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Research Article

Maternal education and infant mortality decline: The evidence from Indonesia, 1980–2015

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Jona Schellekens[1]

Abstract

BACKGROUND
Better maternal education has been credited with making a major contribution to infant mortality decline. Most of the evidence is based on cross-sectional analyses, which show a strong correlation between maternal education and infant mortality. However, cross-sectional analyses do not provide an estimate of the contribution of maternal education to infant mortality *decline*.

OBJECTIVE
The major objective is to obtain a more accurate estimate of the contribution of maternal education to infant mortality decline.

METHODS
Pooling data from all available phases of the Demographic and Health Survey, this article presents a longitudinal, individual-level analysis of the determinants of trends in infant mortality in Indonesia.

RESULTS
Better maternal education explains 15% of the infant mortality decline in Indonesia from 1980 to 2015.

CONTRIBUTION
The article presents the results of the largest individual-level study of its kind in terms of length of the period covered and number of infants involved.

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1. Introduction

Infant mortality has declined dramatically in less developed countries. There are three major explanations for the decline: improved living standards, advances in medical care and public health, and better maternal education (Cutler, Deaton, and Lleras-Muney 2006; Pampel and Pillai 1986). Thomas McKeown (1976) has been the most outspoken advocate of improved living standards as the motivating factor in mortality declines. But others think that advances in medical care and public health made more important contributions to mortality decline, especially in less developed countries. The argument for the role of advances in medical care and public health in reducing mortality has been made most prominently by Samuel Preston (1975). Jack Caldwell (1979) was the first to stress the importance of better maternal education as a means to lower infant and early childhood mortality (Desai and Alva 1998; Hobcraft 1993). He argued that maternal education is not merely a reflection of the standard of living and that it should be considered as a third explanation in addition to rising living standards and advances in medical care and public health.

Caldwell's hypothesis has received support from many studies, the results of which have been widely publicized (e.g., Fischetti 2011; Lutz and KC 2011). Part of the evidence for crediting maternal education with making a major contribution to infant mortality decline is based on cross-sectional studies (e.g., Fuchs, Pamuk, and Lutz 2010; Pamuk, Fuchs, and Lutz 2011). However, cross-sectional studies and longitudinal approaches often reach different conclusions regarding the association between key explanatory variables and outcomes (Phillips 2006).

Longitudinal models of change often use macro-level data. Pooling time series from 175 countries, Gakidou et al. (2010) concluded that about half of the decline in infant and early childhood mortality between 1970 and 2009 can be attributed to increased educational attainment among women of reproductive age. Correlations that are based on aggregate data, however, may be higher than correlations based on individual-level data (e.g., Ostroff 1993).

Indonesia is especially interesting to study. It is the fourth most populous country in the world. Of the ten most populous countries, the greatest increase in education among women aged 25–34 years between 1970 and 2009 occurred in Russia, followed by Indonesia (Gakidou et al. 2010). Using data from all available phases of the Demographic and Health Survey (DHS), this article presents an individual-level analysis of trends in infant mortality in Indonesia covering 36 years between 1980 and 2015. Thus the study models trends in infant mortality for a more extended period of time than previous individual-level studies of infant mortality decline in less developed countries (e.g., DaVanzo 1988; Hale et al. 2009). The results show that better maternal education explains 15% of the infant mortality decline in Indonesia from 1980 to 2015.

2. Maternal education and infant mortality

In the theoretical framework proposed by Mosley and Chen (1984), all social and economic variables operate through five categories of intermediate variables to affect infant mortality. The categories are personal illness control, maternal factors, environmental contamination, nutrient deficiency, and injury.

This article provides an estimate of the net ("cognitive") effect of maternal education on infant mortality through personal illness control. It is thought that better-educated mothers seek medical care more actively; are more aware of sanitary precautions, nutritional information, and health services; and are better able to recognize serious child health conditions (e.g., Hobcraft 1993; Soares 2007: 276). Streatfield, Singarimbun, and Diamond (1990) have shown that maternal education in Indonesia is positively related to knowledge of immunization. Educated mothers may also more actively seek prenatal care. Titaley, Dibley, and Roberts (2009) reported that in Indonesia better-educated mothers were more likely to receive postnatal care services.

Maternal factors, such as age, parity, and birth interval, may mediate the effect of maternal education on infant mortality (Mosley and Chen 1984). For example, educated mothers tend to marry later and have fewer pregnancies. Thus, following previous studies, this study controls for maternal factors (e.g., Bhargava 2003; Hale et al. 2009; Murphy and Wang 2001).

Nutrient deficiency is more likely to be a function of financial resources of the household than of the education of the mother (Mensch et al. 2019). Environmental contamination, which refers to the transmission of infectious agents to infants, also is a function of household resources (Mosley and Chen 1984). Since better-educated mothers tend to live in wealthier households, it is important to control for household wealth (Ware 1984).

