ORIGINAL RESEARCH ARTICLE

Survival Analysis of Low-Birth-Weight Neonates in NICU at a Tertiary Care Hospital in Makassar, Indonesia

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ABSTRACT

Background: Currently, children face the highest risk of death during the neonatal phase. UNICEF data shows that in 2022, globally, approximately 2.3 million children died in the first month of life, accounting for about 6,400 neonatal deaths per day. The aim is determining the survival proportion of neonates, hazard ratios, and maternal factors influencing the survival of low-birth-weight neonates.

Methodology: A retrospective cohort study design using secondary data from 183 medical records of low-birth-weight neonates from 2020 to 2022. Kaplan-Meier analysis and life table were used to observe the time frame and survival proportion, as well as differences among independent variable groups. Cox regression analysis was conducted to estimate hazard ratios and the influence of independent variables.

Results: Gestational age (p=0.028, HR=2.7948, CI 95% = 1.1197-6.9757), ANC visits (p=0.000, HR=2.7057, CI 95% = 1.6320-4.4857), and maternal employment status (p=0.023, HR=2.6546, CI 95% = 1.1430-6.1651) are statistically significant variables that influence the survival of low-birth-weight neonates.

Conclusions: The survival proportion of low-birth-weight neonates is 60.80%. Gestational age, ANC visits, and maternal employment status significantly contribute to the survival of low-birth-weight neonates.

Key-words: Neonatal, Low birth weight, Survival analysis

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INTRODUCTION

Health development aims to improve the optimal health status of the community. Development in the health sector is a significant concern in international commitments, particularly in the Sustainable Development Goals (SDGs). The first goal is to reduce maternal mortality to 70 per 100,000 live births, and the second target is to end infant and child deaths by reducing the neonatal mortality rate to 12 per 1,000 live births by 2030.[1] Children face the highest risk of death in the first month of their lives, with a global average of 18 deaths per 1,000 live births in 2022, where approximately 2.3 million children died in the first month of life, accounting for about 6,400 neonatal deaths every day.[2] Results from the 2017 IDHS also show that 63% of infant deaths occur within one month after birth. It can be assumed that neonates or newborns (0-28 days) are the age group with the highest risk of health disorders.[3]

Globally, based on WHO data in 2021, the neonatal mortality rate has not yet reached the SDG target of 17.55 per 1,000 live births. According to WHO data in 2021, in Indonesia, the Neonatal Mortality Rate (NMR) is estimated to reach 11.33 per 1,000 live births.[4] In 2022, the number of neonatal deaths increased to 945 cases with a Neonatal Mortality Rate (NMR) of 6.53 per 1,000 live births.[5] Meanwhile, data from the Makassar City Health Office in 2022 recorded 63 neonatal deaths with a Neonatal Mortality Rate (NMR) of 2.37 per 1,000 live births.[6]

Considering various trends in maternal aspects related to the occurrence of low birth weight and neonatal mortality, it is interesting to study the influence of maternal factors on the survival of low-birth-weight neonates and their survival proportions. The study focuses on NICU care at Dr. Wahidin Sudirohusodo Hospital Makassar with the hope that the results of this study can be used as a reference in determining policies not only nationally but also globally to contribute to achieving the SDGs, especially SDG 3 target 2, which aims to end infant and child deaths by reducing the neonatal mortality rate.

The study was conducted with an objective to determine the proportion of neonatal survival, hazard ratio, and maternal factors influencing the survival of low-birth-weight neonates at Wahidin Sudirohusodo Hospital Makassar.

METHODOLOGY

Study Design: This research was conducted at the Dr. Wahidin Sudirohusodo Hospital Makassar. The type of research used in this research is observational analytic with a retrospective cohort study design. The dependent variable is the survival of low-birth-weight neonates, while the independent variables include maternal age, parity, gestational age, antenatal care visits (ANC), maternal education and maternal employment status.

Population and Sample: The population in this study were all low-birth-weight neonates who received NICU care and were recorded in medical records during the 2020–2022 research period at Dr. Wahidin Sudirohusodo Hospital Makassar. The sampling method used was purposive sampling technique. A total of 183 low birth weight neonates meeting the inclusion criteria, namely low birth weight neonates with complete medical records, were included in the study. Neonates with normal birth weight, not admitted to the NICU, incomplete medical records, and those who survived beyond 28 days postnatal were excluded from the study. The follow-up period in this study was 28 days.

