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**Maternal height and child mortality in 42  
developing countries**

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## ABSTRACT

Previous research reports mixed results about the association between maternal height and child mortality. Some studies suggest that the negative association might be stronger in contexts with fewer resources. This hypothesis has yet not been tested in a cross-nationally comparative design. We use data on 307,223 children born to 194,835 women in 444 districts of 42 developing countries to estimate the association between maternal height and child mortality and test whether this association is modified by indicators at the level of the household (like sex, age and twin status of the child and socio-economic characteristics of the mother and her partner), district (regional level of development, public health facilities and female occupational attainment) and country (GDP per capita). We find a robust negative effect of logged maternal height on child mortality. The effect of maternal health is strongest for women with least education and is more important in the first year after birth and for twin births. The indicators of development at the district and country level do not modify the effect of maternal height.

Keywords: maternal height, child mortality, ecological factors, developing countries, socio-economic factors

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## INTRODUCTION

There are indications that under the more difficult circumstances experienced by women in developing countries taller women have lower child mortality than shorter women. For instance, among Gambian, Guatemalan, Colombian and Bangladeshi women a positive effect of maternal height on child survival rates has been documented (Allal et al., 2004; Baqui et al., 1994; Mueller, 1979; Pollet and Nettle, 2008; Sear et al., 2004). The evidence for developing countries, however, is not conclusive. Some studies found no association or even a negative one (Devi et al., 1985; Frisancho et al., 1973; Kirchengast, 2000; Lasker and Thomas 1976; Strickland, 2002; Strickland and Tuffrey, 1997).

These mixed results seem surprising, as being tall is likely to entail advantages for child survival. Taller women have the straightforward physiological advantage of having wider pelves than shorter women, which allows them to have easier births and higher birth-weight babies, and hence less infant mortality (Kelly et al., 1996; Magadi et al., 2003; Prasad and Al-Taher, 2002; Sear et al., 2004). Also, there is broad evidence that adult height is an indicator of strength and general health potential (Batty and Leon, 2002; Cavelaars et al., 2000; Engeland et al., 2003; Marmot et al., 1984; Silventoinen, 2003; Silventoinen et al., 1999; Wadsworth et al., 2002), which would increase child survival. Obviously, women who are exceptionally tall or short because of health problems might have higher child mortality (Brush et al., 1983; Pollet and Nettle, 2008; Silventoinen et al., 1999).

Life history theory tells us that women can be tall because they grow for a longer time and start having children later, or because they grow faster due to resource abundance in early life stages such as more favorable material nutrition and nutrition, less infectious disease and better access to public health care (Crompton and Nesheim, 2002; Roberts et al., 1978; Sear et al., 2004; Silventoinen et al., 2006). In both cases, lower child mortality can be expected, because of the physiological advantages of being tall (Sear et al., 2004), and, in the second case, also the advantage of resource abundance and better health.

Why then is maternal height not always positively related to child survival? One explanation for the mixed findings is that maternal height might be especially important in situations where resources are scarce during pregnancy and the child's first years. Several authors have suggested that under poor circumstances maternal height might be a stronger reflection of health than in more affluent contexts (Sear et al., 2004;

Silventoinen, 2003). In highly developed societies with extremely low infant and maternal mortality, mother's body strength and physiological advantage will hardly influence child survival. In developing countries, on the other hand, these factors are probably much more important, and hence in those countries a positive association between maternal height and child survival is expected.

The hypothesis that maternal height is more important under difficult circumstances was tested by Pollet and Nettle (2008) on a stressed population in rural Guatemala. They found a stronger positive effect of mothers' tallness on child survival in their data compared to Western patterns. Similar results were found by Sear et al. (2004) for a sample of Gambian women, by Baqui et al. (1994) for Bangladesh women and by Mueller (1979) for Colombian women. However, not all studies on this relationship in developing countries point in the same direction. Negative effects have been reported for India and Peru (Devi et al., 1985; Frisancho et al., 1973), no effects for Namibia and Brazil (Kirchengast 2000; Menezes et al., 2005) and non-linear effects for Nepal and Papua New Guinea (Brush et al., 1983; Strickland and Tuffrey, 1997). Although these findings are based on specific and non-representative populations, they indicate that also within developing countries the effect of maternal height could depend on ecological factors, including the situation of the household.

To increase our understanding of the relationship between maternal height and child mortality within developing countries and the way in which this relationship is shaped by the context in which a child is born, we analyze data on under-five mortality for over 300,000 children born under different social and economic circumstances within 42 countries covering all regions of the developing world. To gain insight into the role of ecological factors at the household, district and country level, we study interactions between maternal height and these ecological factors.

