The Intergenerational Correlation of Health in Developing Countries

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Abstract

This paper investigates the intergenerational transmission of health using individual survey data on 2.24 million children born to 600000 mothers during 1970-2000 in 38 developing countries. These data are merged with macroeconomic data by region and birth cohort to create an unprecedentedly large sample of comparable data that exhibits massive variation in maternal and child health as well as in aggregate economic conditions. Our measure of maternal health is height, and our measure of child health is infant mortality risk. We find a substantial positive intergenerational correlation of health. This is undiminished when we purge pure endowment effects using environmental conditions in the mother's birth year to instrument her height. The effects are nonlinear, being larger at the tails of the height distribution. They are asymmetric in that the penalty associated with having a short mother is much larger than the gain attached to having a tall mother. The higher fertility of shorter women in these data does not seem to be an important mechanism driving the correlation. Higher education and urban location at the individual level and wider economic development at the aggregate level are both shown to weaken the intergenerational coefficient, and these SES effects are most marked for short women. Overall, the analysis suggests that relaxing liquidity constraints and improving the supply or effectiveness of public services will limit the degree to which child health is tied to family circumstance and, accordingly, limit intergenerational persistence in inequality in health and wealth.

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I. Introduction

This paper documents the intergenerational correlation of health using comparable microdata on 2.4 million children born to 600,000 mothers in 38 developing countries in the period 1970-2000. These data exhibit substantial variation in the levels of health, education and income, which are exploited to investigate whether education and growth weaken the intergenerational correlation. The results contribute new evidence using unique data to a potentially important but little explored aspect of the persistence of inequality in health and living standards.

The pioneering models of intergenerational mobility in earnings are Becker and Tomes (1979, 1986). The empirical prediction of these models is that persistence in earnings across generations is a function of the genetic transmission of ability and parental investments in human capital. In natural extensions of this framework, Grawe and Mulligan (2002) introduce credit constraints and Solon (2004) emphasises the role of public expenditure. A number of empirical studies have sought to estimate the size of the intergenerational correlation of earnings (Grawe and Mulligan 2002) and some have looked directly at the intergenerational correlation of education as a mechanism driving the correlation of earnings (e.g., Black et al. 2003, Chevalier 2004). Some recent studies have looked at the intergenerational correlation of health; see Drake and Walker (2004) for a review.

It is important to identify the importance of human capital investments as distinct from heritability in the intergenerational correlation of health. This is because, while heritability is not amenable to policy, it is in the scope of states and markets to influence human capital investment by relaxing family-level liquidity constraints or by raising public expenditure on health. We conduct a number of reinforcing investigations to detect the extent to which education, income and public health improvements around the birth year of a child, and also in the birth year of the mother, act to weaken intergenerational persistence. We allow for asymmetry and non-linearity which fit with the notion of constraints on investment.

Previous studies have tended to investigate either the effect of SES or the effect of maternal health on child health. The only previous study that looks at the effect of an interaction term between maternal health and SES is Currie and Moretti (2007). The interaction provides clearer evidence of the mechanisms underlying the intergenerational transmission of health and, in turn, wealth. Our paper would appear to be the second to investigate an SES gradient in the intergenerational correlation of health, and the first to do this for developing countries. And its use of a larger and more diverse sample permits the first exploration of sensitivity of the intergenerational correlation to economic growth and business cycles.

The evidence on intergenerational transmission, whether of earnings or human capital, is particularly scarce for developing countries (Solon 2002), where child health is a particularly serious problem (e.g. Cutler et al. 2006). For example, infant mortality rates in poor countries are often as much as twenty times as high as in richer countries (e.g. Deaton 2006). Also, the share of public expenditure in GDP tends to be smaller in poorer countries (Fan and Rao 2003), effective social services reach a much smaller fraction of people (World Bank 2004), a larger fraction of people are credit constrained (Banerjee and Duflo 2007), and the consequences of credit constraints are more extreme because so many people live at the margin.

Our measure of maternal health is height, which is an indicator of long term or permanent health. It has been shown, for example, to predict life expectancy (Waaler 1984). Our indicator of child heath is infant mortality risk, although we investigate birth weight as an alternative (and correlated) outcome (these results are yet to be inserted in this version). Our main findings are summarised here.