Data Collection and Analysis: This study utilized secondary data sourced from medical records. The researcher collected data by tracing the medical records of low-birth-weight neonates who were previously admitted to the NICU of Dr. Wahidin Sudirohusodo Hospital in Makassar between 2020 and 2022. Subsequently, the researcher identified and selected medical records that met the inclusion criteria as samples for this study. Data analysis was conducted using three methods: univariate, bivariate, and multivariate analyses through the STATA application. Kaplan-Meier analysis and life table were used to observe the time profile, survival proportions, and differences between groups of independent variables. Cox regression analysis was performed to estimate the hazard ratio and the impact of independent variables on the survival of low-birth-weight neonates.

Ethical Approval: This research has been approved by the Hasanuddin University Health Research Ethics Committee with approval recommendation number 5164/UN4.14.1/TP.01.02/2023. The confidentiality of respondent data will not be shared.

RESULTS

Table 1 shows that the majority of birth weights fall into the Low Birth Weight (LBW) neonates' group, with 114 neonates (62.30%). There were more male neonates, with 101 (55.52%) compared to female neonates. Most neonates came from outside Makassar, totalling 118 (64.48%). Based on the mode of delivery, more than half, 125 neonates (68.31%), were born via caesarean section.

Figure 1 shows that the overall survival rate of low-birth-weight neonates from 2020-2022 was 60.8%.

Figure 2 displays the distribution of low-birth-weight neonates based on birth weight. Extremely Low Birth Weight (ELBW) infants had the lowest survival rate, with 0% survival, as all neonates experienced an event on the 9th day with a median value of 6 days, indicating that by the sixth day, half of the ELBWI group had experienced death (event).

Figure 3 shows that the survival curves based on gestational age, ANC visits, and maternal employment

status did not intersect, indicating that the PH assumption was met. The p-value (log rank) for gestational age=0.0205, ANC visits=0.0001, and maternal employment status=0.0173, indicating that there were differences in the survival of low-birth-weight neonates based on gestational age, ANC visits, and maternal employment status. The survival proportion for the full-term gestational age variable was higher (76.55%) compared to less or more than full-term (57.66%). The survival proportion for the ANC visits variable at ≥6 times was higher (71.29%) compared to ANC visits <6 times (44.47%). Meanwhile, for the maternal employment status variable, the survival proportion for working mothers (80.01%) was higher compared to non-working mothers (56.29%).

Table 1: Distribution of Low-Birth-Weight Neonates Based on the Characteristics of Low-Birth-Weight Neonates

Neonatal Characteristics	Cases (%)
Birth Weight	
LBW	114 (62.3)
VLBW	65 (35.52)
ELBW	4 (2.19)
Gender	
Male	101 (55.19)
Female	82 (44.81)
Origin	
Makassar	65 (35.52)
Outside Makassar	118 (64.48)
Mode of delivery	
Spontaneous	58 (31.69)
Cesarean section	125 (68.31)
Total	183 (100)

Table 2: Distribution of Low-Birth-Weight Neonates Based on Independent Variables

Variable Characteristics	Cases (%)
Survival Status	
Events	62 (33.88)
Censored	121 (66.12)
Maternal Age	
20-35 years	117 (63.93)
<20 or >35 years	66 (36.07)
Parity	
Primipara	72 (39.34)
Multipara	111 (60.66)
Gestational Age	
Less than full-term	142 (77,60)
Full-term	31 (16,94)
More than full-term	10 (5,46)
Antenatal Care (ANC) Visit	
≥6 times	111 (60.66)
<6 times	72 (39.34)
Maternal Education	
Low	53 (28.96)
Middle	73 (39,89)
High	57 (31,15)
Maternal Employment Status	
Working	35 (19.13)
Non-working	148 (80.87)

