

## Multilevel survival analysis for under-fives in Indonesia 2015

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### Abstract

**Background** Marking the end of the *Millennium Development Goals* (MDGs) era, governments continue their plans via the *Sustainable Development Goals* (SDGs). One of the MDGs that has continued is the reduction in under-five mortality. Even though the trend of under-five mortality in Indonesia is decreasing, more efforts are needed to reduce the under-five mortality rate.

**Objective** To determine the individual and contextual factors of the under-five survival rate and to assess for possible characteristics that may lead to variance among regencies in Indonesia.

**Methods** Data from 2015 *Intercensal Population Survey* (*Survei Penduduk Antar Sensus/SUPAS 2015*) in Indonesia were analyzed using multilevel survival analysis. The *Intercensal Population Survey* covers all regions in Indonesia up to the regency level. Data were collected by direct interviews of selected household members, with regards to demographic and household characteristics, including births and deaths of under-fives. Our sample population was limited to all under-fives who were born and died during the 2010-2015 period. The number of subjects analyzed was 219,413 after exclusion of children with incomplete data.

**Results** Individual factors associated with under-five survival rate were maternal education, maternal age at first birth, work status, sex, previous birth interval, type of birth, place of residence, and sanitation level. The contextual factor (health care facility ratio per 1000 under-fives per regency) was not associated with under-five survival rate. The 5.27% variance can be explained by the differing characteristics among regencies.

**Conclusion** The individual factors affecting the survival of under-fives are maternal education, maternal age at first birth, maternal work status, sex, previous birth interval, type of birth, place of residence, and sanitation level. [Paediatr Indones. 2020;60:103-110; doi: <http://dx.doi.org/10.14238/pi60.2.2020.103-110>].

**Keywords:** survival; under-five; individual factor; contextual factor

Welfare, health, and well-being are rights of every child in the world. The fate of the future is in the hands of these children. To achieve a brighter future, we need to prepare our children to be healthy and educated in order to have a high-quality generation. Decreasing child mortality is one step to achieve that goal.

Child mortality is an important indicator for child health and welfare. In 2000, world leaders agreed on the *Millennium Development Goals* (MDGs). One of the goals was to urge the world to decrease under-five mortality by two-thirds in 2015. Great progress was made during those 15 years of effort. The under-five mortality has decreased and the chances of surviving the five first years of life keeps increasing. The worldwide under-five mortality rate has decreased as much as 53%, from 91 deaths in 1990 to 43 deaths in 2015 per 1000 livebirths. In the same period of time, under-five mortality has decreased from 12.7 million

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to 5.9 million each year.<sup>1</sup> One-third of the world (62 countries) has succeeded in decreasing the under-five mortality rate and met goal number 4 of the MDGs, including Indonesia. According to the 2015 UNICEF Report, the under-five mortality rate in Indonesia had dropped to 27 deaths per 1000 livebirths, while the MDGs target for Indonesia was 28 deaths per 1000 livebirths. Although Indonesia looked like it had reached the goal, the report was based on estimated numbers.

Despite great progress, the MDGs target number 4 has still not been reached globally. The decline of the under-five mortality rate amounted to 53%, which was far from the target of decreasing two-thirds of the under-five mortality rate. If this trend continues, the world will only reach the target in 2026, which is a delay of more than a decade.<sup>1</sup>

As 2015 came to an end, world leaders wrapped up the MDGs program and focused on a new program, the Sustainable Development Goals (SDGs). SDGs are the continuation of the MDGs program in which the health of under-fives remains a concern. This aim is listed on the SDGs target number 3.2, which aims to decrease infant and under-five mortality to a maximum of 12 deaths per 1000 livebirths for neonatal mortality and 25 deaths per 1000 livebirths for under-fives at the end of 2030.<sup>2</sup>

In this study, we evaluated child health with a focus on under-five survival. The basic concept of social research is that individuals always interact with the group to which they belong. Both individuals and the group influence each other.<sup>3</sup> In addition to the group where individuals belong, under-five survival is also influenced by place of residence. The availability of healthcare facilities is an important factor in under-five survival. Therefore, determining under-five survival based only on individual factors may not be enough. There may be a community or contextual factor that affects under-five survival. Hence, we aimed to analyze under-five survival with regards to both individual and contextual factors using multilevel survival analysis.

