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Birth Intervals and Infant Mortality in Indonesia

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Abstract

Birth interval is the period between two live births of a woman. In Indonesia, the National Family Planning Agency recommends a birth interval of between 36-60 months to reduce the risk of maternal and child mortality. The objective of this research is to analyze birth intervals and their relationship with infant mortality using survival analysis of data from the 2017 Indonesia Demographic and Health Survey. Infant mortality was calculated using person-years, and Kaplan-Meier curves were used to describe the relationship between infant mortality and preceding birth interval. The Cox proportional hazard model was used for multivariate analysis, revealing a negative relationship between birth interval and infant mortality. For each one-year increase in birth length, there is a reduction in infant mortality of 11.9 percent. This study also shows that the economic status of mother significantly affects infant mortality, with babies born to poor mothers 1.84 times more likely to die.

Keywords

Birth interval, Indonesia, infant mortality, survival analysis, Cox proportional hazard

Introduction

Birth interval is the period between two live births of a woman. Spacing births refers to a period of the rest between pregnancies that allows a mother to recover from a previous pregnancy. According to the World Health Organization (WHO, 2005), after live birth the recommended interval before attempting the next pregnancy is at least 24 months, in order to reduce the risk of adverse maternal, perinatal and infant outcomes. However, recent research by Rutstein (2005) – using demographic and health survey data from 2000-2005 in 52 countries around the world – showed that a birth interval of at least 36 months provides more benefits, while birth intervals less than 36 months increase the risk of neonatal mortality and morbidity, infant mortality and child mortality. Rutstein (2005) found that children born less than 24 months after a previous birth were almost 2.5 times more likely to die than children born between 36-47 months after the previous birth. Furthermore, children born within 24-35 months of birth were also 41 percent more likely to die than children born between 36-47 months after the previous birth.

These findings were supported by Kozuki et al. (2013), who showed a significant correlation between birth spacing of less than 36 months or more than 60 months, and the incidence of underweight babies, preterm births and infant mortality. Thus, spacing the distance between births, as part of a family planning program, can reduce both the infant mortality rate (IMR) and maternal mortality rate (MMR). The purpose of this study is to determine the relationship between birth interval and IMR in Indonesia using data from the 2017 Indonesia Demographic and Health Survey (IDHS).

Literature review

Previous studies using the 2012 IDHS found that mother factors (education, working status, autonomy, economic status, maternal age at birth, birth interval, type of births, complications, history of previous mortality, breastfeeding, antenatal care and place of delivery), infant factors (birth size), residence, and environmental conditions were associated with childhood mortality (e.g., see Warrohmah, et al. 2017). Using the same data source (the 2012 IDHS), Suparmi et al. (2016), found that low-birth-weight children had a 9.89-fold higher risk of neonatal mortality compared with normal-weight children; children delivered from younger mothers (aged 15-19 years) had a 94 percent higher risk of neonatal mortality compared with children delivered from mothers aged 20-35 years; and working mothers had a 81 percent higher risk of neonatal mortality compared with unemployed mothers.

Similar findings from the 2002-2003 IDHS (BPS and Macro, 2003) showed that children born to mothers living in urban areas had lower mortality rates than those born to women in rural areas. Using the same data source – the 2002-2003 IDHS – Titaley, et al. (2008) found that the odds of neonatal death were higher for infants born to both mothers and fathers who were employed, for infants with a short birth interval, male infants, smaller than average-sized infants, and infant's whose mother had a history of delivery complications.

Using data from the 1997 IDHS, Poerwanto et al. (2003) found that infant mortality was associated with the Family Welfare Index (FWI) and maternal education. Relative to families of high FWI, the risk of infant death was almost twice among families of low FWI, and three times for families of medium FWI. In Nigeria, using the 2013 Nigeria Demographic and Health Survey, Biradar et al. (2018) reported that children whose mothers were illiterate and had less than two years of a birth interval had the highest under-five mortality. Under-five deaths were higher among those mothers who were poor and had less than two years of birth interval. Indeed, child mortality was significantly higher in poor households with a low birth interval.

Related to birth interval, the results of the 2002 IDHS (BPS and Macro, 2003) concluded that childhood mortality rates decline sharply as the interval since the previous birth increases, and that the infant mortality rate for children born less than two years after a previous birth is more than twice as high for children born after an interval of two years. These findings are supported by Davanzo et al. (2004) in Bangladesh, who found that compared with intervals of 3-5 years in duration, preceding interbirth intervals of less than 24 months in duration were associated with significantly higher risks of early neonatal mortality, and that interbirth intervals of less than 36 months were associated with significantly higher risks of late neonatal mortality, post-neonatal mortality and child mortality.