3. Data

Data were drawn from the standard Indonesian DHS of 1987, 1991, 1994, 1997, 2002–2003, 2007, 2012, and 2017. Each survey contributed children born in the period starting the year before the previous survey (or in 1980 in the case of the first DHS) and ending two years before the survey. There may be recall lapse of dead infants (e.g., Baird, Friedman, and Schady 2011). Recall lapse is a function of time, getting worse the farther we reach back in time from the year of the survey. To limit the effect of recall lapse, the study starts in 1980. The individual-level data for infants collected from each survey were pooled to create a data set that constitutes a random sample of infants born in every single year between 1980 and 2015. Table 1 presents summary statistics for each survey.

Table 1: Summary statistics by survey

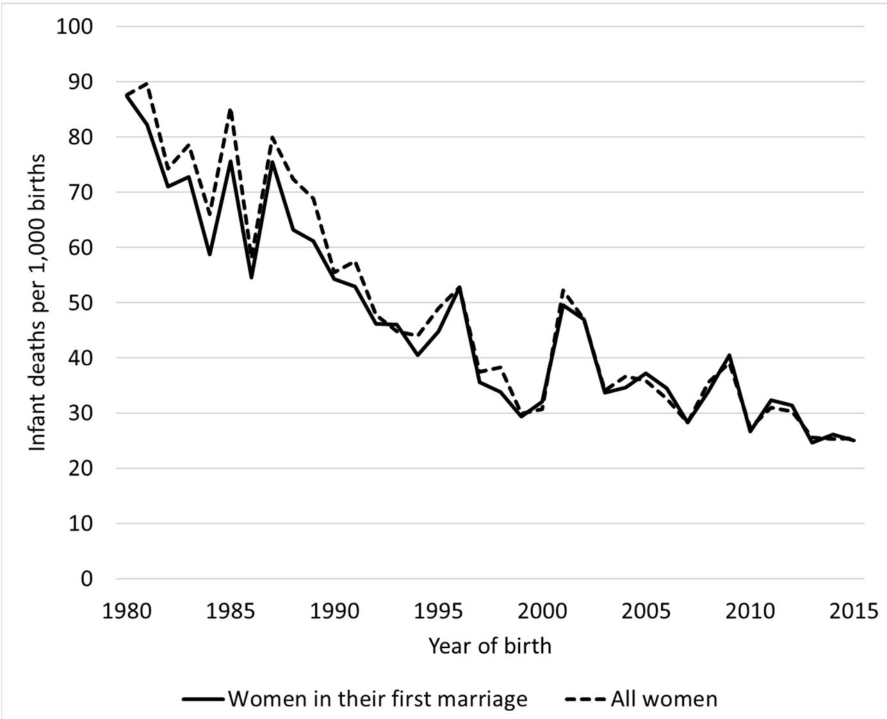
Survey	Period	Years	Infant deaths	Births
1987	1980–1985	6	614	9,024
1991	1986–1989	4	698	10,965
1994	1990–1992	3	551	9,947
1997	1993–1995	3	436	9,379
2002–2003	1996–2000	5	610	14,664
2007	2001–2005	5	712	16,612
2012	2006–2010	5	561	15,813
2017	2011–2015	5	473	15,486

4. Variables

The dependent variable is the probability of an infant death – i.e., a child dying in the first year of its life. Because the surveys do not report the exact year of death, I used the cohort infant mortality rate (IMR) as a summary measure of infant mortality. The cohort IMR provides an estimate for the probability of dying in the first year of life (${}_1q_0$) in a cohort life table. When the number of births does not fluctuate much from year to year, the cohort IMR will be close to the period IMR (e.g., Guralnick and Winter 1965).

To facilitate the inclusion of paternal education, the study was limited to women who were in their first marriage at the time of the survey. Figure 1 compares weighted estimates, based on the DHS, of the cohort IMR by single year of birth among women in their first marriage (solid line) to the IMR among all women (dashed line). The comparison shows that restricting the analysis to women in their first marriage leads to only slightly lower estimates in the 1980s. The civil registration system in Indonesia is imperfect, making it difficult to evaluate the accuracy of estimates based on the DHS. However, estimates derived from other surveys are very similar. Thus the estimate of IMR for the period 1982–1987 based on the DHS (70 per 1,000 births) is very close to the IMR of 71 calculated indirectly from the 1985 intercensal population survey (Central Bureau of Statistics 1989: 70).

Figure 1: Weighted estimates of cohort infant mortality rate by single year of birth among all women (dashed line) and among women who were in their first marriage at the time of the survey (solid line), Indonesia 1980–2015