## MATERIALS AND METHODS

### *Materials*

The data are derived from the Demographic and Health Surveys (DHS). These are large representative household surveys held since the 1980s in many developing countries. We use recent surveys for 42 countries: Armenia, Bangladesh, Benin, Bolivia, Burkina Faso, Cambodia, Chad, Colombia, Congo Brazzaville, Egypt, Eritrea, Ethiopia, Gabon, Ghana, Guatemala, Guinea, Haiti, Honduras, India, Kazakhstan, Kenya, Lesotho, Madagascar, Malawi, Mali, Mauritania, Moldova, Morocco, Mozambique, Nepal, Nicaragua, Niger, Nigeria, Peru, Rwanda, Senegal, Tanzania, Togo, Uganda, Yemen, Zambia, Zimbabwe. Within these countries we distinguish 444 sub-national districts. The combined dataset contains information on 194,835 women who gave birth to 307,223 children in the five years before the survey, of which 22,848 had died by the time of interview. Across the districts average child mortality was 7% and ranged from close 0% to 20% among the districts.

We include the following characteristics of the child: sex, age, birth order, and twin status. For the mother we include: height, age at birth, age at birth<sup>2</sup>, educational level (none, primary education, or secondary/tertiary education), home delivery, living in a rural area, and whether the mother had a partner at the time of the interview, partner's education, partner's occupation (farm, lower non-farm, upper non-farm), and household wealth at the time of the interview. As we are interested in height independent of weight, weight is also included in the analysis. Maternal height was measured in centimeters by the interviewers and maternal weight in kilograms. To reduce the influence of health problems related to extreme height or weight and of extreme measurement errors, we removed the shortest, tallest, lightest and heaviest 1 percent within each country. Height of the remaining women ranged from 134 to 178 cm and weight from 35 to 93 kilos. In all countries, height showed a normal distribution and no evidence of digit-heaping was found. Household wealth was measured by an index constructed on the basis of household assets (like radio's, cars and telephones), the possession of land, and characteristics of the housing (like floor material, roofing, toilet facilities and source of drinking water). Using a method developed by (Filmer and Pritchett, 1999), all households within a country are ranked on the basis of these characteristics and divided into three categories: poorest 20%, middle 20-80%, and the richest 20%.

Ecological factors at the district level are level of development, availability of health facilities and women's status. Level of development is measured by the percentage of households in the district owning a television. This is assumed to be a good district development indicator, because at the national level it has strong correlations with GDP per capita ( $r=0.68$ ) and the UNDP human development index (HDI) ( $r=0.84$ ). As indicator of the availability of health facilities at the district level we use the percentage of births in the five years prior to the year of survey that took place in a hospital. Women's status is indicated by the percentage of women in the district aged 16-49 who are employed in a high-level occupation (professional, managerial, technical, or clerical). GDP per capita at the country level is derived from (UNDP, 2004). Table A1 (appendix) shows descriptive information on the major characteristics of the data.

### *Statistical analysis*

We employ multilevel discrete-time hazard models (Omariba and Boyle, 2007; Sear et al., 2002; Yamaguchi, 1991). These models deal correctly with right-censoring while simultaneously taking the nested structure of the data into account. Children (level 1) are clustered within mothers (level-2), within districts (level-3) and within countries (level-4) (Snijders and Bosker, 1999). Random intercepts of the effect of maternal height are estimated at level 2, 3 and 4. Technically, we estimate four-level logistic regression models on child-year records in MLwiN (Rasbash et al., 2004) using Markov chain Monte Carlo (MCMC) estimation. The dependent variable indicates whether a child died in a given year. Children are observed up to the year of survey, age five or year of death. The total number of child-year records was 867,307.

We performed several sensitivity checks. Firstly, we estimated the final model with fixed intercepts, once by  $n-1$  dummies for the countries and once by including  $n-1$  dummies for the districts. Secondly, we left India, the largest subsample, out of the analysis. Thirdly, we added dummies for 7 world regions. Fourthly, we estimated interactions between maternal height and country dummies in a simple logistic regression model. And finally, we estimated the models including the smallest, tallest, lightest and heaviest 1% women. These five sensitivity checks showed that the results presented below are robust. It should be noted that a causal interpretation of some effects is not strictly possible. This is particularly true for working status, partnership and wealth that were measured at the time of interview and that could have been affected by the fertility

history of the women. However, it seems reasonable to assume that education and especially maternal height preceded the fertility history.

