Survival Analysis of Under-five Mortality in West Sulawesi Indonesia using Cox Regression

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Abstract: Reducing infant mortality is one of the targets of SDGs goal 3, promoting wellbeing for all at all ages and ensuring healthy lives. Although the under-five mortality in Indonesia has declined, some provinces show a high mortality rate such as West Sulawesi. Hence, efforts to decrease the rate is still needed by identifying the main determinant of under-five mortality. The main objective of this study is to determine the main factors that affect under-five mortality in West Sulawesi using Intercensal Population Survey 2015. In this study, the impact of mother's education, age of first delivery, previous birth interval, birth type, the gender of the under-five child, and paramedics help during labor were investigated using the Cox Proportional Hazard Regression. All variables impacted mostly to the survival rate of under-five children. Female under-five children had a lower hazard (risk) of death compared to the males. Twin had a three times higher hazard of death as compared to single born children. In addition, higher mother's education tends to have a lower hazard.

1 INTRODUCTION

All health issues in the SDGs are integrated into goal number 3, which is to ensure a healthy life and wellbeing for all at all ages. Reducing the mortality rate for infants and under-five children is one of the target SDGs' goals (United Nations, 2017).

Countries around the world have been trying to reduce child mortality in the last few decades. Child mortality is an important indicator of children's health. The under-five mortality rate is the number of under-five deaths (1 – 5 years) per 1000 live births within one year. This mortality can describe the level of health problems of children under five, the level of primary health services and the success of primary health (Danzhen You, Lucia Hug, Simon Ejdemyr, Jan Beise and World, 2015).

In general, under-five mortality in Indonesia has declined. However, some provinces have a high mortality rate. The highest under-five mortality is dominated by Provinces in Eastern Indonesia, one of them is West Sulawesi Province. Based on the Health Office report 2016, there has been a decrease in child mortality rates over the past year in West Sulawesi from 2010 to 2015. It was 16.4 per 1000 live births in 2010 and 14.26 per 1000 live birth in 2015 (Dinas Kesehatan Provinsi Sulawesi Barat, 2016). However, West Sulawesi became the province with the highest number of infant deaths (IMR) in Indonesia which is 50 infant deaths that occurred in 1000 live births. Infant mortality also increased in 2017 (Dinas Kesehatan Provinsi Sulawesi Barat, 2017). Factors influence this situation need to be investigated to know the right policy in reducing the rate.

The main objective of this study is to determine the main factors that affect or influence the survival of under-five in West Sulawesi.

2 METHOD

This study used secondary data namely Intercensal Population Survey 2015 in Indonesia performed by BPS-Statistics Indonesia. The unit of this study is under-five born children. There are 2549 cases in West Sulawesi.

The response variable is the death risk of under-fives which measured by under-fives survival time from birth until death. The survival time is presented in months which ranges between 0 to 60 months. The

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explanatory variables are the mother's education, mother's first age of giving birth, previous birth interval, birth type, the gender of the under-five child and whether paramedics help labor. The impact of these variables was investigated using the Cox Proportional Hazard Regression.

The Cox proportional hazard model is a survival model that measures the relationship between one or more covariates with time. The risk of the event per time unit changes over time at baseline levels of covariates was denoted by $h_0(t)$. The hazard function was represented by $h(t)$. The hazard ratio was expressed by $h(t)/h_0(t)$. The Cox proportional hazard model was defined by the equation:

$$\frac{h(t)}{h_0(t)} = e^{(\beta_1 x_1 + \beta_2 x_2 + \cdots + \beta_p x_p)} \quad (1)$$

Here $h(t)$ hazard at time t, $h_o(t)$ is a baseline hazard, x_p is the p-th explanatory variable.

3 RESULT

3.1 Descriptive Analysis

From Table 1, we can observe that there are 254 (10%) infants could not survive before reaching five years old. The percentage of infants who died before 5 years from the family whose mother has low education (up to elementary school) is higher (12.3%) than, other educational backgrounds.

The age of the mother at the first delivery seems to be the risk of under-five mortality. Furthermore, 22.6% of the infant with the mother's age at first delivery above 35 years old was dead.

Moreover, infants with the birth type of multiple (twin, triplets, etc) have almost triple risk to die as compared to the single born infant. In addition, a male infant has a higher risk to die before five as compared to a female infant.

3.2 Survival Analysis

3.2.1 Kaplan Meier

The curve of Kaplan Meier in Figure 1 shows that at the beginning of the first year the curve looked decrease. It means that they are struggling to survive, but afterward, the probability of the children to survive is relatively stable until five years old or the cumulative survival of the child was 60 months.