## Methods

We used secondary data from the 2015 *Intercensal Population Survey* in Indonesia which was conducted

by the *Central Bureau of Statistics*, Indonesia. The *Intercensal Population Survey* covers all regions in Indonesia up to the regency level. Data were collected by direct interviews of selected household members, with regards to demographic and household characteristics, including births and deaths of under-fives.

Our sample population was limited to all under-fives who were born and died during the 2010-2015 period, assuming that all demographic and household characteristics of the households stayed the same. We chose to focus on data for only a five-year interval in order to limit the likelihood of significant changes in demographic and household characteristics if we studied data from longer time intervals. The number of subjects analyzed was 219,413 after exclusion of children with incomplete data.

The number of healthcare facilities from each regency was secondary data obtained from the *Indonesian Ministry of Health*. We converted the data into ratios of the number of healthcare facilities per 1000 under-fives per regency. Unit of analysis in this study was the under-fives born between 2010-2015. The outcome variable was the risk of death for under-fives, as measured by under-five survival time from birth until death. In this study, the survival time is presented in months, ranging from 0 to 60 months.

The variables were categorized as individual and contextual factors. Individual factors consisted of maternal education, maternal age first birth, maternal employment status, sex of the child, previous birth interval, birth type, place of residence, source of drinking water, and sanitation level (private toilet, public toilet, or no toilet). The contextual factor consisted of only the ratio of healthcare facilities per 1000 under-fives per regency.

Maternal education status was defined as the last education which the mother had pursued. It was categorized into 3 categories: low, middle, and high. Mothers who only pursued at maximum of elementary schools fell into category 'low', including those who never attended school at all. Mothers who pursued until junior or high schools were categorized into category 'middle' and those who attended universities were categorized into category 'high'. Maternal age at first birth was also one of the individual factors. It was defined as the mother's age when gave birth to the first child. In this study, we categorized maternal age

at first birth into two different categories. The first category was for those who gave birth to the first child at age '20-35 years old', and the second category was for those who gave birth to the first child at '<20 years old or >35 years old'. Another maternal information that was used in this study was maternal employment status. The maternal employment status was obtained through mother's last week activities approach. In the 2015 *Intercensal Population Survey* questionnaire, last week activities had four selections which were working, doing house chores, attending to school, and others. From these four selections, we categorized mothers who were working for the past week as 'employed', and the rest as 'unemployed', including mothers who were attending school at the time.

Variable sex referred to the sex of the child. It was categorized into 'male' and 'female'. Previous birth interval was the interval between the time when the child in this study was born and the child born exactly right before of the same mother. Time interval was calculated into months and categorized into 2 categories, which were '<24 months' and '≥24 months old'. If the child in this study was a first born child, it fell into '<24 months' category automatically. Another child information that went into account was whether the child was the result of 'single' birth or 'multiple' birth. While single birth was clearly defined as one-baby at one birth, multiple birth could be the result of twin, triplet, or quadruplet births.

In addition to those key variables, we also added three household variables. The first one was the place of residence. The importance of the place of residence was the availability of infrastructure and health care to support the delivery and child care. 'Urban' area apparently had better infrastructure and health care, while 'rural' area had less basic infrastructure and fewer health care. The second household variable was source of drinking water. It was divided into 2 categories, 'clean' and 'poor' source of drinking water. The availability of clean water was really important for the health. Poor source of drinking water was more likely to be contaminated with bacteria. Household which consuming water from bottled water, pipe water, protected well, or protected water spring and had >10 meters distance from landfill site was categorized as having clean source of drinking water. Meanwhile household which consuming from protected well or protected water spring but had ≤10 meters distance

from landfill site would be categorized as having poor source of water. Poor source of water also included river water and rain water. The last household variable was sanitation. Variable sanitation in this study referred to the ownership of the toilet. In the 2015 *Intercensal Population Survey* in Indonesia, selected household was asked whether they had a toilet or not. Households which had toilet and used only by household members were categorized as having 'private toilet'. Households that shared toilet with other households, or had to go to public toilet, were categorized as having 'public toilet'. Meanwhile, households that had no toilet facilities at all were categorized as having 'no toilet'.

