 91%, and female sex by 64%. Birth at health facilities increased the mortality risk by 2.1 times. Birth weight acts as a significant mediator for neonatal survival. Provided descriptive statistics of variables. Consideration of variables like education level, wealth status, maternal age, place of delivery, and receipt of iron tablets during pregnancy.

Table 1. Distribution of characteristics and personal preventive actions of research respondents (n = 13,826)

Variables	Neonatal survival n (%)	Neonatal death n (%)	IR/1,000 Live births	Distribution n (%)
Maternal Characteristics				
Age (years)				
At risk	3,617 (98.91)	40 (1.09)	0.34	3,657 (26.45)
No at risk	10,120 (99.51)	49 (0.48)	0.16	10,169 (73.55)
Wealth level				
Lowest	3,041 (99.18)	25 (0.82)	0.24	3,066 (22.18)
Lower middle	2,764 (99.57)	12 (0.43)	0.17	2,776 (20.08)
Middle	2,732 (99.45)	15 (0.55)	0.17	2,747 (19.87)
Upper middle	2,661 (99.18)	22 (0.82)	0.27	2,683 (19.41)
Highest	2,539 (99.41)	15 (0.59)	0.19	2,554 (18.47)
Education level				
Low	3,239 (99.20)	26 (0.80)	0.27	3,265 (23.61)
Medium	3,227 (99.41)	19 (0.59)	0.13	3,246 (23.48)
High	7,271 (99.40)	44 (0.60)	0.21	7,315 (52.91)

Variables	Neonatal survival n (%)	Neonatal death n (%)	IR/1,000 Live births	Distribustion n (%)
Residence				
Rural	7,140 (99.35)	47 (0.65)	0.24	7,187 (51.98)
Urban	6,597 (99.37)	42 (0.63)	0.17	6,639 (48.02)
Infant Characteristics				
Birth weight (g)				
<2,500	948 (96.44)	35 (3.56)	1.43	983 (7.11)
≥2,500	12,789 (99.58)	54 (0.42)	0.12	12,843 (92.89)
Sex of infant				
Male	7,048 (99.11)	63 (0.89)	0.30	7,111 (51.43)
Female	6,689 (99.61)	26 (0.39)	0.11	6,715 (48.57)
Number of fetuses				
Single	13,634 (99.39)	83 (0.61)	0.20	13,717 (99.21)
Multiple (twins)	103 (94.50)	6 (5.5)	1.41	109 (0.79)
Personal Preventive Actions				
Number of ANC visits				
Inadequate	2,996 (99.04)	29 (0.96)	0.28	3,025 (21.88)
4 visits (K4)	1,325 (99.03)	13 (0.97)	0.39	1,338 (31.56)
6 visits (K6)	6,544 (99.45)	36 (0.55)	0.20	6,58 (47.59)
8 visits (K8)	2,872 (99.62)	11 (0.38)	0.11	2,883 (20.85)
Place of delivery				
Non-health facility	2,604 (99.54)	12 (0.46)	0.12	2,616 (18.92)
Health facility	11,133 (99.31)	77 (0.69)	0.22	11,210 (81.08)
Number of iron tablets consumed during pregnancy (tablets)				
< 90	5,835 (99.37)	37 (0.63)	0.21	5,872 (42.47)
≥90	5,816 (99.45)	32 (0.55)	0.15	5,848 (42.30)
Consumed, but quantity unknown	571 (98.62)	8 (1.38)	0.48	579 (4.19)
No data	1,515 (99.21)	12 (0.79)	0.32	1,527 (11.04)
		Total IR	**6.4**	

IR = Incidence Rate; ANC= Antenatal Care

Table 2. Distribution of incidence rates and hazard ratios for neonatal survival

Variables	IR	HR	(95% CI)
Maternal age			
At risk	0.34	1	
No at risk	0.16	0.46***	0.29 – 0.69
Wealth level			
Lowest	0.24	1	
Lower middle	0.17	0.69	0.34 – 1.41
Middle	0.17	0.71	0.35 – 1.43
Upper middle	0.27	1.09	0.58 – 2.05
Highest	0.19	0.76	0.38 – 1.53
Education level			
Low	0.27	1	
Medium	0.13	0.49*	0.26 – 0.93
High	0.21	0.79	0.49 – 1.29
Residence			
Rural	0.24	1	
Urban	0.17	0.70	0.45 – 1.09
Birth weight (g)			
<2,500	1.43	1	
≥2,500	0.12	0.09***	0.06 – 0.13
Sex of infant			
Male	0.30	1	
Female	0.11	0.04***	0.22 – 0.59
Number of fetuses			
Single	0.20	1	
Multiple (twins)	1.41	6.99***	2.54 – 19.26
Number of ANC visits			
Inadequate	0.28	1	
4 visits (K4)	0.39	1.39	0.70 – 2.74
6 visits (K6)	0.20	0.71	0.41 – 1.21
8 visits (K8)	0.11	0.39*	0.19 – 0.81
ANC at 6 visits			
No	0.31	1	
Yes	0.17	0.53**	0.34 – 0.82
ANC at 8 visits			
No	0.24	1	
Yes	0.11	0.46*	0.25 – 0.86