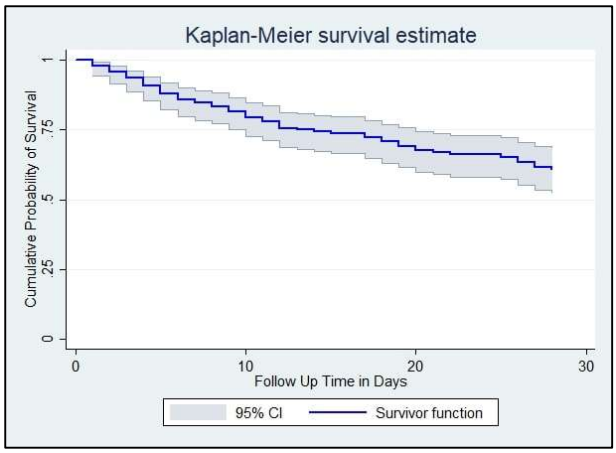

Figure 1: Curve of Survival of Low-Birth-Weight Neonates

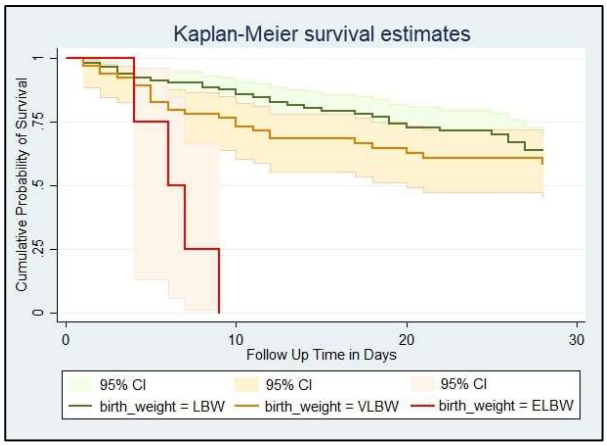

Figure 2: Curve of Survival of Low-Birth-Weight Neonates Based on Low-Birth-Weight Category

Table 2 shows that approximately 33.88% of the observed neonates experienced an event (death) during the neonatal phase (28 days), while 66.12% survived. It can be assumed that during the neonatal phase, roughly one-third of the observed neonates died. The majority of mothers of low-birth-weight neonates were aged 20-35 years, accounting for 63.93%, while those aged <20 or >35 years were around 36.07%. Multiparous mothers (60.66%) had a higher frequency compared to primiparous mothers (39.34%). In general, 86.06% of low-birth-weight neonates were born either less or more than full-term, while neonates born at full term were only around 16.94%. Based on ANC visits, the most frequent visits were ≥6 times, accounting for 60.66%. The majority of mothers of low-birth-weight neonates had at least a secondary education (71.04%), such as high school or higher, and were predominantly non-working mothers (80.87%).

Table 3 shows that gestational age, ANC visits, and maternal employment status statistically influenced the survival of low-birth-weight neonates. Mothers with less or more than full-term gestational age had a higher likelihood of experiencing an event, at 37.50%, with a probability of death 2.7948 times higher compared to mothers with full-term gesta-

tional age. Mothers with ANC visits of less than 6 times experienced the highest number of events and had a probability of death 2.7057 times higher compared to mothers with ANC visits of 6 times or more. Meanwhile, neonates born to non-working mothers also experienced the highest number of events, where based on hazard ratio, they had a probability of death 2.6546 times higher compared to neonates born to working mothers.

Table 4 shows that gestational age was the variable that had the most dominant influence on the survival of low-birth-weight neonates, with a p-value of 0.032 and HR of 2.7334 CI 95% (1.0903 – 6.8522). This means that low birth weight neonates born to mothers with less or more than full-term gestational age had a probability of death 2.7334 times higher compared to low-birth-weight neonates born to mothers with full-term gestational age.

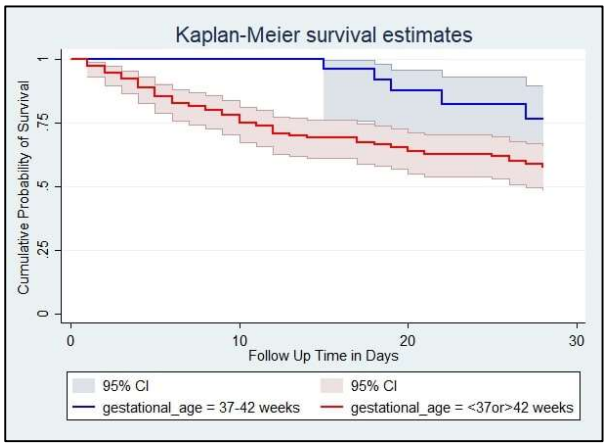

Figure 3a: Curve of survival of low-birth-weight neonates based on gestational age