We used both descriptive and inferential analyses for this study. Descriptive analyses are presented in tables and graphics to give the general picture about the characteristics of under-fives in Indonesia, shown in percentages in order to see into which categories the majority of under-fives fall. For the inferential analysis, we used a multilevel survival analysis which had two levels, individual and regency. We aimed to assess the effect of individual and contextual factors on the survival of under-fives, as well as to evaluate variations in under-five survival time caused by different characteristics among regencies.

The first step of this study was to choose the best model for the data using the akaike information criterion (AIC) produced by null models of exponential, gamma, lognormal, loglogistic, and Weibull distribution.<sup>3,4</sup> The null model produced the smallest AIC, so it was chosen as the best model, followed by assumption test for the chosen distribution and multilevel survival model estimation. The last step was to calculate the intraclass correlation (ICC) to assess for variations among regencies.

The purpose of this multilevel survival analysis was to assess for effects of individual and contextual factors on under-five survival. The smallest AIC was produced by a null model of Weibull distribution. The proportional hazard for assumption test showed that all explanatory variables met the criteria and could be included in the model. Random effect significance test was done to compare the usefulness of multilevel survival model to the usual survival model. The likelihood ratio was 1649.29 with P value < 0.0000. As such, we could reject the null hypothesis and conclude that there was a significant random effect to under-five survival in Indonesia. Also, multilevel

survival analysis was a better model for the data than the usual survival analysis. Subsequently, test was done to see if there was at least one explanatory variable with a significant effect on under-five survival. The value was calculated as shown below:

$G^2$  value of 2522.8 was larger than  $X^2_{0.05, 10} =$

$$G^2 = -2 \ln \left[ \frac{\text{Likelihood of null model}}{\text{Likelihood of conditional model}} \right]$$

$$= -2 [-81949.288 - (-80678.888)]$$

$$= 2522.8$$

18.307, so it could be used to reject the null hypothesis. With 5% significance level, we can conclude that there is at least one significant explanatory variable to under-five survival in Indonesia.

Variation among regencies was analyzed by intraclass correlation (ICC). According to the variation from the Weibull null model from Appendix 2, ICC was calculated as follows:

This ICC of 5.27% under-five survival variation

$$\rho = \frac{(\sigma^2_{\mu 0})}{(\sigma^2_{\mu 0} + \sigma^2_e)}$$

$$= \frac{0.1829546}{0.1829546 + 3.29} = 0.0527$$

was due to regencies' variations.

## Results

During 2010-2015, 6.3% of under-fives in Indonesia died before reaching age five. Most of these died in their first year of life (89.8%), with the trend decreasing as the age increased. Overall, the average age at death for these under-fives was 0.26 years (3-4 months) (Figure 1). The percentages of under-fives who had died based on explanatory variables are shown in Table 1. The three highest mortality percentages were seen in those who were of multiple birth type, had low previous birth interval (<24 months), and no toilet.

Kaplan-Meier test revealed that the survival curve for under-fives with high maternal education was above the survival curves for middle and low

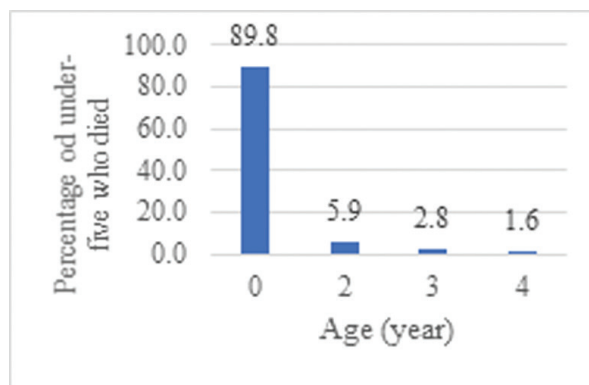
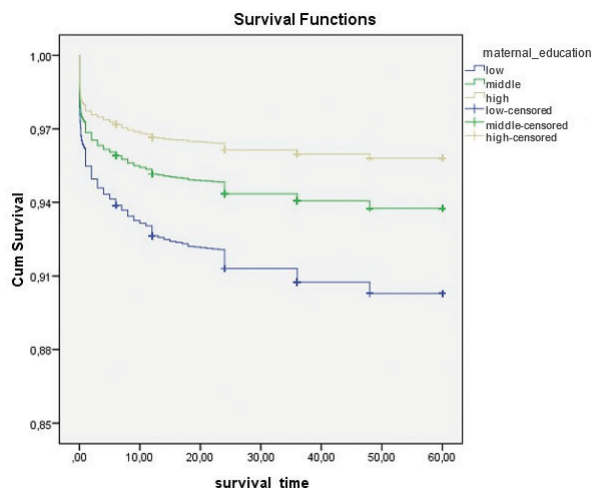