Variables	IR	HR	(95% CI)
Place of delivery			
Non-health facility	0.12	1	
Health facility	0.22	1.82	0.86 – 3.85
Number of iron tablets consumed (tablets)			
<90	0.21	1	
≥90	0.15	0.71	0.43 – 1.19
Consumed, but quantity unknown	0.48	2.28*	1.02 – 5.06
No data	0.32	1.52	0.81 – 2.82

IR= Incident Rate; HR = Hazard Ratio; CI = Confidence Interval; P-value * = <0.05 ** = < 0.01 *** = <0.001; ANC= Antenatal Care

Table 3. Multivariable analysis results of the relationship between the dependent variable, the primary independent variable, and other independent variables on neonatal survival

Variables	HR	(95% CI)	aHR	(95% CI)
Maternal age				
At risk	1		1	
No at risk	0.46***	0.29 – 0.69	0.45***	0.28 – 0.71
Wealth level				
Lowest	1		1	
Lower middle	0.69	0.34 – 1.41	0.68	0.33 – 1.41
Middle	0.71	0.35 – 1.43	0.71	0.34 – 1.48
Upper middle	1.09	0.58 – 2.05	0.97	0.47 – 1.98
Highest	0.76	0.38 – 1.53	0.71	0.32 – 1.61
Education level				
Low	1		1	
Medium	0.49*	0.26 – 0.93	0.61	0.32 – 1.16
High	0.79	0.49 – 1.29	1.03	0.60 – 1.78
Residence				
Rural	1		1	
Urban	0.70	0.45 – 1.09	0.71	0.44 – 1.17
Birth weight (g)				
<2,500	1		1	
≥2,500	0.09***	0.06 – 0.13	0.10***	0.06– 0.16
Sex of infant				
Male	1		1	
Female	0.37***	0.22 – 0.59	0.36***	0.22 – 0.59
Number of fetuses				
Single	1		1	
Multiple (twins)	6.99***	2.54 – 19.26	1.69	0.59 – 4.85
Number of ANC visits				
Inadequate	1			
4 visits (K4)	1.39	0.70 – 2.74	1.41	0.71 – 2.82
6 visits (K6)	0.71	0.41 – 1.21	1.01	0.58 – 1.77
8 visits (K8)	0.39*	0.19 – 0.81	0.61	0.28 – 1.31
Place of delivery				
Non-health facility	1		1	
Health facility	1.82	0.86 – 3.85	2.12*	0.97 – 4.60
Number of iron tablets consumed (tablets)				
<90	1		1	
≥90	0.96	0.62 – 1.49	0.84	0.49 – 1.41
Consumed, but quantity unknown	2.28*	1.02 – 5.06	2.36*	1.05 – 5.31
No data	1.52	0.81 – 2.82	1.44	0.77 – 2.69

IR= Incident Rate; HR = Hazard Ratio; CI = Confidence Interval; P-value * = <0.05 ** = < 0.01 *** = <0.001; ANC= Antenatal Care

Table 4. Comparison of indirect effect values and percentage of mediation effect across three anc variable categorizations

Variables	Indirect effect	95% CI	Mediation effect (%)
ANC category I			
Inadequate	1		1
4 visits (K4)	0.99	0.93 – 1.07	-57.09
6 visits (K6)	0.85***	0.79 – 0.92	31.55
8 visits (K8)	0.77***	0.68 – 0.85	28.66
ANC category II			
<6 visits	1		
≥6 visits	0.82***	0.75 – 0.92	30.53
ANC category III			
<8 visits	1		
≥8 visits	0.82***	0.77 – 0.89	28.99

DISCUSSION

Neonatal mortality in this study is 6.4 per 1,000 live births. According to the 2017 IDHS, overall neonatal mortality is 15 per 1,000 Live births [9]. This difference arises because the IDHS data considers births in the five years before the survey, while this study only includes the most recent live birth. This rate is lower compared to other studies by UNHCR in 21 countries, which reported 12-56 per 1.000 live births [10]. Babies with birth weights ≥2500g have a 91% lower risk of neonatal death compared to those <2500g. Smaller babies have a 9.1x higher mortality risk [11], and in Ethiopia, LBW infants had 12.2% higher mortality [12]. This supports the importance of fetal growth monitoring in ANC policies.