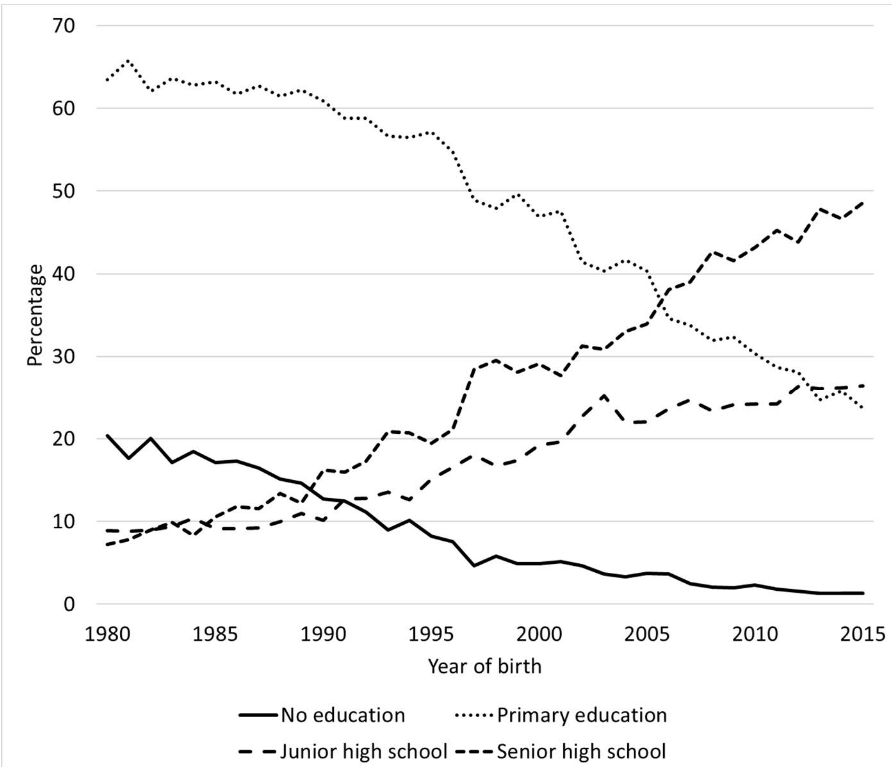


The following individual-level covariates were used to model infant mortality: maternal and paternal education, gender, maternal age, parity, length of the birth interval, and urban residence.

Unfortunately, there is no retrospective information in the surveys with which to estimate household income around the time of birth of infants who were born in years preceding the surveys. Following Ben-Porath (1973), I have used paternal education as a proxy for lifetime household income. It is important to recognize that paternal education may be capturing more than just household income. For example, like maternal education, it may have a cognitive effect on infant mortality.

The coding for maternal and paternal education is composed of four blocks: no schooling, attended primary school (one to six years of schooling), attended junior high school (seven to nine years of schooling), attended senior high school/postsecondary education (ten years or more of schooling), with one to six years being the reference category. Figure 2 presents weighted estimates of the percentage of births by category of maternal education based on the DHS.

Figure 2: Weighted estimates of the percentage of births in each category of maternal education by single year of birth among women who were in their first marriage at the time of the survey, Indonesia 1980–2015



In countries where there is evidence of son preference, such as Indonesia, mortality among girls may be higher (Guilmoto 2015). It is important to control for gender, because in such countries mothers are more likely to seek medical care for sons (Hossain and Glass 1988).

To control for maternal age, I coded births for the age of the mother at birth. The coding for maternal age is composed of six blocks: 15–19, 20–24, 25–29, 30–34, 35–39, and 40–49, the latter being the reference category.

Fertility decline may affect infant mortality by reducing the proportion of births at higher parities (Bongaarts 1987; Morris, Udry, and Chase 1975). Thus it is important to control for the number of surviving siblings, or net parity. Survival chances of an infant and those of its older siblings, however, are determined by a similar set of factors. As a result, the error term in the statistical model is likely to be correlated with the number of surviving siblings, which may lead to inconsistent estimates of the coefficients (e.g., Bhargava 2003). Following Suwal (2001), I used the number of older siblings ever born, or crude parity, instead of the number of surviving siblings, or net parity. Short spacing has repeatedly been shown to increase mortality (e.g., Murphy and Wang 2001). Hence I have added a variable to the analysis indicating whether a child was born less than 18 months after the previous birth.

Rural infants face higher mortality rates than their urban counterparts (e.g., van de Poel, O'Donnell, and van Doorslaer 2009). Therefore I have included a variable indicating urban residence at the time of the survey to control for shifts in the rural–urban distribution. The coefficient of urban residence may be biased, however, because I assume that women in urban areas have lived there since their marriage or the previous survey (or 1980 in the case of the first DHS), whichever came last.

Infants nested within a community are often exposed to a common set of community-derived influences. For example, they may share access to a similar level of health care (Frankenberg 1995). To control for unobserved community effects, such as access to health care, I added a community (or primary sampling unit) random effect to the statistical models (e.g., Griffiths, Brown, and Smith 2004).

5. Statistical methods

The dependent variable is the probability of an infant death. I used ordinary least squares (OLS) instead of logistic regression models to facilitate the comparison of coefficients across models (e.g., Mood 2010). Hellevik (2009) has made a case for using OLS regression when the dependent variable is a dichotomy. A logistic model should be used if it fits the data much better than a linear model. However, often the linear model fits just as well as the logistic model, especially when probabilities are not close to zero or one.

To estimate the total effect of better maternal education on infant mortality decline, I first regressed the probability of an infant death on birth year dummy variables. Next I controlled for maternal education to test whether the relationship between year of birth and infant mortality is mediated by maternal education. A noticeable reduction in the size of the coefficients of the birth year dummy variables would suggest mediation (VanderWeele 2016; for examples, see Hill and Needham 2006; Schellekens and Ziv 2020).