Another study by Molitoris (2017) reported that there was a strong negative effect of birth intervals on both neonatal and post-neonatal mortality in a Swedish population, with the effect size significantly larger for post-neonatal and younger child mortality risks than for neonatal mortality. For children beyond five years of age, there was no significant association between interval length and mortality, all else being equal. Similar results by Bhalotra and Soest (2006), using retrospective fertility histories from a large sample of Indian mothers, found evidence that childhood mortality risk is influenced by the pattern of childbearing (i.e., by the timing and spacing of births) and that birth spacing and fertility are, in turn, a function of realized mortality. Fotso et al. (2012), using data from the Nairobi Urban Health and Demographic Surveillance Site (NUHDSS), found that the length of the preceding birth interval (PBI) is a major determinant of infant and early childhood mortality in Nairobi. In infancy, a PBI of less than 18 months is associated with a two-fold increase in mortality risks compared with lengthened intervals of 36 months or longer, while an interval of 18-23 months is associated with an increase of 18%. During the early childhood period, children born within 18 months of an elder sibling are more than twice as likely to die as those born after an interval of 36 months or more.

Another study by Starnes et al (2018) concluded that birth spacing greater than 18 months was negatively associated with under-five mortality. Longer birth spacing has consistently been associated with lower childhood mortality in widely varying contexts. Their study – based on a cross-sectional survey containing a complete birth history that was administered to a representative sample of the catchment area of the Lwala Community Alliance in rural Kenya – found an effect of similar magnitude with an increased likelihood of mortality for children born less than 18 months after a previous sibling. Khim Bahadur Khadka, et al. (2015) – using the Nepal Demographic Health Survey 2011 – found that socioeconomic distal and proximate determinants are associated with infant mortality in Nepal. Infant mortality was higher in the poor and middle classes than in the wealthier classes. The populations in the mountain ecological region and the far western development region had a high risk of infant mortality. Similarly, infant dying was higher for infants whose birth size, as reported by mothers, was very small and who had higher birth ranks and shorter preceding birth intervals.

Data

The 2017 IDHS, which comprehensively reflects the population and health of mothers and children in Indonesia, was used to compile the data for the present study. The 2017 IDHS was conducted between 24 July to 30 September 2017, with 49,250 samples of households and 59,100 samples of women of childbearing age. Four types of questionnaires were used in the 2017 IDHS: household, women of childbearing age, married men, and young men. Data on children born to a woman of childbearing age (14-59 years) during the last five years, starting from July 2012 to June 2016, were used in the study. The variables included: preceding birth interval (PBI), succeeding birth interval (SBI), birth order, birth status, sex, age of mother, education of mother, marital status, economic level, residence, and children year of birth.

Method of analysis

Survival analysis was the analytical method used in this research. Infant mortality was calculated using person-years. Log-rank tests were conducted to determine whether there were differences between categories of the risk of infant mortality. The Cox proportional hazard (PH) model was used for multivariate analysis. The time variable was the age of the baby, while the sensor variable was the status of death. An individual was considered to experience an event if they died before reaching the age of one year and considered to be censored if they survived to the age of one year. The Cox PH model is written in the form of a hazard model formula as follows:

$$h(t, X) = h_0(t)\exp\sum_{j=1}^{p}\beta_j X_j$$

The PH assumption was tested using the Schoenfeld residual test. Succeeding birth interval (SBI) and birth year variables did not meet the PH assumption, so they did not meet the requirements for analysis using Cox PH. Inference analysis was performed through three models: Model 1 included the variable distance of previous birth (categorical) and birth status as a predictor variable, Model 2 included all variables, and Model 3 was almost identical to Model 2, except that the PBI was defined as a continuous variable (in years). The chi-square test of independence was used to determine if there is a significant relationship between the economic status of mother and PBI.

Results and discussion

Sample characteristics and description of results

The characteristics of 14,720 births in Indonesia between July 2012 and June 2016 are presented in Table 1 (see Annex 1 to the present document). Almost 50 percent of the 14,720 births had a birth interval greater than or equal to 36 months, with 33.27 percent of births being the mother's first child. Regarding the remainder, 3.17 percent of births with birth spans of less than 18 months from older siblings amounted to 4.26 percent of births with a distance between births of 18-23 months from older siblings, and 9.72 percent of births with a distance between births of 24-35 months from older siblings.

Most births (76 percent) were the last birth at the time of recording, with only 23.62 percent of births being followed by subsequent births, namely 3.58 percent of births followed by subsequent births with birth spans of less than 20 months and 20.05 percent of births followed by subsequent births with distances greater than or equal to 20 months. The proportion of births of order 1 and sequence 2 was almost similar (33 and 31 percent, respectively), and most births were single births (98.57 percent). The sex ratio at birth was 106 males for 100 females. Most births occurred in mothers aged 20-34 years (73.97 percent), married (96.58 percent), with at least junior high school education (72.58 percent), and from the lowest economic level (47.24 percent).