When using several indicators of socio-economic position and resources at the higher levels multicollinearity is a potential problem. The baseline correlations at the two lowest levels are not problematic; especially since the number of cases is so large that we have sufficient statistical power to deal with moderate correlations. At the district and country level the indicators have correlations of between  $r=0.4$  and  $r=0.7$ . We therefore estimated various models per level in which we included the indicators separately and simultaneously. We found no indications that the reported estimates are confounded.

## **RESULTS**

To test whether the effect of height on child mortality has a non-linear form, we estimated three models; one with maternal height, one with maternal height and maternal height squared, and one with the log of maternal height. All three specifications of the effect of maternal height showed a significant negative effect on child mortality. The likelihood that a child dies in its first five years is smaller if the mother is taller. The form of the relationship between height and child mortality is nonlinear; both the model with height and height square and the model with log height had a substantial better fit according to the Deviance (DIC) than the linear model. Because the model with log height fitted slightly better and the shape of the predicted relationship hardly differed between the nonlinear models, in the remainder of this paper only models with log maternal height will be presented.

In table 1, we present three models in which the effect of maternal height is increasingly adjusted for by other predictors. The first model simply includes maternal height, mother's age at the time of birth and basic characteristics of the child (level-1). In the second model, level-2 characteristics are added, including socio-economic characteristics of the mother and her partner and household wealth. The effect of maternal height on child mortality could be spurious because height is related to socio-economic position (Cavelaars et al., 2000; Silventoinen et al., 1999). The third model adds determinants at the district and country level (level-3 and level-4) as described above.



In all three models, the association between maternal height and child mortality is statistically significant. In other words, the association between maternal height and child mortality cannot be explained by characteristics of the mother and household or ecological factors the district or country level. Although it is clear that the strength of the association between maternal height and child mortality is somewhat attenuated by controlling for socio-economic factors, the effect of maternal height appears to be very robust. A graphical presentation of the effect gives more insight in the size and shape of association between maternal height and child mortality. In Fig. 1, the two lines representing the association between maternal height and child mortality are based on the coefficients of maternal height from the unadjusted and fully adjusted models in Table 1. For easier interpretation, children of women of average height (155 cm) serve as the reference group. The hazard rate is highest among children of shorter mothers. Children whose mother is 135 cm tall are 1.40 times as likely to die before the age of 5 compared to children whose mother is of average height. For children of mothers who are 170 cm tall, the likelihood of dying before the age of 5 is about 20% smaller than for children of women of average height (hazard ratio 0.80). It is clear from Fig. 1 that the effect of maternal height is almost linear. The effect of an additional centimeter of maternal height on child mortality slightly decreases as mothers are taller, but this decrease does not seem very substantial. The lines of unadjusted and fully adjusted model lie very close together, suggesting that the effect of maternal height is robust against including socio-economic and demographic determinants.

How does the effect of maternal height compare to other predictors of child mortality? In Table 2, we present the effects of all variables in model 3. Most effects are as expected from the literature. Well-known effects of child's age, sex and twin status are observed. Most deaths occur in the first year after birth. Girls are less likely to die than boys (hazard ratio=0.860). Members of a twin birth are more than 5 times (hazard ratio=5.298) as likely to die before the age of 5 than singletons. Controlling for all other factors, children of young mothers are more likely to die. Mother's educational level has a strong effect: the hazard rate of child mortality decreases about one-fourth when the mother has secondary education or more compared to mothers with no education (hazard ratio=0.761). There is an additional significant and substantial effect of the educational level of the male partner of the mother. The likelihood of child mortality is lower in cases where the father has more education. In the multivariate model, the educational

differences are larger than the difference in child mortality between households in the highest and lowest wealth quintile.

The effect of maternal weight is significantly positive. We also tested for nonlinear effects of weight, but these turned out to be insignificant. Hence after control for maternal height, child mortality is higher among heavier women. We refrain from interpreting this effect, because maternal weight is strongly influenced by pregnancy episodes. However, comparing models with and without maternal weight showed that the presence of this factor in the model had no substantial influence on the effect of maternal height.

### *Does the effect of maternal height differ across contexts?*

The main aim of this study is to test whether the effect of maternal height on child mortality is stronger in contexts with fewer resources. To test this hypothesis we estimated interaction effects of maternal height with all other factors in model 3 at the level of the household, district and country. Each interaction was tested separately and only the significant ones were included in the final model. The conclusions from the final model in which the interactions are estimated simultaneously, did not differ substantially from the separate models. Two factors at the individual level– child’s age and twin birth - and one factor at the household level – mother’s education – showed significant interaction effects with maternal height. For the ecological factors at the level of the districts and countries no significant interactions effects with maternal height were found. However, at the country level there is some variation in the effect of maternal height as indicated by the significant variance component ( $\text{var}=0.267$ ;  $\text{s.e.}=0.095$ ) for the random slope of maternal height. The coefficients for the significant interactions effects are reported in Table 3.