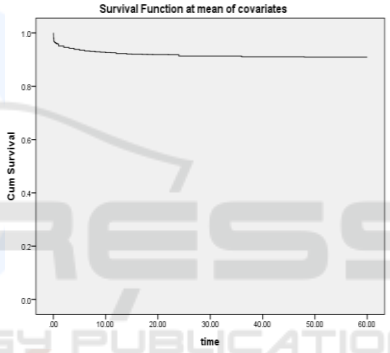

Figure 1: Overall Under-five child survival status in West Sulawesi.

Table 1: Sample characteristics.

Variables	Died (n=254)	Alive (n=2295)	Total (n=2549)
	n (%)	n (%)	n (%)
Mother's education status			
Low	158 (12.3%)	1126 (87.7%)	1284 (100%)
Middle	80 (8.2%)	901 (91.8%)	981 (100%)
High	16 (5.6%)	268 (94.4%)	284 (100%)
Mother's age at the first delivery			
20-35 years old	150 (9.6%)	1416 (90.4%)	1566 (100%)
<20 or >35 years old	97 (10.2%)	855 (89.8%)	952 (100%)
≥ 35 years old	7 (22.6%)	24 (77.4%)	31 (100%)
Previous birth-interval			
<24 months	117 (11.9%)	863 (88.1%)	980 (100%)
≥24 months	137 (8.7%)	1432 (91.3%)	1569 (100%)
Birth Type			
Single	239 (9.6%)	2258 (90.4%)	2497 (100%)
Multiple	15 (28.8%)	37 (71.2%)	52 (100%)
Gender			
Male	164 (12.2%)	1185 (87.8%)	1349 (100%)
Female	90 (7.5%)	1110 (92.5%)	1200 (100%)
Paramedics at Labor			
Non-Medic	89 (11.2%)	704 (88.8%)	793 (100%)
Medic	165 (9.4%)	1591 (90.6)	1756 (100%)

An overview of the under-five child in West Sulawesi from the Kaplan Meier curve based on explanatory variables can be seen in Figure 2 up to Figure 6. The Kaplan Meier curve in Figure 2, it appears that the survival curve of an under-five child who has mothers with higher education is above the survival curve of an under-five child who has mothers with middle education and low. It could be concluded that under-five child who has mothers with higher education has a tendency to survive longer compared to under-five who have mothers with middle and low education.

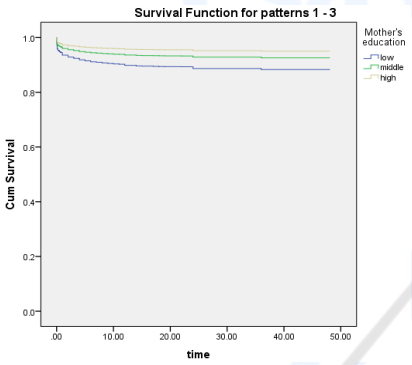

Figure 2: Kaplan Meier curve for under-five survival in West Sulawesi based on mother's education.

According to Figure 3, it shows that mother which age of first delivery above 35 years old tends to have less survival compared to mother's ideal first age of giving birth (20-35).

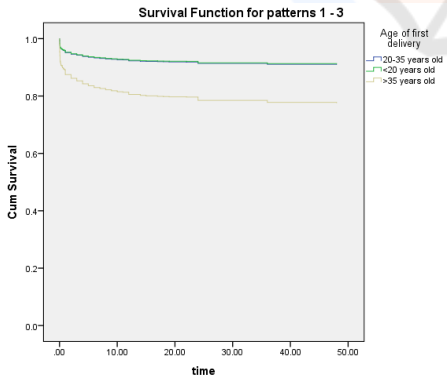

Figure 3: Kaplan Meier curve for under-five survival in West Sulawesi based on mother's age of first delivery.

Figure 4 is the Kaplan-Meier curve which shows that the survival curve for infants with previous birth intervals more than 24 months is above the survival curve for infants whose birth intervals are less than 24 months. This indicates that toddlers born to mothers whose birth intervals are more than 24 months tend to have the opportunity to survive longer.

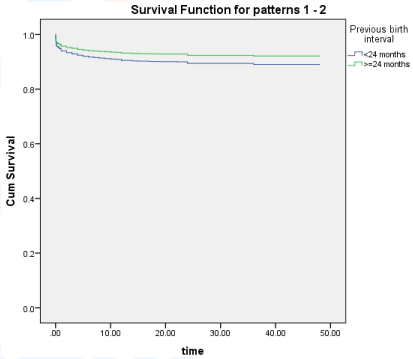

Figure 4: Kaplan Meier curve for under-five survival in West Sulawesi based on previous birth interval.