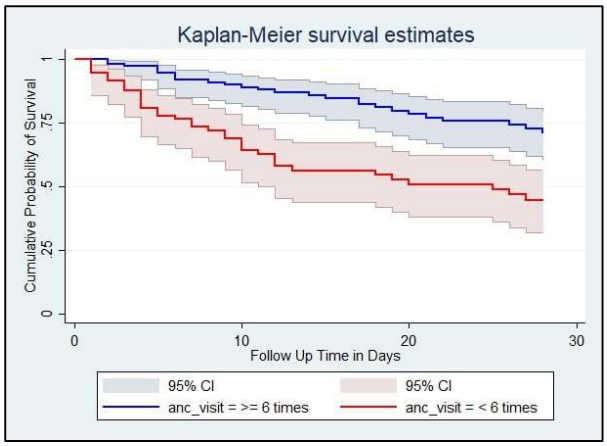

Figure 3b: Curve of survival of low-birth-weight neonates based on ANC visits

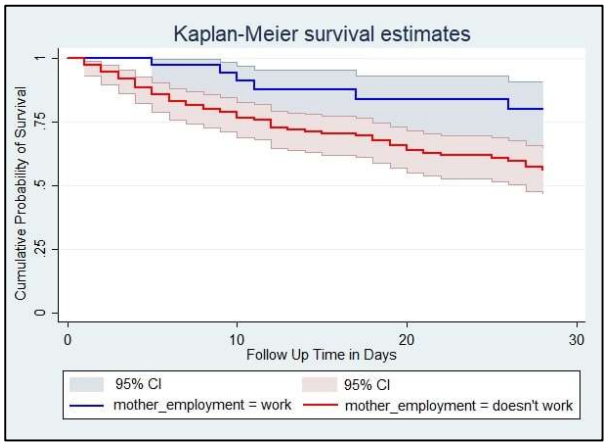

Figure 3c: Curve of survival of low-birth-weight neonates based on maternal employment status

Table 3: Results of Bivariate Cox Regression Analysis on the Survival of Low-Birth-Weight Neonates

Independent Variable	Survival Status		Hazard Ratio	95% Confidence Interval	*P* value
	Event (n = 62) (%)	Censored (n =121) (%)			
Maternal Age					
20-35 years	41 (35.04)	76 (64.96)	'ref'	0.5094 - 1.4593	0.581
<20 or >35 years	21 (31.82)	45 (68.18)	0.8622		
Parity					
Primipara	28 (38.89)	44 (61.11)	'ref'	0.4764 - 1.2962	0.345
Multipara	34 (30.63)	77 (69.37)	0.7859		
Gestational Age					
Full-term	5 (16.13)	26 (83.87)	'ref'	1.1197 - 6.9757	0.028
Less or more than full-term	57 (37.50)	95 (62.50)	27.948		
Antenatal Care (ANC) Visit					
≥6 times	26 (23.42)	85 (76.58)	'ref'	1.6321 - 4.4857	0.000
<6 times	36 (50)	36 (50)	27.057		
Maternal Education					
Middle to upper	47 (36.15)	83 (63.85)	'ref'	0.4496 -1.4392	0.463
Low	15 (28.30)	38 (71.70)	0.8044		
Maternal Employment Status					
Working	6 (17.14)	29 (82.86)	'ref'	1.1431 - 6.1651	0.023
Non-working	56 (37.84)	92 (62.16)	26.546		

Table 4: Results of Multivariate Cox Regression Analysis on Survival of Low-Birth-Weight Neonates

Independent Variables	Hazard Ratio	P Value	95% CI
Gestational Age	2.7334	0.032	1.0903-6.8522
Antenatal Care (ANC) Visit	2.2591	0.002	1.3446-3.7956
Maternal Employment Status	2.2326	0.068	0.9413-5.2954