The results in Table 3 indicate that the effect of maternal height on child mortality is weaker for women with more education. These effects are significant ( $p<0.001$ ) and substantial, as can be observed in Fig. 2, which shows how the effect of maternal height is modified by education. For easier interpretation, mothers of average height without education are the reference group. The slopes for children of primary (or higher) educated mothers are less steep than that for mothers with no education. Hence, the association between maternal height and child mortality is most pronounced among the least educated mothers. Figure 2 also shows that compared to the educational differences in child mortality, the effect of maternal height appears to be substantial.

Most deaths occur in the first two years after birth, 76.5% and 13.5% in the first and second year respectively. Fig. 3 visualizes the interaction between child's age and maternal height. Children of mothers of average height (155 cm) serve as the reference group for the first and second year separately. It can be clearly observed that the effect of maternal height is much stronger in the first year after birth than in the second year; the slope is much steeper. Finally, the significant negative interaction effect between twin status and maternal height means that for twins having a taller mother has a greater positive impact on their survival chances than it has among singletons.

## **DISCUSSION**

By pooling data for 42 countries, we were able to examine the association between maternal height and child mortality for a broader height range than in prior country studies. Moreover, it enabled us to test the hypothesis that the association between maternal height and child mortality is stronger in environments with fewer resources. Our analyses clearly show that, in the broad range of maternal height across developing countries, maternal height is significantly and negatively related with under-five child mortality. Each additional centimeter of maternal height decreases the risk of child mortality. The relationship appears to be slightly curvilinear; increases in maternal height among smaller women have a somewhat greater effect.

We found no support for the hypothesis that the effect of maternal height is modified by factors at the district level (percentage hospital deliveries, percentage households with TV, percentage women with a high occupation) or at the national level (GDP per capita). However, our findings at the household level provide some support for the hypothesis that maternal height is more important in a less resourceful environment. The modifying effect of education is in the expected direction. As far as low maternal education is an indicator of current and prior poverty or resource abundance, this result seems to imply that maternal height is more important for women from a stressed environment than for women who had or have more resources.

The effect of maternal height on the risk of dying is highest in the first year after birth. This could be the result of purely physiological advantages, such as wider pelvis, and be related to complications at the time of birth. It is also possible that taller women have more resources to provide the baby in utero and during the vulnerable first months. This

could be interpreted as support for the general hypothesis. Perhaps taller women have more energy stored to provide sufficient breast-feeding. This would be in line with the trade-off between somatic and reproductive effort proposed in life history theory (Sear et al., 2004). Investing in being tall would postpone reproduction but once women start reproducing the investment in a stronger body pays off in terms of child survival.

Some prior studies (Devi et al., 1985; Frisancho et al., 1973; Kirchengast, 2000; Lasker and Thomas 1976; Strickland and Tuffrey, 1997) appear not to be in line with our main finding, because they report no association or non-linear associations between maternal height and offspring survival. The discrepancy is not that stark, however. We use large representative samples for complete populations, whereas the prior studies concern mostly small samples and very specific sub-populations (such as probands of hunter-gathers or small mountain villages). Our overall finding of a robust relationship does not rule out the possibility that within specific groups and environments the association may differ from the general pattern. The open question that remains is what the mechanisms are behind these deviations from the general pattern.

The findings of at least two prior studies (Pollet and Nettle, 2008; Sear et al., 2004) suggest that female height and reproductive success are stronger associated in more stressed environments. We only examined one aspect of total reproductive success, namely child mortality and found no support for systematic variation in the association at the level of districts or countries among developing countries. However, a more elaborate test of the hypothesis is needed that examines the association between maternal height and all aspects of reproductive success incorporated in life history theory (Hawkes and Paine, 2006; Pollet and Nettle, 2008; Sear et al., 2004), e.g. mating, timing and spacing of births, offspring survival and total number of births. Life history theory provides a comprehensive framework for testing more specific hypotheses and interpreting the empirical findings.

Our findings concern only developing countries and do not rule out significant differences in the effect of maternal height between developed and developing countries, as Pollet and Nettle (2008) suggested. Given the extremely low level of child mortality in highly developed countries it seems unlikely that maternal height would play an important role there. The question now is at what level of development the effect of maternal height becomes negligible. This threshold could be quite high as our data

includes also a number of modern districts within the developing countries and no effect of district level of development was found.