We find a positive intergenerational correlation of health in that births to shorter women are systematically and significantly less likely to survive infancy. A more general model shows that the effects are non-linear, being stronger at the tails of the distribution of maternal height. There is significant asymmetry in that the decrease in infant survival chances associated with the mother being short is between 1.2 and 4 times as large as the increase in survival chances associated with the mother being tall. It does not seem that fertility differentials by maternal health can explain this. The intergenerational correlation coefficient (0.11) falls by about 20% (to 0.08) when we condition upon mother’s and father’s education and GDP. It is undiminished when we instrument mother’s height using an index of environmental conditions in her childhood, which suggests that it does not simply reflected shared endowments within families. In fact, it rises, possibly because the instrument identifies the effect for a selectively unhealthy sample of women who are more sensitive to environmental conditions at birth.

Intergenerational persistence in health increases between birth cohorts 1970-75 and 1990-95 in sub-samples of countries with positive growth, negative growth, and insignificant growth, and the increase is significantly larger amongst the negative growth countries.. Cross-sectional variation in the coefficient by country is (weakly) inversely correlated with the average level of GDP. The intergenerational correlation is weaker in economic upturns. A one standard deviation (10.8%) increase in log p.c. GDP reduces the correlation by 26.4%. The intergenerational correlation is also smaller amongst more educated and urban women. For example, an increase of 1 year in mother's education reduces the correlation by 5% of the estimated total effect, and amongst women who are between 1 and 2 s.d. below mean height, being educated to at least the secondary level and resident in an urban area has the same effect on infant mortality risk as moving to within 0.5 s.d. of mean height. Overall, improvements in both individual education and aggregate income weaken the correlation, and both aggregate income shocks and longer term economic development are effective. These effects are most pronounced amongst shorter women, consistent with shorter women being more likely to be liquidity constrained in the investments they can make in their children's health. Indeed, the SES interactions are mostly insignificant for taller women. Liquidity constraints may apply to maternal nutrition and antenatal care, delivery conditions, or postnatal investments in the child. The results suggest that a woman's stature is not merely a genetic disposition but that it is correlated with her health and SES and, for both reasons, confers a survival disadvantage upon her children.

This paper documents, using country-cohort variation in infant mortality rates in the mother's birth year, that improvements in infant survival prospects influence maternal height (also see Deaton 2007). In the main analysis, we show that maternal height improves child survival chances. In this way, we establish long run persistence in infant mortality rates and show that one mechanism through which this intergenerational persistence in child health works is through maternal health. It follows that public health or interventions that improve early childhood health today will have positive knock-on effects for child health a generation later. As far as we know, no previous study has established this or shown how it may operate *via* maternal height (health). Amongst other things, this means that improvements in girl health have particularly large multiplier effects.

II. Data

This section describes the two main data sources and the way in which the micro and macro data are merged. It also discusses our choices of indicators of health for the mother and child. The microdata are compiled from 77 Demographic and Health Surveys (DHS) for 38 developing countries. For countries for which more than one survey is available, Table 1 lists the countries by continent and associates them with acronymns used in Tables and Figures to follow. Where more than one survey is available for a country, successive rounds are pooled. The DHS contain information on a wide range of demographic and health variables for households, women and children (see www.measuredhs.com). A great advantage of these data is their breadth-we have comparable information on about 2.24 million children born to 600,000 mothers during 1952-2005 (see Table 2).

Women aged 15 to 49 years at the time of the survey record their complete fertility histories so that we have information on the birth of every child of the sampled women, and any deaths.[1] A potential limitation of these retrospective data is that they get thinner as we go further back in time, and also less representative. In particular, the sample of children born earlier in time are disproportionately from mothers who were relatively young at birth (e.g. Bumpass et al. 1978). For this reason, we restrict the sample to children born after 1970 and control for maternal age at birth. We also drop children born in 2001-2005 since not many countries contribute information for these years. Amongst older cohorts, the sample of women may be biased in favour of healthier women because inclusion in the survey is, of course, conditional upon being alive at the time of interview (survivor bias). However, as we are studying individual child health conditional upon maternal health, this is not a problem.