A simple way to show the net effect of change in an independent variable on the dependent variable in a multiple linear regression model is to simulate what trends in the dependent variable would have been if an independent variable were to remain constant (e.g., Gakidou et al. 2010). Therefore I computed counterfactual-predicted series of IMR that factor out change in maternal education from the predicted series of IMR using the coefficients in the full regression model. For each birth year *t*, the level of IMR was simulated by computing for each infant the predicted probability that it would die within a year. These probabilities were summarized to obtain the predicted number of deaths among infants born in year *t*. To obtain the predicted series of IMR, the number of infant deaths was divided by the observed number of births in year *t*.

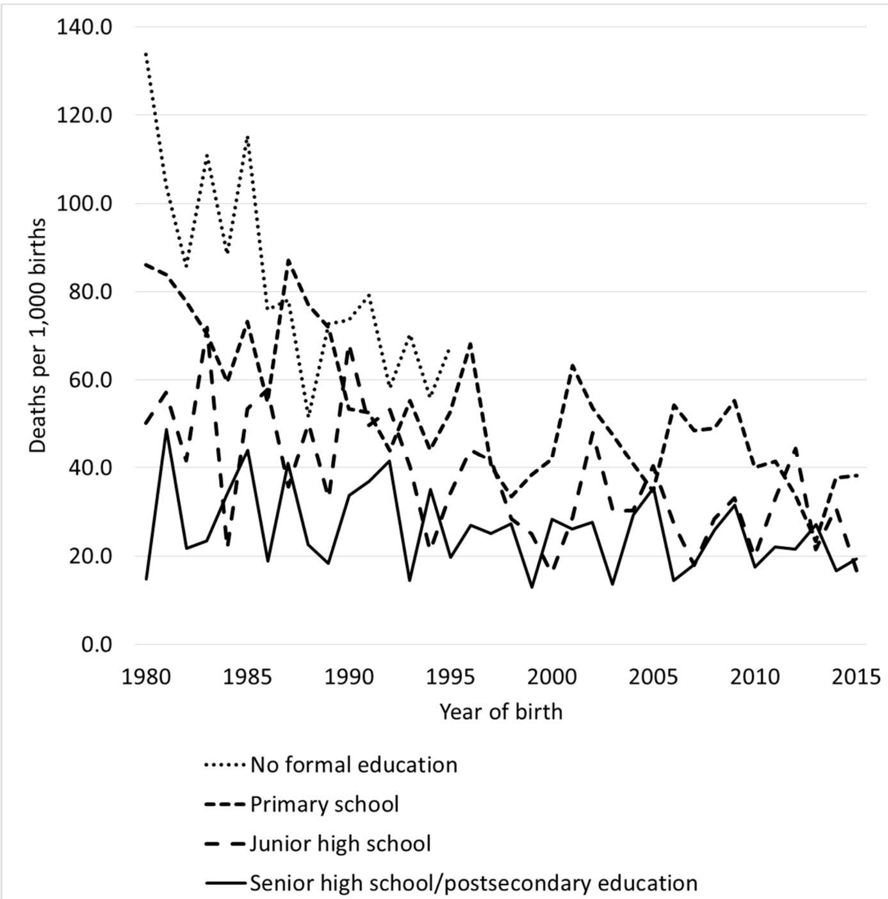
The analysis is based on 101,890 infants born to 57,037 women. The regression model assumes that the observations are independent, but since observations from the same woman tend to be correlated, this is not a reasonable assumption. In such cases, there is a need to correct standard errors for clustering in women (Singer and Willett 2003: 384). All models also include a community random effect, which contains the effects of factors not specifically included in the models that are common to infants in the same community (Bolstad and Manda 2001). I used lme4, a mixed-effects regression package in R (R Core Team 2014).

The DHS uses a complex sampling design. Where sampling weights are solely a function of independent variables included in the model, unweighted estimates of the coefficients are preferred because they are unbiased, are consistent, and have smaller standard errors than weighted estimates (Winship and Radbill 1994). However, I have used sampling weights to estimate IMR (see Figures 1–3).

6. Results

Infant mortality and the percentage of mothers without any formal education have both declined. If better maternal education explains the decline in IMR, then younger cohorts of better-educated mothers with low infant mortality should gradually replace older cohorts of less educated mothers with high infant mortality. Figure 3 presents weighted estimates of the cohort IMR by single year of birth for each category of maternal education. It shows evidence for cohort replacement. For example, there was only a moderate decline in IMR over time among mothers who had reached senior high school. However, Figure 3 also shows that there was a large decline in IMR among mothers without any formal education, suggesting that there were additional causes of the infant mortality decline.[2]

Figure 3: Weighted estimates of cohort infant mortality rate by single year of birth for each category of maternal education among women who were in their first marriage at the time of the survey, Indonesia 1980–2015



[2] After 1995, the percentage of mothers without any formal education is so small that the series of IMR for this educational group becomes very erratic. Hence, in Figure 3, this series ends in 1995.