It is also very well possible that there are other factors at the district level and, especially, country level that affect the strength of the association between maternal height and child mortality. After all, we found a significant random slope for maternal height at the country level. Possible relevant factors could be quality – rather than quantity – of the health care system and the distribution of resources rather than the level of resources. We would expect maternal height to be more important in contexts with lower quality public health and higher inequality.

## **Conclusions**

Over the range of maternal height observed across 42 developing countries, maternal height is negatively associated with under-five child mortality. This association is stronger among women without education compared to women with some primary or more education. It is not modified by the level of development of the district or country.

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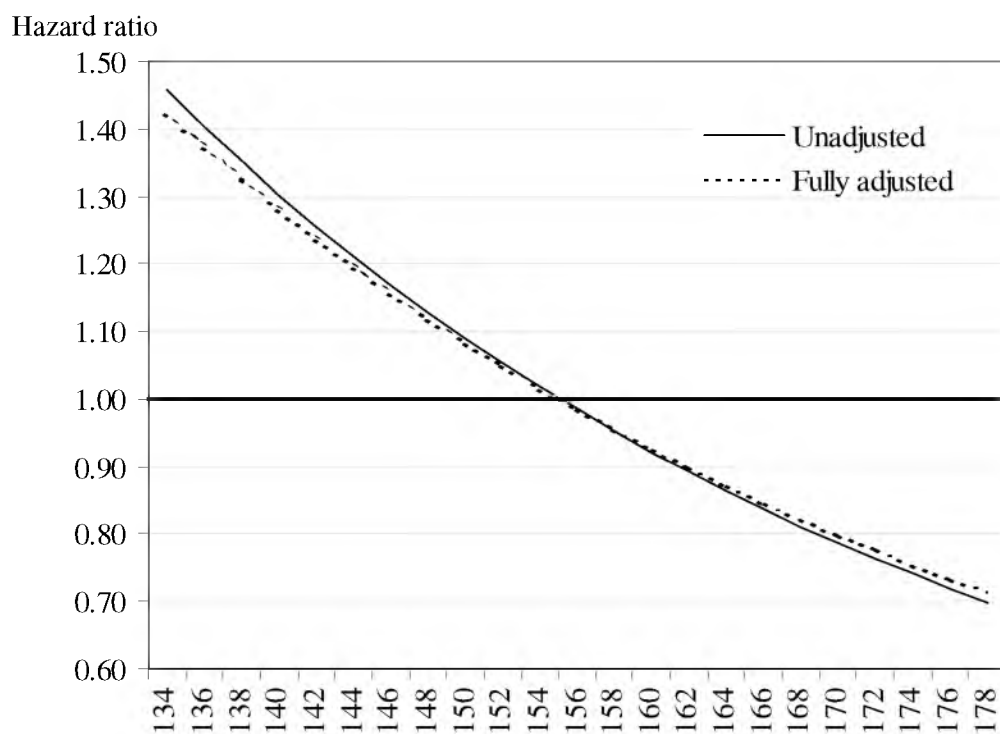


Fig. 1 Hazard ratio's for child mortality by maternal height relative to the hazard rate among children with average maternal height (155cm). The unadjusted model includes determinants at the child's level. The fully adjusted model includes all determinants at household, district and country level.