Infant mortality is defined as death in the first year of life. To allow for (observed) age-heaping at the twelfth month, we define this to include the twelfth month. To ensure that every child in the sample had full exposure to infant mortality risk, children born less than 12 months before the date of interview (which is specific

[1] For 2 countries, the lower age limit is 13, for one it is 12 and for 3 it is 16.

to each of the 77 surveys) are excluded. The time range of the sample analysed varies by country (see Table 2) but, in the pooled sample, it is 1970-2000. Infant mortality is the most widely used indicator of child and, indeed, population health in developing countries, where the risk of mortality is often as much as 20 times as great as in richer countries (e.g. Deaton 2006).

We also investigate birth weight. The DHS data on birth weight in grams are missing for about 85% of the sample, and clearly in a non-random way. So we use another variable in the DHS which records the mother's subjective assessment of birth weight as above, at, or below average and use it to define an indicator of low birth weight. This clearly has its limitations but it has limited missing data and is "well behaved" in that it exhibits the expected correlations with, for example, infant mortality and mother's education. There is a recent resurge of interest in birth weight amongst economists, given evidence that low birth weight predicts worse health and lower education and earnings in adulthood (Behrman and Rosenzweig 2004). The handful of studies that look at the intergenerational correlation of health (in the USA) tend to use birth weight (see Currie and Moretti 2007 and citations therein).

To summarise, we use both infant mortality risk and birth weight as measures of initial health or frailty at birth. Alternative measures such as child height-for-age, weight-for-height or morbidity are all subject to survival selection. An advantage of infant mortality is that we can potentially construct indicators of this for cohorts of children born across a half-century, although we have restricted the span to 31 years. In contrast, birth weight data are reported only for recent births and so the sample is much smaller. Another advantage of using mortality as the outcome is that we observe realised risk whereas birth weight data are subject to the concern that smaller women may give birth to smaller babies without this having any health implications or, at least, with the health implications being uncertain. For example, Almond, Chay and Lee (2005) argue that birth weight may have no direct causal effect on health, even if it is correlated with relevant omitted variables including genes and SES.

Our measure of maternal health is height which, as indicated in the Introduction, proxies permanent health. The retrospective fertility histories recorded by mothers establish a clean link between mothers and children. There are two features of adult height that are relevant to note. First, once fully attained, it does not vary within individual, in contrast, for example, to morbidity indicators. Second, height is a stock that reflects the cumulative impact of net nutrition over the entire growth period. Variation in adult height within populations is most profoundly influenced by net nutrition up until age two or three (e.g. Bozzoli et al. 2007, Banerjee et al. 2007, Cole 2000, Deaton 2007, Bhalotra 2008a; also see Dubois et al. 2007). In this way, our use of the height of a mother is not dissimilar to, for example, using her birth weight. We exploit this by using an index of environmental conditions in the mother's birth year to instrument her height; details are in the following section.

Mother's height is measured by trained surveyors, so that it is not subject to subjectivity. This may be especially relevant in this analysis since measures of self-reported height have been shown to bias downwards estimates of the heritability of height (Macgregor et al, 2006). The design of questionairres, the training of surveyors and the measurement devices are harmonised across the 77 surveys exploited in this paper, yielding comparable data across our sample of about 60000 mothers. However many of the surveys interview ever-married rather than all women in the age range 15-49. At the lower end, there is a potential problem of selectivity since age at marriage is correlated with height (e.g. Bhalotra (2008b). So the sample will tend to contain selectively short women amongst younger cohorts. To circumvent this problem, we exclude women younger than 21 from the analysis. In the pooled sample, 21 is the 95th percentile of age at marriage. This also allows, importantly, for the fact that women continue to grow beyond the age of 15. There are missing values for mother's height in every survey. We assume these are "missing at random", and regress the available heights data on all of the regressors in our estimated equation, using prediction-matching to generate imputed values (Cameron and Trivedi, 2005 p.923).[2]. To remove outliers in height, we exclude from the analysis women with height that is more than three standard deviations away from the country mean. About 0.42% of the sample is deleted in this way. We exclude surveys in which height was not recorded at all and we drop Nigeria as this country has an outlying distribution of mother's height.[3]

The literature on the intergenerational correlation of earnings and education has tended to isolate fathers and sons, primarily because this is easier given that fewer women work and record earnings. When looking at health it may make more sense to look at mothers and children because of paternity uncertainty, and this is what is done

[2] We use the –uvis-command in Stata to perform this imputation.