Table 2 presents descriptive statistics of the covariates used in the regression analysis. The denominator is the total number of infants born in 1980–2015. Table 2 also presents estimates of the cohort IMR for each category of the categorical variables. IMR is highest among women without any formal education and lowest among those who attended senior high school/postsecondary education.

Table 2: Descriptive statistics of covariates in the regression analysis and the cohort infant mortality rate (IMR) in each category of the categorical variables

Variables	Mean	IMR
Gender		
Male	0.515	51.3
Female	0.485	39.8
Maternal age		
15–19	0.100	69.5
20–24	0.285	45.6
25–29	0.283	39.3
30–34	0.199	40.0
35–39	0.101	45.1
40–49	0.032	65.9
Maternal education		
No education	0.084	79.1
Primary	0.436	56.7
Junior	0.180	35.6
Senior and postsecondary	0.301	26.4
Paternal education		
No education	0.054	73.7
Primary	0.410	57.7
Junior	0.175	43.5
Senior and postsecondary	0.361	28.9
Crude parity	2.685	-
Birth interval		
< 18 months	0.242	55.6
≥ 18 months	0.758	42.5
Residence		
Rural	0.618	53.6
Urban	0.382	32.9

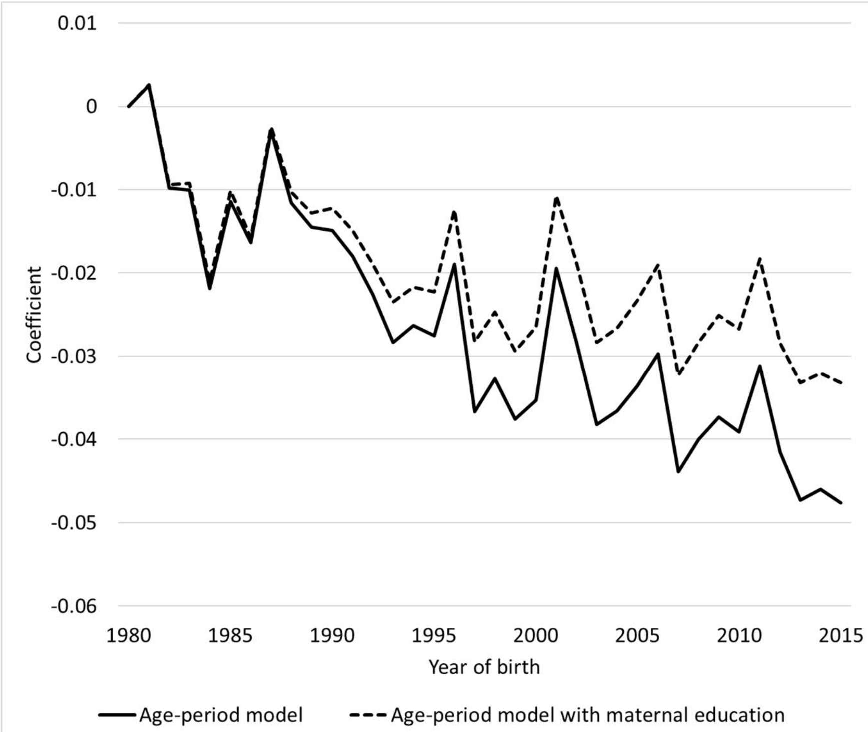
Table 3 presents three mixed-effects OLS regression models of the probability of an infant death. In the first model, the probability of an infant death is a function of age and year of birth (age-period model). The second model adds a cohort variable: maternal education. The third model includes all the independent variables (full model).

Table 3: Mixed-effects OLS regression of infant mortality in Indonesia, 1980–2015

	Model 1		Model 2		Model 3	
Variables	***b***	**S.E.**	***b***	**S.E.**	***b***	**S.E.**
Maternal age						
15–19	–0.0015	0.0042	0.0031	0.0042	0.0183	0.0049
20–24	–0.0232	0.0038	–0.0163	0.0039	–0.0027	0.0044
25–29	–0.0276	0.0038	–0.0205	0.0038	–0.0102	0.0042
30–34	–0.0252	0.0039	–0.0197	0.0039	–0.0128	0.0041
35–39	–0.0195	0.0042	–0.0162	0.0042	–0.0130	0.0042
40–49	0.0000	-	0.0000	-	0.0000	-
Maternal education						
No education			0.0179	0.0026	0.0129	0.0028
Primary			0.0000	-	0.0000	-
Junior			–0.0162	0.0019	–0.0109	0.0020
Senior and higher			–0.0216	0.0017	–0.0096	0.0021
Gender						
Male					0.0000	-
Female					–0.0112	0.0013
Crude parity					0.0041	0.0005
Short birth interval					0.0211	0.0020
Urban residence					–0.0077	0.0016
Paternal education						
No education					0.0027	0.0033
Primary					0.0000	-
Junior					–0.0031	0.0020
Senior and higher					–0.0087	0.0020
Constant	0.0945	0.0065	0.0893	0.0066	0.0724	0.0074

Figure 4 presents the coefficients of 35 birth year dummy variables in the first and second model. To test whether the relationship between birth year and infant mortality is mediated by maternal education, the second model adds maternal education. Maternal education attenuates the coefficients of the birth year dummies. The first model shows that the probability of an infant death declined by 0.048 between 1980 and 2015 (solid line). After controlling for maternal education, the probability of an infant death declines by only 0.033 (dashed line). Thus better maternal education explains 30% of the infant mortality decline.