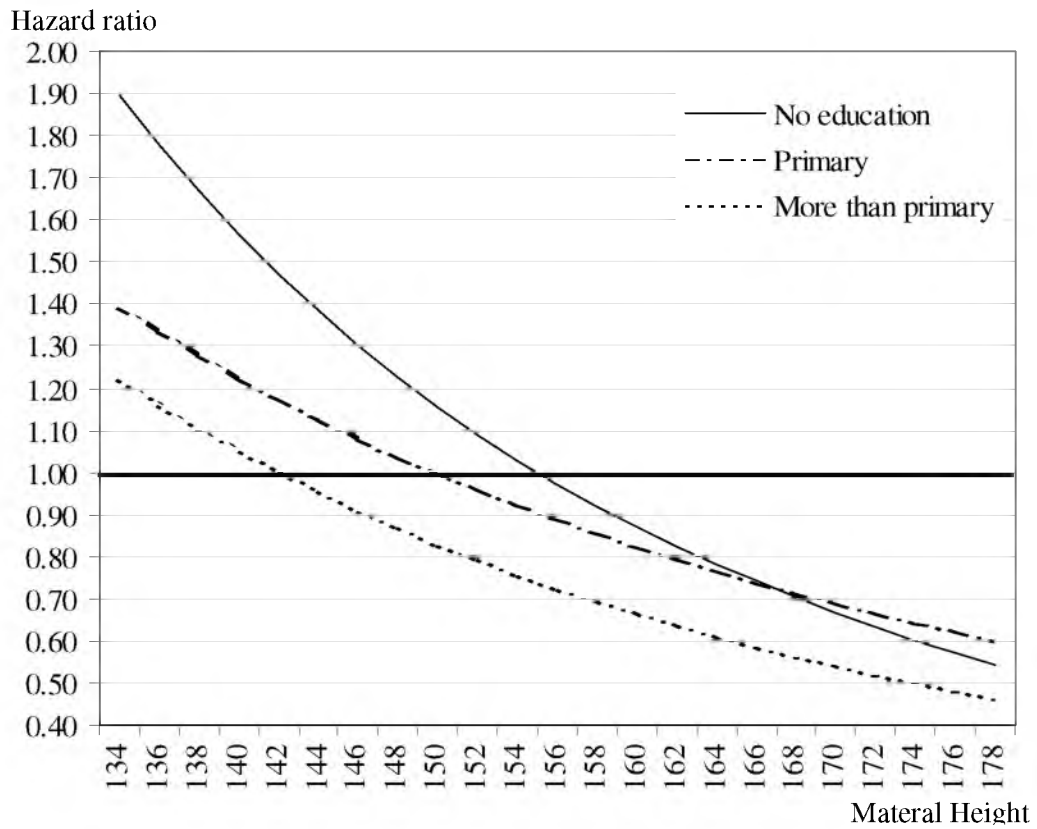


Fig. 2 Hazard ratio's for child mortality by maternal height and maternal education relative to the hazard rate among children with average maternal height (155cm) and no maternal education.

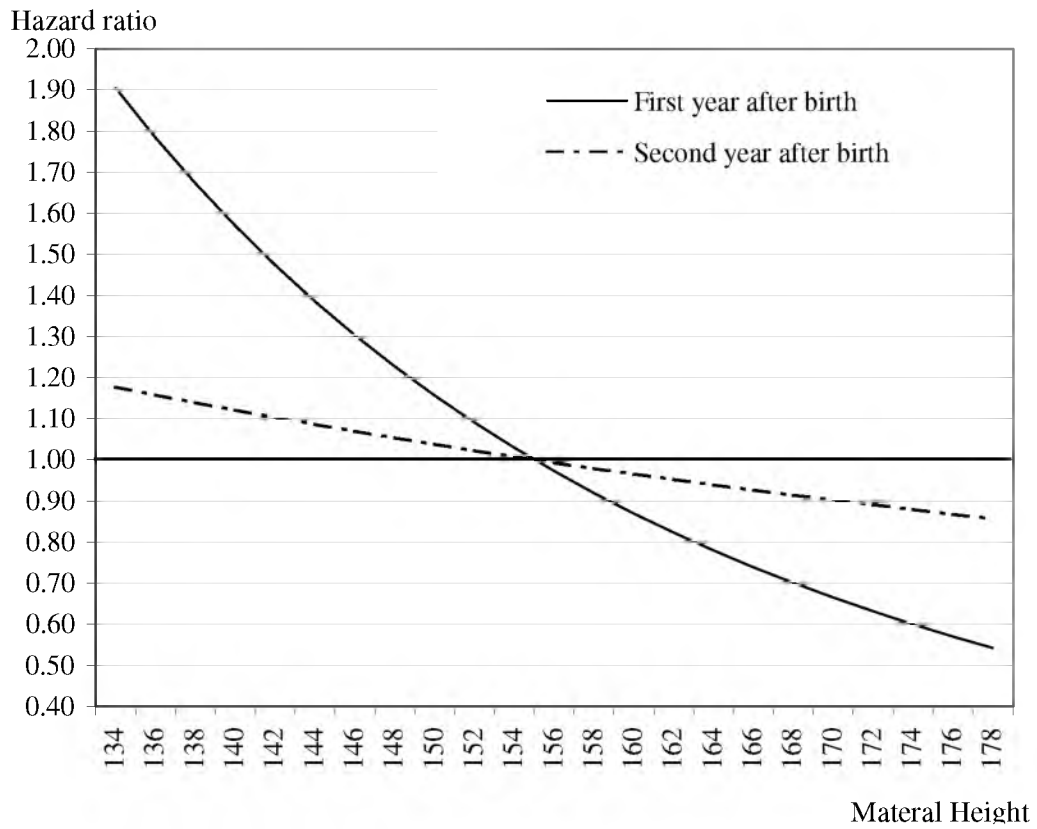


Fig. 3 Hazard ratio's for child mortality by time (child's age) and maternal height. For each year, the hazard ratio's are relative to the hazard rate among children with average maternal height (155cm).