[3] The distribution of heights was much wider, mostly on account of many women recorded as being much shorter (<100 cm) and it was difficult to determine why.

here and in the related literature. It is also convenient for reasons of data availability. With a few exceptions, the DHS surveys do not record father's height. Many previous studies of mother-child health simply ignore fathers. Our estimates condition upon the father's education. This will contribute to controlling for SES. Also, given a positive correlation of health and education (confirmed in our sample) and assortative mating, missing information on the father's height (or health) will not add too much noise.

We merge GDP data with the DHS microdata by country and the birth year of the child. Data on GDP per capita in constant 2000 prices (chain series) for 1970-2000 is obtained from the Penn World Tables (Summers, Heston and Aten, 2006). We also construct, using sample weights provided in the DHS surveys, country-level time series of infant mortality rates. These are merged into the file by country and birth year of the mother in order to instrument her height with (disease) conditions in her birth year.

III. Methodology

Baseline Model

The baseline model is:

$$Y_{imjt} = \alpha + \beta H_{mjt} + X'_{imjt}\lambda + \gamma_{jt} + \varepsilon_{imjt} \qquad (1)$$

The dependent variable (Y) is a binary variable indicating whether child *i* born to mother *m* in country *j* in year *t* died before the age of 12 months or, in an alternative specification, was of below-average birth weight. The individual data are, effectively, nested in a country-level panel. The regressor of interest is *H*, mother's height, *X* is a vector of control variables and γ denotes country-year fixed effects. We initially define H as height in metres. The fact that being 5 foot 3 inches tall in Kenya may not confer the advantage it does in Nepal is taken care of by the country-year dummies which absorb country-specific mean height. These country means may reflect ethnic or other cross-sectional heterogeneity that is independent of health.

The country-year dummies capture, in a comprehensive and flexible way, *all* fixed and time-varying unobservables at the aggregate level. This includes time-invariant unobserved differences between countries that are common to mother and child (e.g. climate, institutions), and trends in infant mortality associated, for example, with medical technological progress. Unobserved trends are allowed to evolve on a nonlinear country-specific path and will include one-off shocks associated with, for example, oil prices, war or famine. Country-year dummies also capture all aggregate shocks although, as mother's height is predetermined, shocks that induce a spurious correlation between child health and maternal height are unlikely in this context. X includes indicators for the gender and birth month of the child, maternal age at birth of the child, the level of education of the mother and father, urban *vs* rural residence and religion. These controls are predetermined although not all are strictly exogenous. We confirm that the results are not sensitive to excluding them. It also includes the logarithm of real per capita GDP. The model is estimated as a probit using maximum likelihood. With a long time dimension to the country panel, we do not face the problem that probit fixed effects estimates may be inconsistent but we have confirmed that the linear probability model yields very similar estimates. Reported standard errors are robust to arbitrary forms of heteroskedasticity and clustered by country to allow for autocorrelation within country.

Extensions

The model is first estimated on the full sample, pooling countries. The parameter β in this model is the intergenerational coefficient that we are after. We expect this to be positive and, in general, to reflect a combination of endowment and "behavioural" effects. A "frailty" gene may be passed from mother to child, physiological characteristics such as pelvic size may constrain a small woman to produce a small child (Barker et al, 1996), or fetal programming that may have occurred in response to resource scarcity when the mother was *in utero* may scar her in ways that are transmitted to her children (Barker 1998). Alternatively, shorter women may produce less healthy children because they are liquidity constrained in the investments they make in pregnancy, birth and early childhood. See, for example, Grawe and Mulligan (2002) who argue that the intergenerational transmission of health may occur via (low) income. Evidence that adult height is positively correlated with socioeconomic status is in Maccini and Yang (2007) for Indonesia and in Bhalotra (2008c) for India.[4] Overall, it is unclear a *priori* what the weight of socio-

[4] Osmani and Sen (2003) highlight the case of reproductive malnutrition, whereby undernourished women produce less robust children. This may be relevant here for any of two reasons. Either short women are more likely to be poor and, as a result, undernourished during pregnancy. Alternatively, the reason they are short is that they were undernourished in their childhood.

economic as against biological mechanisms is. We attempt to discern this in the following ways.