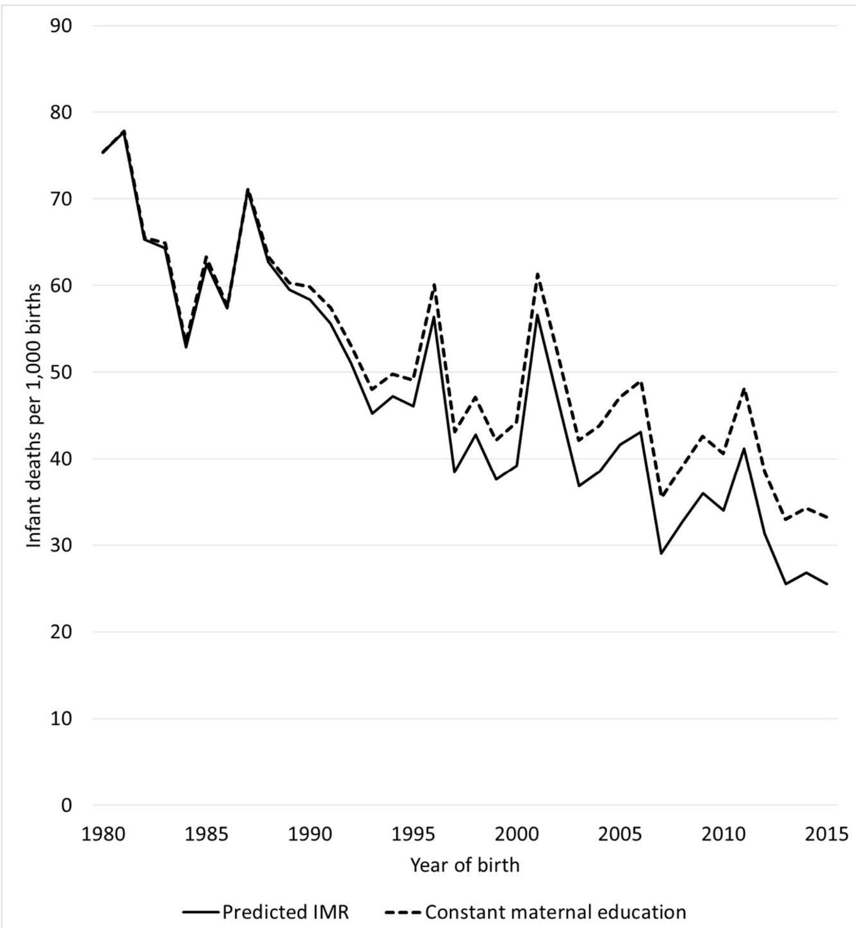
Figure 4: Regression coefficients of the birth year dummy variables in age-period models with and without maternal education, Indonesia 1980–2015



Fertility may mediate the effect of maternal education on infant mortality, whereas paternal education and urban residence may confound the relationship between maternal education and infant mortality. Moreover, gender may moderate the relationship. Therefore the third model adds these variables to estimate the net effect of maternal education. In the full model, girls have lower mortality than boys. Thus there is no evidence of son preference in infancy in Indonesia. In particular, there is no evidence that mothers are more likely to seek medical care for sons, at least not in infancy. There is a positive correlation between parity and infant mortality. Infant mortality is higher after a short birth interval and is lower in urban areas. There is a negative correlation between paternal education and infant mortality. A comparison of the full model with the second model shows that a short birth interval, parity, urban residence, and paternal education attenuate the effect of maternal education.

Figure 5 compares trends in cohort IMR as predicted by the third model (solid line) with a counterfactual-predicted series that assumes that the educational distribution of mothers remained constant at the initial level of 1980 (dotted line). The figure shows that better maternal education explains 15% of the decline in infant mortality.

Figure 5: Predicted and counterfactual-predicted cohort infant mortality rate (IMR) by single year of birth among women who were in their first marriage at the time of the survey, assuming constant maternal educational distribution, Indonesia 1980–2015



The analysis omits 11,614 infants born to women who were not in their first marriage. To see if the results for all married women differ, I replicated the analysis for the entire sample of married women, including those not in their first marriage. In the entire sample of married women, the total effect of maternal education increases from 30% to 32%. However, the net effect of maternal education in the entire sample of married women is 15%.

7. Conclusion and discussion

This study pools all available phases of the Indonesian DHS to analyze the contribution of maternal education to infant mortality decline over 36 years and finds that better maternal education explains 30% of the infant mortality decline from 1980 to 2015. However, the relationship is considerably attenuated after controlling for paternal education, fertility variables, and urban residence, with the net effect of maternal education being only 15%.

To the best of my knowledge, this is the largest study of its kind in terms of length of the period covered and number of infants involved. My estimate for the contribution of maternal education is much lower than the estimate of Gakidou et al. (2010) for the contribution of maternal education to the decline in infant mortality and early childhood mortality from 1970 to 2009, which is based on aggregate data.