**Table 1**  
**Unstandardised parameter estimates and hazard ratios for the effect of ln(Maternal height) on child mortality (in multilevel discrete time hazard models)**

	ln(Maternal height)	
	$\beta$	$\exp(\beta)$
Model 1: All child (level-1) characteristics, maternal age and ln(maternal height)	-2.591 ***	0.075
Model 2: Model 1 + All maternal and household (level-2) characteristics	-2.487 ***	0.083
Model 3: Model 2 + All district (level-3) and country (level-4) characteristics	-2.428 ***	0.088

\*\*\*  $p < .001$  \*\*;  $p < .01$ ; \*  $p < 0.05$

**Table 2**  
**Unstandardised parameter estimates and hazard ratios for a 4-level multilevel discrete time hazard model of child mortality**

	$\beta$		$\exp(\beta)$
<i>Child (level-1)</i>			
Sex (0=boy; 1=girl)	-0.151	***	0.860
Age	-0.952	***	0.386
Birth order	0.023	***	1.024
Twin	1.667	***	5.298
Home delivery	0.209	***	1.233
Maternal age	-0.164	***	0.849
Maternal age <sup>2</sup>	0.002	***	1.002
<i>Maternal and household characteristics (level-2)</i>			
Ln(Maternal height)	-2.428	***	0.088
Maternal weight	0.004	***	1.004
Maternal education			
Primary (vs none)	-0.083	***	0.920
More than primary (vs none)	-0.273	***	0.761
Mother employed (at time of interview)	-0.118	**	0.889
No partner present	0.077		1.080
Education partner			
Primary (vs none)	-0.050	**	0.951
More than primary (vs none)	-0.146	***	0.864
Occupation partner			
Lower nonfarm (vs farm)	-0.046	**	0.955
Upper nonfarm (vs farm)	-0.147	***	0.863
Wealth			
Middle quintiles (20-80) (vs lowest 20)	-0.031	**	0.970
Upper quintile (80-100) (vs lowest 20)	-0.188	***	0.829
Rural (vs urban)	-0.014		0.986
<i>District factors (level-3)</i>			
Percentage deliveries in hospital in district	-0.414	***	0.661
Percentage households with tv in district	-0.132	**	0.876
Percentage women with high occupation in district	-0.164		0.849
<i>Country factors (level-4)</i>			
National GDP per capita (in US\$)	-0.013	***	0.987
Variance components	Estimate		(s.e.)
Level-2 variance	.80728		(.00400)
Level-3 variance	.05446		(.00558)
Level-4 variance	.15753		(.03500)
Deviance (MCMC) = 165631			

\*\*\*  $p < .001$  \*\*;  $p < .01$ ; \*  $p < 0.05$

**Table 3**  
**Unstandardised parameter estimates and hazard ratios for ln(Maternal height) and significant interaction effects from a 4-level multilevel discrete time hazard model of child mortality**

	$\beta$		$\exp(\beta)$
Ln(Maternal height)	-4.408	***	0.012
Ln(Maternal height) * education			
Primary (vs none)	1.438	***	4.212
More than primary (vs none)	0.974	***	2.649
Ln(Maternal height) * time	-3.307	***	0.037
Ln(Maternal height) * twin	-1.281	***	0.278

