PAA 2008 – Extended Abstract

Maternal health is a confounder in the relationship between maternal education and infant mortality

Emre S. Ozaltin and Kenneth H. Hill
Harvard University

Background & Objectives

The last half of the past century has seen large declines in mortality globally and particularly in the developing world. The causes for historical mortality decline, as well as how these causes relate to mortality differentials among countries and among groups within countries today, are highly contentious (see Cutler[1] for an excellent overview). Neonatal, infant and child mortality are conditions representing one of the greatest inequalities in health today with an over 100-fold difference between the best and worst countries. Large within-country differentials exist both in developed and developing countries by ethnicity, region, socioeconomic status, place of residence and rurality[2]. Maternal factors related to mortality have been found to be mother's age, birth interval, birth order, prior reproductive loss and duration of breast-feeding among others.

The education of mothers has been the one variable consistently linked to mortality of their children, likely operating through heath behaviors and as a proxy for autonomy of women to make health-decisions for their children[3,4,5]. This is complicated by the finding that there is important reverse causality between income, education, and health[6,7]. Given this, we explore whether the health of the mother may be a confounder in the relationship between household income, mother's education and child mortality. The health of the mother as a possible determinant of child mortality has received little attention to date. The health of mothers may impact the subsequent mortality of their children indirectly through education and income or directly through biological mechanisms. The principal mechanism may be that healthier mothers have heavier babies, whose survival rates are better than those of low-birth weight babies. One can hypothesize a number of other mechanisms through which the health of the mother affects fetal conditions leading to increased risk for mortality for children later in life, in agreement with Barker's early-life factors hypothesis[8].

One measure that has been suggested as a proxy for health is height. The average height of a population is governed by three factors: genetics, disease and nutrition. There is a detectable excess risk of morbidity and mortality from being short; assuming that the childhood environment is an important determinant of adult stature it is also important for adult health[9]. Health of mothers, as measured by height, may be an important determinant of subsequent mortality of their children. The only study we were able to find exploring this issue is an unpublished paper by Thomas and colleagues who find that mother's height is an important determinant of child mortality even after controlling for income and education though they fail to control for secular trends[10].

Methods

We use DHS survey data from 10 countries representing a range of geography, culture, family structure and mortality. Analysis is run separately in each country and on the pooled dataset using country-dummies. The DHS interviews all women of reproductive age in selected households; this analysis is restricted to women who have had children, the dependent variable applies to children ever-born.

Panel 1

Countries	Year	n (women)
Bolivia	2003	17,654
Dominican Rep.	2002	23,384
Egypt	2005	19,474
Ghana	2005	5,691
India	1998/99	90,303
Kazakhstan	1999	4,800
Kenya	2003	8,195
Madagascar	2003/04	7,949
Nepal	2001	8,726
Vietnam	2002	5,665

Panel 2 – Variables in the Model

Dependent Variable

- Death of child (dichotomous)

Independent Variables

- Mother's Health (Height; 100-200cm)
- Mother's Age at birth (15-49)
- Education (0-22 years)
- Income (sum of durable goods; 0-5)
- Setting (urban/rural)
- State/province/region*
- Religion*
- Ethnicity*
- Mother tongue*

**Where applicable, not included in pooled run*

General Analysis

We run logistic regressions to determine the effect of maternal height on mortality of their children, clustering by household and by mother. Panel 2 summarizes the variables included in the model, not including interaction terms. Interaction terms between height, education and income are included to test for confounding. We look at non-linear effects of height on mortality. Height is both dichotomized categorized, categorizing the bottom 10%, next 20%, middle 40%, next 20% and top 10% of the distribution. This is done as the bulk of the data is in a restricted range with long outliers on either side. Various cutoffs for dichotomization are chosen to assess any threshold effects in the data. Age and education are similarly included both continuously and categorically exploring various cutoffs and dichotomies.

Secular trends

We divide the surveys into 5-year periods prior to implementation (the first period being 0-4.9 years prior to survey and the last period being 25+ years prior to the survey) and apply the model only to children born during this interval. This is to deal with any secular trends in height increase and mortality decrease (with a 15-49 year lag) which may create a spurious association between mother's height and mortality. The restriction of the analysis to 5-year periods should eliminate the effects of any such trends. The model is run separately in each of 5 year periods.

Biological link hypothesis

The proposed hypothesis of a biological link between mother's health and her child's mortality should be stronger for mortality at earlier ages. The analysis is run separately in each of 4 age categories (0-4, 4-12, 12-24, 25+) to assess the effect of mother's height on mortality in each.

Partial exposures

To account for potential partial exposures we run the analysis on those alive at the beginning of each age category. We then run survival analysis on birth cohorts constructed by the same age categories, and estimate coefficients using Cox proportional hazard model.

Confounding of the height effect

The model is run restricting the analysis to mothers aged 20-49. Height is determined by this age and related to childhood health and nutrition. This restriction reduces the possibility that there are other factors present in the mother's immediate environment that are jointly determining height and child mortality. Further, height may be affected by early childbearing, itself associated with higher mortality risks. To deal with this we run the analysis restricting to women who have had their first child after the age of 20.