Studies indicate that ANC significantly influences the occurrence of LBW and neonatal mortality. Research in the Netherlands found that ANC frequency is associated with a 32% reduction in LBW incidence [13], while complete ANC visits can reduce the risk of LBW by up to 8 times [14]. Antenatal nutritional interventions and infection treatment also play a role in increasing birth weight and reducing LBW risk [15]. Other factors, such as maternal age, baby's gender, and place of delivery, also affect neonatal outcomes [16].

CONCLUSION

Factors positively affecting neonatal survival include maternal age, baby's gender, birth weight, and number of babies. The number of ANC visits influences neonatal survival, with a higher frequency of visits correlating with better outcomes. The neonatal mortality rate in the study was 64 per 1,000 live births, with most mothers attending at least six ANC visits.

Policy Development can enhance policies for healthy pregnancy age management, fetal weight monitoring programs, and increase the minimum ANC visits to eight as per WHO standards. For educational purposes, it can 0pomote education on safe pregnancy practices, focusing on maternal age and reducing high-risk pregnancies. To improve ANC Quality and quantity, strengthen the quality and increase the frequency of ANC visits, ensuring early and continuous monitoring throughout pregnancy, including the third trimester for high-risk categories.

REFERENCES

1. United Nations International Children's Emergency Fund (UNICEF). Neonatal mortality 2023. Available from: [Website]
2. Kementrian Kesehatan Republik Indonesia. Profil kesehatan Indonesia 2021. Jakarta: Kementerian Kesehatan RI; 2022. Available from: [Website]
3. Paunno M, Siahaya GC. Pengaruh Perawatan kehamilan dan persalinan dengan kematian neonatal. Jurnal Kesehatan Reproduksi. 2021;8(3):164-172.
4. Chilupula N. Demographic and socio-economic determinants of child mortality. 2020.
5. World Health Organization. WHO guidelines approved by the guidelines review committee: WHO recommendations on antenatal care for a positive pregnancy experience. Geneva: World Health Organization. 2016. Available from: [Website]
6. Bhusal MK, Khanal SP. A systematic review of factors associated with under-five child mortality. BioMed Research International. 2022;2022:1181409.
7. Kementrian Kesehatan Republik Indonesia. Pedoman pelayanan antenatal terpadu. Jakarta: Kemenkes RI; 2020. Available from: [Website]
8. Buis ML. Direct and indirect effects in a logit model. The Stata Journal. 2010;10(1):11-29.
9. USAID. Survei demografi dan kesehatan Indonesia 2017. Jakarta: Kementerian Kesehatan RI; 2018. Available from: [Website]
10. Tappis H, Ramadan M, Vargas J, Kahi V, Hering H, Schulte-Hillen C, et al. Neonatal mortality burden and trends in UNHCR refugee camps, 2006-2017: a retrospective analysis. BMC Public Health. 2021;21:390.
11. Titaley CR, Mu'asyaroh A, Que BJ, Tjandrarini DH, Ariawan I. Determinants of early neonatal mortality: secondary analysis of the 2012 and 2017 Indonesia Demographic and Health Survey. Frontiers in Pediatrics. 2024;12:1288260.
12. Chan GJ, Goddard FGB, Hunegnaw BM, Mohammed Y, Hunegnaw M, Haneuse S, et al. Estimates of stillbirths, neonatal mortality, and medically vulnerable live births in Amhara, Ethiopia. JAMA Network Open. 2022;5(6):e2218534.
13. Henrichs J, Verfaille V, Jellema P, Viester L, Pajkrt E, Wilschut J, et al. Effectiveness of routine third trimester ultrasonography to reduce adverse perinatal outcomes in low risk pregnancy (the IRIS study): nationwide, pragmatic, multicentre, stepped wedge cluster randomised trial. BMJ. 2019;367: l5517.
14. Kurniasari W, Amalia R, Handayani S. Hubungan antenatal care, jarak kelahiran dan preeklampsia dengan kejadian BBLR. Jurnal 'Aisyiyah Medika. 2023;8(1).
15. Mekonnen Y, Wolde E, Bekele A, Mehari Z, Abebe S, Hagos T, et al. Effect of the enhancing nutrition and

antenatal infection treatment (ENAT) intervention on birth weight in Ethiopia: a cluster randomized controlled trial. BMC Pregnancy Childbirth. 2023;23:620.

16. Lean SC, Derricott H, Jones RL, Heazell AEP. Advanced maternal age and adverse pregnancy outcomes: A systematic review and meta-analysis. PLoS ONE. 2017;12(10):e0186287