\*\*\*  $p < .001$  \*\*;  $p < .01$ ; \*  $p < 0.05$

## APPENDIX

**Table A1 Descriptive statistics of the data per country**

	Survey year	Maternal height <sup>a</sup>			Women in high occ.	Ecological factors			GPD p/c in \$	Number of cases		Mortality Under 5 mort.
		min	max	mean		Households with tv	% of all births in hospital	Women		Births		
Armenia	2005	144.9	171.3	158.1	15%	89%	99%	3,120	942	1,238	2.3%	
Bangladesh	2004	138.2	163.0	150.5	1%	29%	12%	1,700	4,851	6,736	7.0%	
Benin	2001	147.1	175.0	158.3	2%	21%	76%	1,070	5,433	10,483	12.1%	
Bolivia	2003	139.4	166.6	151.3	12%	69%	62%	2,460	6,856	10,205	6.2%	
BurkinaFaso	2003	144.1	172.1	161.6	2%	15%	41%	1,100	2,949	5,272	11.3%	
Cambodia	2005	139.7	164.4	152.3	3%	43%	20%	2,060	2,949	4,142	7.6%	
Chad	2004	148.0	177.1	162.3	5%	11%	24%	1,020	2,991	5,515	12.3%	
Colombia	2005	141.4	169.9	155.2	15%	86%	90%	6,370	10,515	13,869	2.3%	
Congo	2005	140.0	177.0	158.3	5%	32%	86%	980	2,995	4,722	8.3%	
Egypt	2005	145.4	171.2	158.5	11%	93%	63%	3,810	9,095	13,629	3.6%	
Eritrea	2002	142.3	169.3	156.1	3%	13%	22%	890	4,086	6,262	7.4%	
Ethiopia	2005	141.8	172.8	157.4	3%	17%	12%	780	3,090	4,843	8.9%	
Gabon	2000	144.1	173.0	158.3	4%	51%	83%	6,590	2,154	4,053	5.5%	
Ghana	2003	144.8	173.9	159.0	3%	28%	49%	2,130	2,449	3,699	8.1%	
Guinea	1999	144.3	173.4	158.7	1%	12%	30%	2,100	1,813	3,296	11.1%	
Guatemala	2005	134.4	162.5	147.4	5%	46%	28%	4,080	2,506	4,380	4.7%	
Haiti	2005	144.3	173.6	158.5	4%	27%	24%	1,610	1,897	2,936	6.6%	
Honduras	2005	137.7	167.0	151.7	8%	57%	60%	2,600	7,391	10,510	2.7%	
India	2006	138.8	166.1	151.9	5%	60%	52%	2,670	32,879	49,097	5.6%	
Kazakhstan	1999	146.4	173.5	159.6	22%	94%	98%	5,870	506	673	5.9%	
Kenya	2003	144.7	174.3	159.7	6%	28%	42%	1,020	3,518	5,602	8.5%	
Lesotho	2004	142.2	172.0	156.9	5%	12%	52%	2,420	941	1,335	11.0%	
Madagascar	2004	140.0	167.5	153.6	5%	37%	38%	740	3,389	5,209	5.9%	
Malawi	2004	141.8	171.0	155.8	2%	6%	71%	580	6,572	10,268	9.7%	
Mali	2001	146.7	175.6	161.5	2%	19%	36%	930	6,737	12,500	15.2%	
Mauritania	2001	145.1	175.0	160.8	4%	33%	54%	2,220	2,777	4,631	7.9%	
Moldova	2005	148.0	175.0	161.5	22%	84%	99%	1,470	1,329	1,524	1.2%	
Morocco	2003	145.0	172.2	158.5	5%	66%	59%	3,810	4,402	6,157	4.3%	
Mozambique	2003	141.5	169.7	155.4	3%	17%	57%	1,050	5,872	9,779	11.6%	
Nepal	2006	137.9	163.5	150.8	2%	31%	19%	1,370	3,790	5,714	5.4%	
Nicaragua	2001	140.9	167.9	153.4	9%	58%	61%	2,470	4,511	6,713	3.8%	
Niger	2006	146.1	174.5	160.4	2%	17%	26%	800	2,331	4,521	10.4%	
Nigeria	2003	141.8	173.2	158.3	5%	34%	35%	860	3,172	5,898	14.1%	
Peru	2000	138.6	164.8	150.4	12%	70%	53%	5,010	9,599	13,137	4.1%	
Rwanda	2005	140.5	171.6	157.2	3%	5%	31%	1,270	2,586	4,316	10.0%	
Senegal	2005	147.6	178.2	162.9	2%	46%	60%	1,580	1,468	3,375	8.0%	
Tanzania	2004	141.1	171.0	156.3	3%	9%	46%	580	5,064	8,464	8.3%	
Togo	1998	145.3	172.8	158.8	2%	18%	48%	1,480	3,037	5,873	9.9%	
Uganda	2006	143.9	174.2	158.8	3%	9%	46%	1,390	1,563	2,883	9.2%	
Yemen	1997	139.4	167.7	152.5	2%	50%	18%	870	6,188	11,926	7.6%	
Zambia	2002	142.1	172.0	157.6	3%	21%	41%	840	4,005	6,725	12.8%	
Zimbabwe	2006	145.7	173.9	159.9	5%	36%	67%	2,400	3,637	5,113	7.1%	

<sup>a</sup> Excluding the shortest and tallest 1% per country