We first investigate interactions of mother's height with three measures of her SES: her education, her partner's education and urban residence.

$$Y_{imjt} = \tilde{\alpha} + \tilde{\beta} H_{mjt} + X'_{imjt}\tilde{\lambda} + \tilde{\delta} SES_{mjt} + \tilde{\tau}(H_{mjt} \cdot SES_{mjt}) + \gamma_{jt} + \tilde{\varepsilon}_{imjt} \qquad (2)$$

Education is expected to capture both permanent income and "technical efficiency" in combining inputs to produce child health. Urban residence is included to reflect the greater reach of public services in urban as opposed to rural locations. The expectation is that, even if short women are, on average, poorer and so less able to invest in their children, a short woman who is educated and urban will be better off than a short woman who is not. If this is relevant then we should witness a weakening of the intergenerational correlation for the educated and urban group. A woman's education (and, *via* assortative mating, her partner's education) is positively correlated with her height, but there is enough variation in educational levels (and urban location) within height-categories to make this a useful exercise. Both education and height are influenced by endowments and family background and, were individual (family) income data available, it would face the same limitation- of being correlated with endowments.

We therefore exploit the large country-cohort dimensions of our data using information on real GDP per capita, which is plausibly exogenous. First, we exploit the diversity of growth experiences in the sample across the 31 year period, estimating equation 3 below for two (child) birth cohorts separated by 15 years, separately for countries with positive growth of at least 1.5% p.a., countries with negative growth of at least 1.5%, and countries with insignificant growth.

$$Y_{imjt} = \tilde{\alpha} + \tilde{\beta} H_{mjt} + X'_{imjt}\tilde{\lambda} + \tilde{\delta} y_{jt} + \theta_j + \theta_t + \zeta_j t + \tilde{\varepsilon}_{imjt} \qquad (3)$$

We also examine whether variation in the correlation coefficient across the 38 countries in the sample is correlated with their average GDP. These experiments are interesting because they are suggestive of the effects of long run economic development. We also investigate the effects of shocks by including an interaction term between maternal height and GDP in equation (1) to get

$$Y_{imjt} = \tilde{\alpha} + \tilde{\beta} H_{mjt} + X'_{imjt}\tilde{\lambda} + \tilde{\delta} y_{jt} + \tilde{\tau}(H_{mjt} \cdot y_{jt}) + \theta_j + \theta_t + \zeta_j t + \tilde{\varepsilon}_{imjt} \qquad (4)$$

Most of the notation is familiar from equation (1), y is log per capita real GDP in country j and year t and the last three terms denote country and year dummies and country-specific trends. We need to replace country-year dummies with these additive controls in order to accommodate GDP as an explicit regressor. The coefficient of interest now that on the interaction term, τ, and we expect $\beta < 0$, $\delta<0$ and $\tau > 0$.

Our hypothesis is that, to the extent that the tendency for shorter women to produce weaker children reflects economic constraints, we may expect these constraints to be relaxed in economic upturns (or with growth), weakening the impact of maternal stature on child health. Using the Indian DHS, Bhalotra (2007) finds that upturns are associated with higher average household consumption, a greater demand for maternal and child health, and with higher social expenditure. There are no consistent time series data on health expenditure for the countries in our sample but there is considerable evidence that health and development expenditure in poor countries is pro-cyclical (Woo 2005, Paxson and Schady 2005) in contrast to the case in richer countries (Lane 2003).

We have focused on biological *vs* socioeconomic components of the intergenerational correlation and spoken in general terms of the socioeconomic component involving information or income constraints on investments in child health. A particular mechanism by which these constraints may operate is higher fertility. Shorter women tend to marry earlier in developing countries (Bhalotra 2008) and to have more children (e.g. Martorell et al. 1981). There is considerable evidence that higher fertility is associated with higher early mortality (e.g. Bhalotra and van Soest 2008). As a check on this, we estimated the model on the sample of first-borns. Infant mortality for first-born children should be unaffected by sibling competition unless the succeeding birth interval is less than a year, and we control for maternal age at (first) birth to account for the fact that first-borns are, by definition, born to younger women. If fertility is an important mechanism, then we should see a smaller intergenerational correlation for first-borns.