There are very few individual-level studies for comparison. Moreover, these cover a much shorter period. DaVanzo (1988) estimated that increased maternal education accounted for 27% to 30% of the infant mortality decline in peninsular Malaysia between 1946–1960 and 1961–1975. A more recent study by Hale et al. (2009) estimated that increased maternal education accounted for approximately 25% of the infant mortality decline during the first week of life and for about 10% after the first week in Bangladesh between 1987–1994 and 1995–2002.

An important limitation of the current study is that all analyses were correlational. I estimate that better maternal education explains 15% of the infant mortality decline. However, my results do not show the direction of causality. Andriano and Monden (2019) have shown that net of living standards, maternal education has a causal effect on infant mortality in Malawi and Uganda. Thus, to the extent that their results have any external validity, better maternal education is likely to have contributed to infant mortality decline in Indonesia.

References

Andriano, L. and Monden, C.W.S. (2019). The causal effect of maternal education on child mortality: Evidence from a quasi-experiment in Malawi and Uganda. *Demography* 56(5): 1765–1790. doi:10.1007/s13524-019-00812-3.

Baird, S., Friedman, J., and Schady, N. (2011). Aggregate income shocks and infant mortality in the developing world. *Review of Economics and Statistics* 93(3): 847–856. doi:10.1162/REST_a_00084.

Ben-Porath, Y. (1973). Economic analysis of fertility in Israel: Point and counterpoint. *The Journal of Political Economy* 81(2): S202–S233. doi:10.1086/260162.

Bhargava, A. (2003). Family planning, gender differences and infant mortality: Evidence from Uttar Pradesh, India. *Journal of Econometrics* 112(1): 225–240. doi:10.1016/S0304-4076(02)00162-8.

Bolstad, W.M. and Manda, S.O. (2001). Investigating child mortality in Malawi using family and community random effects: A Bayesian analysis. *Journal of the American Statistical Association* 96(453): 12–19. doi:10.1198/016214501750332659.

Bongaarts, J. (1987). Does family planning reduce infant mortality rates? *Population and Development Review* 13(2): 323–334. doi:10.2307/1973197.

Caldwell, J.C. (1979). Education as a factor of mortality decline: An examination of Nigerian data. *Population Studies* 33(3): 395–413. doi:10.2307/2173888.

Central Bureau of Statistics (1989). *National Indonesia Contraceptive Prevalence Survey 1987*. Jakarta: Central Bureau of Statistics.

Cutler, D., Deaton, A., and Lleras-Muney, A. (2006). The determinants of mortality. *Journal of Economic Perspectives* 20(3): 97–120. doi:10.3386/w11963.

DaVanzo, J. (1988). Infant mortality and socioeconomic development: Evidence from Malaysian household data. *Demography* 25(4): 581–595. doi:10.2307/2061323.

Desai, S., and Alva, S. (1998). Maternal education and child health: Is there a strong causal relationship? *Demography* 35(1): 71–81. doi:10.2307/3004028.

Fischetti, M. (2011). Baby's life, mother's schooling: Child mortality rates decline as women become better educated. *Scientific American* 305: 88. doi:10.1038/scientificamerican0711-88.

Frankenberg, E. (1995). The effects of access to health care on infant mortality in Indonesia. *Health Transition Review* 5(2): 143–163.

Fuchs, R., Pamuk, E., and Lutz, W. (2010). Education or wealth: Which matters more for reducing child mortality in developing countries? *Vienna Yearbook of Population Research* 8: 175–199. doi:10.1553/populationyearbook2010s175.

Gakidou, E., Cowling, K., Lozano, R., and Murray, C.J.L. (2010). Increased educational attainment and its effect on child mortality in 175 countries between 1970 and 2009: A systematic analysis. *Lancet* 376(9745): 959–974. doi:10.1016/S0140-6736(10)61257-3.

Griffiths, P.L., Brown, J.J., and Smith, W.F. (2004). A comparison of univariate and multivariate multilevel models for repeated measures of use of antenatal care in Uttar Pradesh. *Journal of the Royal Statistical Society, Series A* 167(4): 597–611. doi:10.1111/j.1467-985X.2004.00602.x.

Guilmoto, C.Z. (2015). Mapping the diversity of gender preferences and sex imbalances in Indonesia in 2010. *Population Studies* 69(3): 1–17. doi:10.1080/00324728.2015.1091603.

Guralnick, L. and Winter, E.D. (1965). A note on cohort infant mortality rates. *Public Health Reports* 80(8): 692–694. doi:10.2307/4592509.

Hale, L., DaVanzo, J., Razzaque, A., and Rahman, M. (2009). Which factors explain the decline in infant and child mortality in Matlab, Bangladesh? *Journal of Population Research* 26: 3–20. doi:10.1007/s12546-008-9003-0.

Hellevik, O. (2009). Linear versus logistic regression when the dependent variable is a dichotomy. *Quality and Quantity* 43: 59–74. doi:10.1007/s11135-007-9077-3.