DISCUSSION

This research showed that the survival proportion of low-birth-weight neonates in the neonatal phase (28 days) at Wahidin Sudirohusodo Makassar General Hospital was 60.80%, with the highest proportion of deaths occurring on the fourth and fifth days. The survival proportion in a study conducted by Limaso, et al. in Ethiopia showed a higher survival proportion of 95.9%.[7] Meanwhile, research also conducted by Woellie in the NICU of Bahir Dar Special Hospital in Ethiopia showed a lower survival rate of 50.9%.[8] The cause of this variation was the difference in the condition of neonates in these regions, such as nutritional status, geographical conditions, socioeconomic factors, health facility conditions, and doctors or healthcare workers who had received special education or training related to neonatology, among others. The research location was a referral hospital in the Eastern Indonesia region, where the treated neonates had a history of various complications, including sepsis, asphyxia, lung disorders, congenital abnormalities, and various other complications. This certainly made it more difficult for neonates to survive.

Low Birth Weight Category: Low birth weight was categorized into 3 groups: Low Birth Weight (LBW) with a birth weight of 1500 grams to less than 2500 grams, Very Low Birth Weight (VLBW) with a birth weight of 1000 grams to less than 1500 grams, and Extremely Low Birth Weight (ELBW) with a birth weight less than 1000 grams. The low-birth-weight category with the highest mortality rate was the ELBW category, where all neonates in this category were unable to survive the neonatal period. Research conducted by Debere showed similar findings, indicating a lower event proportion in the ELBW category (88%).[9] The results of this study demonstrated that the lower the birth weight, the higher the proportion of mortality. In general, the cause of death in neonates was often due to complications, one of which was low birth weight below 2500 grams.

Maternal age: This study showed that there was no influence of maternal age on the survival of low-birth-weight neonates. The cumulative proportion of neonatal survival in the maternal age groups <20 or >35 years was higher compared to the maternal age group between 20-35 years. Consistent with the study conducted by Wollie, which showed that there was no difference in the survival of low-birth-weight neonates based on maternal age.[8]

Maternal age in the range of 20-35 years was the most common age group based on the results of this study. This age range represents the reproductive age group with high potential for pregnancy. If a mother does not take preventive measures early on, pregnancy complications can occur. This condition can lead to impaired baby development or even infant death. Being too young, under 20 years old, poses risks during pregnancy because at this age, a woman is still in the process of physical and psychological growth. Meanwhile, being too old, over 35 years old, also carries risks during pregnancy, childbirth, and postpartum from a medical perspective. At an older age, mothers are more susceptible to diseases, which can also affect the fetus's health. The risk of stillbirth was significantly higher in the older women. The risks of aneuploidy and fatal congenital anomalies increase with maternal age and, despite antenatal screening, they are likely to have contributed to the increased rate of stillbirth.[10]

Parity: The results of bivariate Cox regression analysis in this study showed that parity did not significantly affect the survival of low-birth-weight neonates. The survival of neonates with multiparous mothers was higher compared to primiparous mothers. This is consistent with the research conducted by Wulandari and Laksono, which showed that parity is not a predictor of neonatal death.[11]

The high incidence of events in the primiparous category is caused by mothers who are pregnant for the first time not having enough experience compared to mothers who have given birth several times. Over time, mothers who have given birth multiple times have more knowledge about pregnancy or childbirth, enabling them to make better decisions for their health and the health of their unborn baby. Mothers with knowledge and experience tend to be more prepared to face the stages of pregnancy and childbirth; they are also better able to recognize signs of danger if complications occur.

Gestational Age: Gestational age significantly affected the survival of low-birth-weight neonates. The cumulative survival proportion of low-birth-weight neonates in full-term neonates was higher. Gestational age less or more than full-term had a probability of death 3.4157 times higher compared to full-term low birth weight neonates.