Table 1 also shows the bivariate relationship of each variable with infant mortality. Babies with PBI of less than 18 months had the highest IMR (27.37 per 1,000 live births), followed by births with a PBI of 18-23 months (14.63 per 1,000 live births) and births with PBI 24-35 months (12.80 per 1,000 live births). First births and births with PBI of at least 36 months had almost the same IMRs, namely 8.36 and 7.41 respectively.

Multivariate analysis of birth interval and infant mortality

The hazard model results on the determinants of infant mortality are shown in Table 2 (see Annex 2 to the present document). In Model 1, the variable interbirth distance (PBI) and birth status variables significantly influenced infant mortality, with babies with very short birth spans (born less than 18 months from previous births) at 3.7 times higher risk than those with birth spans 36 months or more. Babies with PBI 18-23 months were twice at risk of dying as those with babies with a PBI of 36 months or more, whereas babies with a PBI of 24-35 months were at 1.7 times higher risk of mortality than babies with a PBI of 36 months or more.

Twins had a 7.8 times higher risk than singletons. Model 2, which includes all variables, showed that birth spacing and birth status had a major effect on infant mortality. In Model 3, birth intervals modelled as continuous variables (in months) significantly influenced infant mortality, with a hazard ratio of 0.891. For each one-year increase in birth length (PBI), infant mortality was reduced by 11.9 percent.

Model 2, which includes all variables in the analysis, shows that there are other variables that affect infant mortality, namely the economic status of the mother. Births of mothers with a middle-income had around 31.8 percent lower risk of experiencing infant mortality compared with low-income mothers, while births from mothers with the highest income had around 42.5 percent lower risk of experiencing infant mortality compared to births from mothers with the lowest income. In Model 3, birth intervals modelled as continuous variables (in months) significantly influenced infant mortality, with a hazard ratio of 0.891. For each one-year increase in birth length (PBI), infant mortality was reduced by 11.9 percent.

The results of this analysis confirm that there were no significance differences in the following variables on infant mortality: sex of children, age of mother, marital status of mother, and maternal education. In order to find out whether maternal education affects infant mortality partially, this research employs partial test. Table 3 shows that – with a hazard ratio of 1.432 – babies born to mothers with an education of less than junior high school tended to have a 1.432 higher risk of infant mortality than mothers with an education of junior high school or above.

Table 3. Cox PH analysis of infant mortality

Variable	Standard Error	z	p-value	Hazard Ratio
Maternal Education				
<junior high school	0.096	13.956	0.000***	1.432
≥junior high school^R				

Source: 2017 Indonesia Demographic and Health Survey
N = 14720 births
R Reference
*** Significance at $p < 0.001$

Although gender is negligible for infant mortality, female babies tended to have a higher IMR than males, but the difference was not statistically significant. In addition, there was a tendency for babies born in urban areas to have a lower mortality than those born in rural areas, but the difference was not statistically significant.

Table 4 shows that infant mortality is 3.368 higher for babies with a birth interval less than 18

Table 4. Cox PH analysis of categorical data

Variable	Standard Error	z	p-value	Hazard Ratio
Birth Interval				
<18 months	1.081	3.78	0.000***	3.368
18–23 months	0.676	1.74	0.082†	1.872
24–35 months	0.445	1.78	0.075†	1.627
≥36 months^R				
Economic Status				
Not Poor	0.119	-2.79	0.005**	0.541
Poor^R				

Source: 2017 Indonesia Demographic and Health Survey
N = 14720 births
R Reference

***$p < 0.001$; **$p < 0.01$; *$p < 0.05$; †$p < 0.10$

months than for babies with a birth interval of ≥36 months. Infant mortality is 1.872 higher for babies with a birth interval of 18-23 months, and 1.627 higher for babies with a birth interval of 24-35 months than those babies with a birth interval of ≥36 months. Furthermore, infant mortality for poor mothers was higher than those for higher-income mothers, for all categories of birth interval. The hazard ratio of 0.541 means that babies born to 'not poor' mothers tended to have a 0.541 lower risk of infant mortality than babies born to poor mothers. In other words, babies born to poor mothers tended to have a 1.848 higher risk of infant mortality than those of not poor mothers.