Figure 1. Percentage of under-fives in Indonesia who died from 2010-2015 by age at the time of death<sup>5</sup>

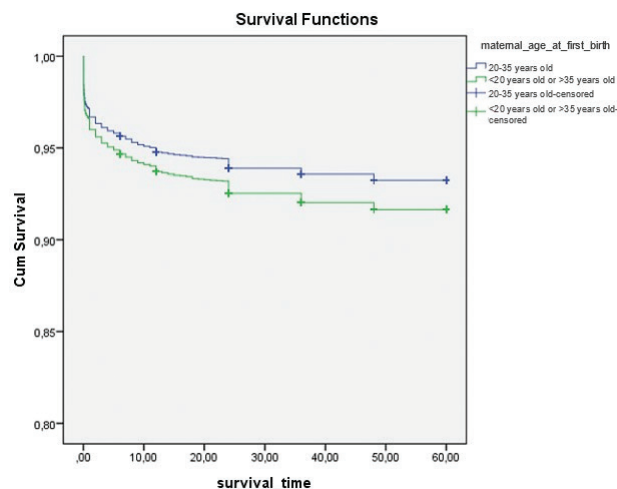
Table 1. Percentages of under-fives who died in 2010-2015 based on explanatory variables

Variables	Category	Percentage (%)
Maternal education status	Low	8.5
	Middle	5.4
	High	3.7
Maternal age at first birth	20-35 years	5.9
	<20 or >35 years	7.2
Maternal employment status	Unemployed	5.9
	Employed	6.8
Gender	Male	7.0
	Female	5.5
Previous birth interval	<24 months	14.3
	≥24 months	5.9
Birth type	Single	6.0
	Multiple	22.9
Place of residence	Rural	7.2
	Urban	4.9
Source of drinking water	Poor	6.1
	Adequate	6.5
Sanitation	Private toilet	5.5
	Public toilet	7.8
	No toilet	9.1

maternal education. Hence, under-fives whose mothers had high education were more likely to live longer than under-fives whose mothers had middle and low education (Figure 2). Figure 3 shows that the survival curve for under-fives whose mothers' age at first birth was 20-35 years was above the survival curve for under-fives with whose mothers' age at first birth was <20 or >35 years. Hence, under-fives who had mothers who had an ideal age at first birth (20-35 years) were more likely to live longer than



**Figure 2.** Kaplan-Meier curve of under-five survival in Indonesia in 2010-2015 based on maternal education status<sup>5</sup>



**Figure 3.** Percentage of under-fives in Indonesia in 2010-2015 based on maternal age at first birth<sup>5</sup>

under-fives with mothers aged <20 or >35 years at first birth. Kaplan-Meier test also revealed that under-fives with unemployed mothers were more likely to live longer than under-fives with employed mothers. In addition, female under-fives were more likely to live longer than male under-fives; under-fives who lived in urban areas were more likely to live longer than under-fives in rural areas; and under-fives with adequate source of drinking water were more likely to live longer than under-fives with poor source of drinking water (Table 2).