This was consistent with the results of research conducted by Menalu et al., Adem et al., and Debere et al., which stated that premature newborns had a higher death rate compared to full-term neonates.[9,12,13] Similar research was also conducted by Ahmed et al at Gadarif Hospital, East Sudan, which

showed that premature birth (<37 weeks) was the most common cause of neonatal death.[14]

The multivariate analysis also consistently showed that gestational age was the variable with the most dominant influence on the survival of low-birth-weight neonates. Neonates born prematurely tend to have immature organs, making them highly susceptible to complications. In post term infant, the placenta involutes as pregnancy progresses and multiple infarcts and villous degeneration develop, causing placental insufficiency. In these cases, the fetus receives inadequate nutrients and oxygen from the mother, resulting in a thin (due to soft-tissue wasting), undernourished infant with depleted glycogen stores and decreased amniotic fluid volume. Such infants are dysmature and, depending on when placental insufficiency develops and the severity of the condition, they may be small-for-gestational-age. Although placental insufficiency with dysmaturity can occur at any gestational age, it is most common in pregnancies that progress beyond 41 to 42 weeks.[15]

Antenatal Care (ANC) Service Visit: The research results indicated that ANC visits influenced the survival of low-birth-weight neonates. Neonates with less than 6 ANC visits were at 2.5994 times higher risk of death compared to those with 6 or more ANC visits. The cumulative survival proportion in neonates with less than 6 ANC visits was lower compared to those with 6 or more visits.

Several similar studies have shown a relationship between neonatal survival and ANC visits.[16,17] A study by Tolossa et al found that the risk of neonatal death was 7.49 times higher in neonates whose mothers did not have ANC visits compared to those with more than 4 ANC visits.[18] Similarly, a study by Berhanu et al. showed that the utilization of ANC reduced the risk of neonatal death, with the risk of death being 39% higher in neonates born to mothers who did not receive ANC compared to those born to mothers who did.[19]

A higher proportion of deaths occurred in the group that did not undergo ANC examinations. ANC examinations are comprehensive monitoring efforts related to the growth and development of the fetus during pregnancy and childbirth, enabling the detection of complications associated with pregnancy or other underlying diseases. Multivariate analysis consistently showed the influence of ANC visit variables on the survival of low-birth-weight neonates.

Maternal Education: The research results indicated that maternal education did not statistically influence the survival of low-birth-weight neonates. The cumulative survival proportion until the end of the observation period (day 28) in mothers with low education was higher compared to those with medium to high education. However, studies conducted by Nurfirdaus et al, Asif et al, and Amoah showed a relationship between a child's survival and maternal education.[20,21,22] Education is crucial in reducing the risk of neonatal death. Educated pregnant women adapt better to health issues during pregnancy, childbirth, and postpartum, while pregnant women without knowledge of maternal health issues are at higher risk. They differ in decision-making regarding their health issues.

Maternal Employment Status: The results of this study indicated that maternal employment status affected the survival of low-birth-weight neonates. Low birth weight neonates born to non-working mothers were 2.4736 times more likely to die compared to those born to working mothers. The cumulative survival proportion of low-birth-weight neonates until the end of the observation period (day 28) was lower for non-working mothers compared to working mothers. Consistent with the research conducted by Alebel et al., newborns born to non-working mothers had a 1.6 times greater risk of death compared to those born to working mothers.[23] Similarly, a study by Wulandari showed that women who did not work had a probability of experiencing neonatal death 0.576 times higher than women who worked.[11]

Employment status in this study was related to economic issues. Non-working mothers tended to lack the ability to help their husbands support the family's economy. If a family had good economic ability, pregnant women in that family would easily access quality health services. The same went for obtaining good food intake and balanced nutrition, which was very supportive of a healthy pregnancy process as an effort to maintain the health of the fetus.

The results of the multivariate Cox regression analysis showed inconsistent results. This was because other variables had a more dominant effect on the survival of low-birth-weight neonates, with these variables having a higher hazard ratio compared to the employment status variable.

CONCLUSION

The survival proportion among low birth weight (LBW) neonates is 60.80%. Survival proportions based on birth weight categories are: LBW (63.91%), Very Low Birth Weight (VLBW) (58.56%), and Extremely Low Birth Weight (ELBW) (0%). Gestational age, ANC visits, and maternal employment status significantly influence the survival of low-birth-weight neonates.

To improve neonatal outcomes, it is crucial to encourage pregnant women, particularly those at risk of delivering low birth weight neonates, to attend ANC visits regularly. Health education programs should emphasize the importance of ANC in early detection and management of complications. Providing support programs for non-working mothers, including access to quality healthcare services and nutritional support, is essential. Additionally, creating opportunities for employment or income-generating

activities for women, especially those from low-income families, can lead to economic empowerment. This, in turn, can improve access to healthcare and enhance nutrition during pregnancy.

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