Kaplan Meier curve for under-five survival in Figure 5 demonstrate that the curve of multiple birth type is below the survival curve for a child with a single birth type. Twin birth types are more likely smaller for life longer than under-fives with a single birth type.

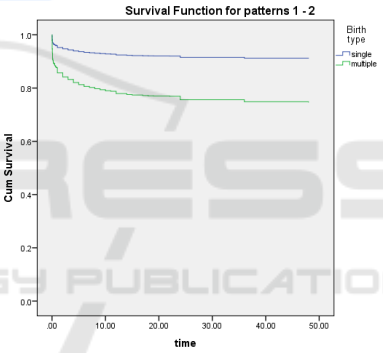

Figure 5: Kaplan Meier curve for under-five survival in West Sulawesi based on birth type.

Figure 6 shows that the cumulative survival for under five for females seems to have lived longer than the male because the survival curve of the female is above the male.

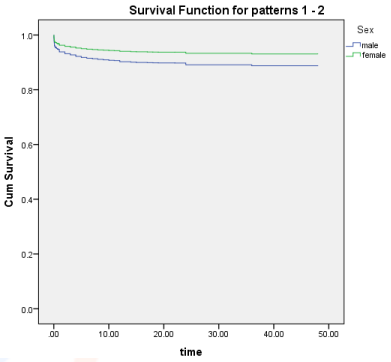

Figure 6: Kaplan Meier curve for under-five survival in West Sulawesi based on gender.

Table 2: Parameter estimation for Cox Regression Survival Model.

Variable	β (Se)	Wald	p-value	Hazard Ratio
Mother's education status				
Low*	-			
Middle	-0.481 (0.141)	11.643	0.001	0.618
High	-0.897 (0.273)	10.792	0.001	0.408
Mother's age of first delivery				
20-35 years old*	-			
< 20 years old	-.0.027 (0.134)	0.041	0.840	0.973
≥ 35 years old	0.986 (0.391)	6.356	0.012	2.681
Previous birth interval				
< 24 months*				
≥ 24 months	-.345 (0.131)	6.936	0.008	0.708
Birth type				
Single*				
Multiple	1.151 (0.271)	18.011	0,0001	3.161
Gender				
Male*				
Female	-0.510 (.131)	15.079	0,001	0.601
Paramedics labor	-0.080 (0.136)	0.347	0.556	.923

*Reference

3.2.2 Cox Regression Model

We use Cox regression to the model prediction of the time (measured in weeks). We explore which factors are associated with the risk of the under-five mortality of children in West Sulawesi.

The result from the Cox Regression model in Table 2 shows that almost all the explanatory variables in the model were statistically significant except variable paramedic labor.

The hazard ratio value indicates that mothers who have higher education are less likely to have infant deaths. This is in line with research conducted by (Ettarh and Kimani, 2012), (Mwangi Muriithi, 2015) and (Aheto, 2019). Mothers with secondary or higher education have a higher desire to seek information or knowledge about health care.

The hazard ratio based on the age of birth delivery shows that mothers with age of first delivery > 35 years have a higher risk to not survive 2.681 times compare to the ideal mother's ages of first delivery (20 – 35 years old).

Meanwhile, a mother who has a longer birth interval with a previous birth, then the tendency for children to die will decrease (Kayode, Adekanmbi and Uthman, 2012). The close birth distance between the first child to the next child can cause problems, both mental and physical health. The World Health Organization (WHO) and Badan Koordinasi Keluarga Berencana Nasional (BKKBN) recommend that the next birth interval should be two to three years to minimize the risk of child and maternal mortality.

The type of births with twins has a greater chance of dying 3.161 times compared to single births. (Monden and Smits, 2017) also explain in their research that twin births are more at risk of dying than single childbirths.

The hazard ratio for gender indicates that the female has a longer survival time than the male. The results of this study are also the same as the research conducted by (Ruggieri et al., 2016) and (Afeez et al., 2018). Female toddlers are more able to survive than male toddlers in terms of the immune system and genetic factors. Female's under-five children are more immune to diseases.

4 CONCLUSIONS

All variables impacted mostly to the survival rate of under-five children. Female under-five children had a lower hazard (risk) of death compared to the males. Twin under-five children had four times higher hazard of death as compared to single born children. Higher mother's education tends to have a lower hazard.

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