Results

Initial results indicate that the health of mothers, as measured by height, is an important determinant of the subsequent mortality of her children. In the pooled analysis, the odds of death is 0.14 and each cm of height decreases the odds of death by 0.015. There appears to be no bimodal effect or a threshold below which the effect of height is particularly pronounced: there is no clear stunting effect. Most of the effect on mortality comes from small changes in height at the middle of the distribution. Table 1 displays the regression coefficients for categorical height (covariates omitted) in one country: India. The difference between the highest and lowest category of height is significant in every period. All coefficients are in the expected direction with the exception of children born 25 years or more prior to the survey. This analysis indicates that the effect of height on survival appears to be linear, a finding is robust and consistent across countries and models analyzed.

Table 1: Regression coefficients for categorical height for children born in 5-year periods prior to survey in India

	Period (# yrs prior to 1998)					
	0-4.9	5-9.9	10-14.9	15-19.9	20-24.9	25+
Height (=100-1445 cm Absorbed)						
144.5-148.5 cm	-0.0850	-0.167***	-0.112*	-0.181***	-0.087	-0.031
148.6-154.2 cm	-0.0224***	-0.222***	-0.185***	-0.192***	-0.199***	-0.183*
154.3-158.3 cm	-0.0265***	-0.304***	-0.301***	-0.303***	-0.245***	-0.074
158.4+ cm	-0.0307***	-0.353***	-0.338***	-0.395***	-0.315***	-0.353**

* p<0.05, ** p<0.01, *** p<0.001

Coefficients tend to drop off somewhat as the period of analysis gets further away from the survey date. This may be due to recall bias regarding births and deaths occurring far in past. These results indicate that the apparent effect of height on survival of children is not being driven in this case by secular trends. The finding that increased height decreases the odds of mortality is robust within 5-year intervals, a finding that is consistent in countries analyzed. Interestingly, the effect of age and urban-rural differences are not significant in some countries 0-4.9 yrs prior to the survey, indicating that in some settings, the effect of age may be due to trend. Cox regressions following birth cohorts to account for partial exposures produces similar results.

Interaction coefficients indicate that there is confounding between health and education though the size of the effect varies by country (and perhaps by time period). Preliminary analysis indicates that health may account for 5-16% of the effect of mother's education on child mortality. The confounding effect of height on the relationship between income and child mortality is much less consistent, possibly due to a weaker association between mother's health and household income in some settings.

Analysis by 5-year birth cohorts supports the hypothesis of a biological link between the health of the mother and child survival. Table 2 displays the Cox regression coefficients for continuously measured height in each of 4 age categories of children in one country: India. The coefficient is strongest and most significant at the youngest age groups getting smaller and less significant at older ages; in ages 25+ there were only 89 deaths.

Table 2: Regression coefficients for height by age group in India

	Risk Set			
	0-4	5-12	13-24	25+
Height cm	-0.017***	-0.011**	-0.01	-0.024

* p<0.05, ** p<0.01, *** p<0.001

Restricting the analysis to women 25-49 years of age and to women with first births after age 20 had no impact on the magnitude or distribution of the height coefficient. Age, education and income were similarly unaffected however differences in health by urban and rural settings disappeared.

Discussion

This analysis indicates that the health of mothers, as measured by height, is a determinant of the subsequent mortality of her children and a confounder in the relationship between maternal education and child mortality. This finding further extends the hypothesis of the importance of early life factors not only in the subsequent health of a woman but extending further to affect the health of her children as well. Furthermore, our findings add to the growing literature attempting to understand the complex causal and associative relationships between income, education and health. The effect observed is not due to a secular trend driving both height and mortality though that both are being driven by another factor not here considered cannot be discounted. The effect appears to be linear and not restricted to a portion of the height distribution or due to stunting. Analysis separately by age group supported our initial hypothesis of the nature of a possible causal link between women's health and their children's mortality. Further research into causes of death is needed to test this hypothesis. We would for example hypothesize that deaths due to injuries would not be correlated with height whereas deaths due to infectious diseases would be correlated.

This analysis may suffer from omitted variable bias. Across countries the models considered explain 3-9% of the variance in mortality of children, as measured by the pseudo r-squared. The variables considered, at the aggregate level, should account for the bulk of variance in mortality. At the individual level many other factors, including genetic variability come into play. Repeating the current analysis at the country-level, instrumenting for height to assess impact on children's mortality may be a fruitful endeavor. Further work is required in this model to identify micro-level determinants of mortality and attempt to control for them in the analysis. Another potential explanation for the relationship evident in this data is that height of women may be determined by the characteristics of the household where they grew up. This may be a proxy for all kinds of other household conditions which then translate into behavioral differences among adults and affect their children's mortality. This however is unlikely as we account for current household income which is likely to be correlated with the household income of women as children and for education which likely proxies the type of behavioral differences we hypothesize to affect child mortality.

References

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