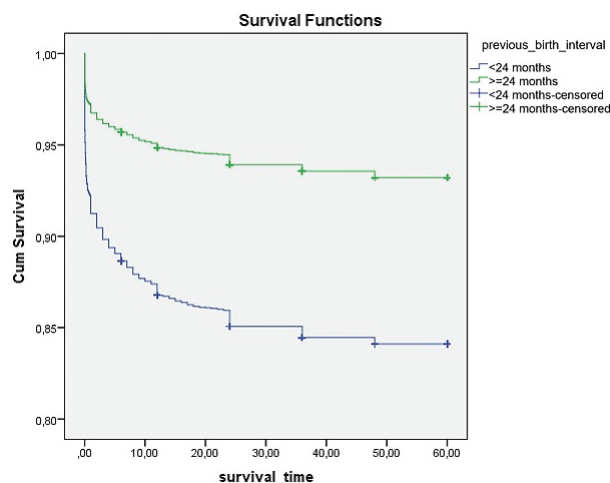
As shown in Table 2, maternal education, maternal age at first birth, maternal employment status, sex, previous birth interval, birth type, place of residence, and sanitation had significant association under-five survival. However, source of drinking water and ratio of healthcare facilities per 1000 under-fives per regency had no significant effects on under-five survival.

Kaplan-Meier test revealed that the survival curve for under-fives with previous birth interval of 24 months or more was above the survival curve for under-fives with previous birth interval of less than 24 months (Figure 4). Thus, under-fives with previous birth interval of 24 months or more were more likely to live longer than those with an interval of less than 24 months.

The survival curve for under-fives with single

birth type was above that from those with multiple birth type. Hence, under-fives with single birth type were more likely to live longer than those with multiple birth type (Figure 5). Figure 6 shows that the survival curve for under-fives with private toilets in their houses was above the survival curves for under-fives who used public toilets or had no toilet. Hence, under-fives with private toilets were more likely to live longer than under-fives who used public toilets or had no toilet.

## Discussion



**Figure 4.** Percentage of under-fives in Indonesia in 2010-2015 based on previous birth interval<sup>5</sup>

**Table 2.** Parameter estimation for multilevel survival model

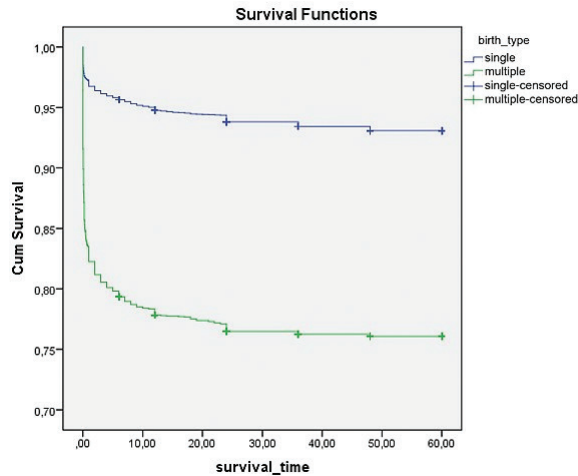
Variables	$\beta$	Wald	HR	P value
<b>Individual factors</b>				
Maternal education status				
Low	0.6648	17.58	1.9442	<0.000
Middle	0.3645	10.07	1.4398	<0.000
High*				
Maternal age at first birth				
20-35 years*				
<20 or >35 years	0.0526	2.79	1.054	<0.005
Maternal employment status				
Unemployed*				
Employed	0.1032	5.63	1.1088	<0.000
Gender				
Male	0.2404	13.93	1.2718	<0.000
Female*				
Previous birth interval				
< 24 months	0.5629	18.02	1.7558	<0.000
$\geq$ 24 months*				
Birth type				
Single*				
Multiple	1.1879	30.11	3.2802	<0.000
Place of residence				
Rural	0.1216	5.26	1.1293	<0.000
Urban*				
Source of drinking-water				
Poor*				
Adequate	0.0356	1.95	1.0363	0.051
Sanitation				
Private toilet*				
Public toilet	0.1967	7.18	1.2173	<0.000
No toilet	0.2087	8.81	1.2321	<0.000
<b>Contextual factor</b>				
Ratio of healthcare facilities per 1000 under-fives per reGENCY	-0.0014	-1.85	0.9986	0.065
$\beta$	-4.4782	-82.62	0.0114	<0.000
$\ln \rho$	-1.2694	-154.12	-1.2694	<0.000
$\rho$	-3.4505		-3.4505	
Level 2 residual variable	0.1214		0.1214	