Hill, T.D. and Needham, B.L. (2006). Gender-specific trends in educational attainment and self-rated health, 1972–2002. *American Journal of Public Health* 96(7): 1288–1293. doi:10.2105/AJPH.2004.061119.

Hobcraft, J. (1993). Women's education, child welfare and child survival: A review of the evidence. *Health Transition Review* 3: 159–175.

Hossain, M.M. and Glass, R.I. (1988). Parental son preference in seeking medical care for children less than five years of age in a rural community in Bangladesh. *American Journal of Public Health* 78(10): 1349–1350. doi:10.2105/AJPH.78.10.1349.

Lutz, W. and KC, S. (2011). Global human capital: Integrating education and population. *Science* 333(6042): 587–592. doi:10.1126/science.1206964.

McKeown, T. (1976). *The modern rise of population*. New York: Academic Press.

Mensch, B.S., Chuang, E.K., Melnikas, A.J., and Psaki, S.R. (2019). Evidence for causal links between education and maternal and child health: Systematic review. *Tropical Medicine and International Health* 24(5): 504–522. doi:10.1111/tmi.13218.

Mood, C. (2010). Logistic regression: Why we cannot do what we think we can do, and what we can do about it. *European Sociological Review* 26(1): 67–82. doi:10.1093/esr/jcp006.

Morris, N.M., Udry, J.R., and Chase, C.L. (1975). Shifting age-parity distribution of births and the decrease in infant mortality. *American Journal of Public Health* 65(4): 359–362. doi:10.2105/AJPH.65.4.359.

Mosley, W.H. and Chen, L.C. (1984). An analytical framework for the study of child survival in developing countries. *Population and Development Review* 10 (Supplement): 25–45. doi:10.2307/2807954.

Murphy, M. and Wang, D. (2001). Do previous birth interval and mother's education influence infant survival? A Bayesian model averaging analysis of Chinese data. *Population Studies* 55(1): 37–47. doi:10.1080/00324720127679.

Ostroff, C. (1993). Comparing correlations based on individual-level and aggregated data. *Journal of Applied Psychology* 78(4): 569–582. doi:10.1037/0021-9010.78.4.569.

Pampel, F.C. and Pillai, V.K. (1986). Patterns and determinants of infant mortality in developed nations, 1950–1975. *Demography* 23(4): 525–542. doi:10.2307/2061349.

Pamuk, E.R., Fuchs, R., and Lutz, W. (2011). Comparing relative effects of education and economic resources on infant mortality in developing countries. *Population and Development Review* 37(4): 637–664. doi:10.1111/j.1728-4457.2011.00451.x.

Phillips, J.A. (2006). Explaining discrepant findings in cross-sectional and longitudinal analyses: An application to U.S. homicide rates. *Social Science Research* 35(4): 948–974. doi:10.1016/j.ssresearch.2005.07.002.

Preston, S.H. (1975). The changing relation between mortality and level of economic development. *Population Studies* 29(2): 231–248. doi:10.1080/00324728.1975.10410201.

R Core Team (2014). *R: A language and environment for statistical computing. R Foundation for Statistical Computing*. Vienna, Austria. http://www.R-project.org/.

Schellekens, J.J. and Ziv, A. (2020). The role of education in explaining trends in self-rated health in the United States, 1972–2018. *Demographic Research* 42(12): 383–398. doi:10.4054/DemRes.2020.42.12.

Singer, J.D. and Willett, J.B. (2003). *Applied longitudinal data analysis: Modeling change and event occurrence*. Oxford: Oxford University Press.

Soares, R.R. (2007). On the determinants of mortality reductions in the developing world. *Population and Development Review* 33(2): 247–287. doi:10.1111/j.1728-4457.2007.00169.x.

Streatfield, K., Singarimbun, M., and Diamond, I. (1990). Maternal education and child immunization. *Demography* 27(3): 447–455. doi:10.2307/2061378.

Suwal, J.V. (2001). The main determinants of infant mortality in Nepal. *Social Science and Medicine* 53(12): 1667–1681. doi:10.1016/S0277-9536(00)00447-0.

Titaley, C.R., Dibley, M.J., and Roberts, C.L. (2009). Factors associated with non-utilisation of postnatal care services in Indonesia. *Journal of Epidemiology and Community Health* 63(10): 827–831. doi:10.1136/jech.2008.081604.

van de Poel, E., O'Donnell, O., and van Doorslaer, E. (2009). What explains the rural-urban gap in infant mortality: Household or community characteristics? *Demography* 46(4): 827–850. doi:10.1353/dem.0.0074.

VanderWeele, T.J. (2016). Mediation analysis: A practitioner's guide. *Annual Review of Public Health* 37: 17–32. doi:10.1146/annurev-publhealth-032315-021402.

Ware, H. (1984). Effects of maternal education, women's roles, and child care on child mortality. *Population and Development Review* 10 (Supplement: Child Survival: Strategies for Research): 191–214. doi:10.2307/2807961.

Winship, C. and L. Radbill. (1994). Sampling weights and regression analysis. *Sociological Methods and Research* 23(2): 230–257. doi:10.1177/0049124194023002004.