Conclusion

The results of 2017 IDHS show that, using chi square test of independence, there is a relationship between economic status of mother and PBI, which means that women from higher-income households tend to have longer PBI. In addition, there is a negative relationship between birth interval and infant mortality rate in Indonesia: the longer the birth interval, the lower the infant mortality rate. Babies born less than 18 months, 18-23 months, and 24-35 months from previous births were more likely to die than those with birth spans of 36 months or more. For each one-year increase in birth length, infant mortality was reduced by 11.9 percent. Furthermore, the mother's economic status, which is represented by a wealth index, had a significant effect on infant mortality, with babies born to poorer mothers being at greater risk of dying. Indeed, mothers with poor economic status had higher infant mortality for all categories of birth interval. However, the sex of the children, age of the mother, marital status of mother, and maternal education had no significant effect on infant mortality.

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Annex 1

Table 1. Number of Births and infant mortality in Indonesia, 2017

Variable	Birth		Infant Mortality	
	N	%	N	Rate
Number of Sample Size	14720	100	377	9,170
Preceding birth interval	X^2=34,151		p=0.000	
First Birth	4898	33.274	129	8.361
<18 months	466	3.166	31	27.371
18–23 months	627	4.260	16	14.628
24–35 months	1431	9.721	32	12.802
≥36 months	7298	49.579	169	7.412
Succeeding birth interval	X^2=373.066		p=0.000	
<20 months	527	3.580	77	5.776
≥20 months	2951	20.048	112	15.736
The last birth	11242	76.372	188	50.522
Birth Order	X^2=24.32		p=0.000	
1	4875	33.118	126	8.396
2	4591	31.189	88	5.538
3–4	4050	27.514	11	9.106
≥5	1204	8.179	53	26.648
Birth Status	X^2=188.342		p=0.000	
Single	14509	98.567	341	8.442
Twins	211	1.433	36	66.759
Sex	X^2=8.451		p=0.004	
Male	7582	51.508	222	8.933
Female	7138	48.492	155	9.420
Maternal age at birth (years)	X^2=9.132		p=0.058	
<20	1210	8.220	41	9.379
20–24	3225	21.909	78	9.496
25–29	4094	27.813	89	7.222
30–34	3569	24.246	88	9.439
≥35	2622	17.813	81	11,368
Marital Status	X^2=1.964		p=0.161	
Married	14217	96.583	369	9.282
Widow	503	3.417	8	6.041
Maternal Education	X^2=188.342		p=0.030	
<junior high school	4037	27.425	122	11.695
≥junior high school	10683	72.575	122	8.221
Economic Status	X^2=14.318		p=0.001	
Lowest	6954	47.242	214	11.959
Middle	5268	35.788	114	6.969
Upper	2498	16.970	49	6.107
Year of Birth	X^2=1.886		p=0.757	

2012	1750	11.889	53	12.296
2013	3674	24.959	95	9.471
2014	3550	24.117	87	9.499
2015	3552	24.130	88	9.199
2016	2194	14.905	54	5.595
Residence	X^2=0.401		p=0.526	
Rural	7453	50,632	197	10.842
Urban	7267	49,368	180	7.456

Source: 2017 Indonesia Demographic and Health Survey
Note: Infant Mortality Rate calculated based on person-years data per 1000

Annex 2

Table 2. Cox PH analysis of infant mortality

Variable	Model 1		Model 2		Model 3	
	Hazard Ratio	p-value	Hazard Ratio	p-value	Hazard Ratio	p-value
Preceding birth interval (ref: ≥36 month)						
First Birth	1.179	0.432	1.479	0.131		
<18 months	3.710	0.000***	3.917	0.000***		
18-23 months	2.005	0.054†	2.153	0.035*		
24-35 months	1.697	0.053†	1.774	0.039*		
Preceding birth interval (years)					0.891	0.002**
Birth Status (ref: single)						
Twins	7.779	0.000***	8.273	0.000***	8.554	0.000***
Sex (ref: male)						
Female			1.081	0.655	1.071	0.694
Maternal age at birth (ref: <20 years)						
20-24			1.073	0.844	1.019	0.718
25-29			0.929	0.847	0.651	0.468
30-34			1.309	0.494	1.190	0.123
≥35			1.555	0.276	1.362	0.886
Marital Status (ref: married)						
Widow			0.634	0.437	0.732	0.470
Maternal Education (ref: <junior high school)						
≥junior high school			0.860	0.448	0.759	0.549
Economic Status (ref: lowest)						
Middle			0.682	0.083†	0.711	0.025*
Upper			0.575	0.080†	0.467	0.001**
Residence (ref: rural)						
Urban			0.860	0.451	0.903	0.464

Source: 2017 Indonesia Demographic and Health Survey
N = 14720 births

Note: Model 3 used PBI as a continuous variable

***p < 0.001; **p < 0.01; *p < 0.05; †p < 0.10