The hazard ratio showed that under-fives whose mothers had higher maternal education were less likely to die. This finding was in agreement with a previous study which showed that maternal education level had a significant effect on under-five survival.<sup>6</sup> Educated mothers may attach a higher value to the welfare and health of children, have greater decision-making power on health-related and other matters, be less fatalistic about disease and health, be more knowledgeable about disease prevention and cure, be

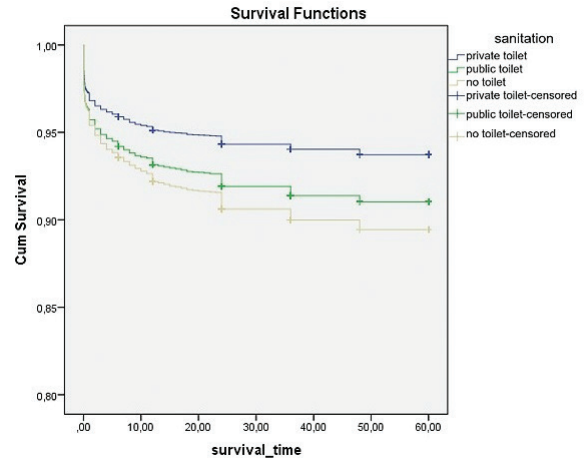
more innovative in the use of remedies, and be more likely to adopt new codes of behavior which improve children's health though they are not perceived as having direct consequences for health.<sup>6</sup>

Under-fives whose mother's age at first birth was under 20 or more than 35 years, had a higher mortality risk than under-fives whose mother's age at first birth was between 20-35 years. Similarly, a study showed that under-fives with mothers who first gave birth at either an early or late age faced a higher risk of death.<sup>7</sup>

The hazard ratio for maternal employment status



**Figure 5.** Percentage of under-fives in Indonesia in 2010-2015 based on birth type<sup>5</sup>



**Figure 6.** Percentage of under-fives in Indonesia in 2010-2015 based on sanitation<sup>5</sup>

showed that under-fives with employed mothers also had a higher risk of death than those with unemployed mothers, similar to a previous study.<sup>8</sup> Furthermore, female under-fives had lower risk of death than males. Another study had similar findings.<sup>9</sup> This is due to boys are vulnerable to perinatal conditions, congenital anomalies, and infectious diseases than girls.

In addition, under-fives with previous birth interval 24 months or more had lower death risk than under-fives with previous birth interval under 24 months, similar to a previous study.<sup>10</sup> Another study also noted that the odds of under-five mortality were reduced by longer preceding birth interval.<sup>6</sup> Longer birth interval could allow time for mothers' bodies to replenish nutrients, in order to be better prepared for the next pregnancy and breastfeeding.<sup>7</sup>

We found that multiple births had a higher death risk than single births, similar to a study conducted by Gebretsadik *et al.*<sup>11</sup> The twin pregnancies have an increased risk of premature birth, uneven growth and other complications. This may lead to a higher risk of mortality under five.

In addition, under-fives who lived in urban areas had lower risk of death than those in rural areas. Two studies had similar findings and reported significantly more under-five mortality in rural areas.<sup>9,12</sup> With regards to sanitation, under-fives whose households used public toilets or had no toilet access had a higher death risk than under-fives whose households had private toilets. A study also showed that under-fives who lived in more sanitary environments had lower death risk,<sup>13</sup>

while another study found that good sanitation was a significant factor to decrease under-five mortality.<sup>7</sup>

According to the Kaplan-Meier curves and percentages, under-fives with low maternal education, maternal age at first birth <20 years or >35 years, employment, previous birth interval of <24 months, male sex, rural residence, adequate source of drinking water, and having no toilet had a higher mortality.

In conclusion, using multilevel survival analysis, individual factors affecting the survival of under-fives are maternal education, maternal age at birth of first child, maternal employment status, sex, previous birth interval, type of birth, place of residence, and sanitation. Two variables, source of drinking water and health center ratio per 1000 infants per district were not significantly associated with under-five survival. Furthermore, Indonesian government should take an action in improving female literacy and healthcare facilities and sanitation especially in rural areas.

## Conflict of Interest

None declared.

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