Shorter women are typically of lower SES[5] and so we may expect that they are more liquidity constrained in investments in child health. Accordingly, we may expect asymmetry in the level effect, that is, that the penalty (in child survival) attached to being short exceeds the gain to being tall. We may further expect asymmetry in the SES-interaction effects, since improvements in education and income will benefit shorter (poorer) women more. This said, we may see asymmetry because there is an upper bound to survival chances and hence diminishing returns in the health production function. This would also lead to improvements in inputs such as nutrition or health services having larger beneficial effects on children of shorter women. To investigate asymmetry, we replace height in metres with a set of six dummy variables, defined to indicate whether the mother is half, one, or two standard deviations above or below the mean height in her country. This specification also allows nonlinearity in the effects of maternal height.

The interaction effects discussed so far are with education, urban location and income of the mother at the time of the child's birth. We also investigate environmental conditions at the time of the mother's birth that are known to influence her height at maturity (references in Section II). Our motivation is to purge the endowment component of intergenerational persistence and this is done by using environmental conditions lagged by the mother's age to instrument her height. Although it is often assumed that their effects are additive, endowments and environment are likely to interact and we will only purge the additive endowment effect. However, we are not concerned with putting a number on the environment effect but, rather, with identifying whether there is any socio-economic content to the effects of maternal height on child health. This specification will indicate whether the intergenerational correlation of health is different when the mother is born in places and times of high *vs* low infant mortality (and high *vs* low women's education), the effects of mortality rates being constrained to operate through height.

The instruments are infant mortality in the mother's country and year of birth and its interaction with the country-average of education-years of mothers giving birth in that year (i.e. grandmothers). We also test over-identifying restrictions associated with using GDP in the birth year of the mother, which proxies nutritional resources. These instruments can be assumed to be independent of maternal endowments. Infant

[5] Adult stature is correlated with birth weight (e.g. Emanuel et al. 1992) and so all the evidence of birth weight effects on SES applies (e.g. Behrman and Rosenzweig 2001).

mortality indexes the environmental risk of contracting disease and the interaction term allows that effective risk is smaller for children of more educated women. We may expect that scarring alone will be more severe at higher mortality levels but if selection effects dominate then scarring effects on the heights of survivors may be smaller (Deaton 2007).

IV. Descriptive Statistics

The Key Variables

For all descriptive statistics reported in the paper, sample weights provided in the surveys are applied to make the data representative of the population. The data span 1970-2000. Across the 38 countries and the 31 years in the sample, the mean infant mortality rate (IMR) is 9.8% and the mean height of mothers is 1.566 m (standard deviation 0.069 m). The standard deviation of maternal height within country is similar, at about 0.060 m (mean) or 0.061 m (median). Our econometric model will exploit the enormous variation in infant mortality risk and maternal height across individuals. It will further exploit country and cohort variation in GDP which, in this sample, is dramatic.

Figure 1 plots the country-averaged trends in IMR and maternal height. IMR falls steadily between 1970 and 2000, from 15.0% to 6.9%, and the linear rate of decline is 0.2% a year. Height rises only very slightly over the 31 years from 1.547 to 1.559 m, which is strikingly slow growth by historical standards, but consistent with the fact that living standards did not improve steadily for large fractions of our sample. Figure 2 shows that country-averaged GDP trends upwards until 1975, after which there is no secular trend and many instances of negative growth during the 1980s.

There is considerable between-country variation in the variables of interest. Infant mortality and mother's height differ widely between countries, ranging from 3.4% in Colombia to 16.3% in Mali and 1.497 m in Peru to 1.627 m in Chad, respectively. Country-specific trends in IMR, maternal height and GDP are in Appendix Figures A1-A3 (also see Table 2). Level differences across countries are huge and dominate any trends. For this reason, the countries are grouped in the graphs by level, and the vertical axes scales are allowed to differ. IMR exhibits a secular decline in each country and there is some convergence by the end of the period, with the standard deviation across countries falling from 0.047 in 1970 to 0.029 in 2000. The average height of mothers does not show much change. The ratio of the highest GDP to the lowest is 30.27 in 1970, whilst in 2000 it is 20.31. Average yearly GDP growth varies from -2.98% in Nicaragua to 3.13% in Egypt. Of the 38 in the sample, 9 countries experience significant negative growth, 14 experience significant positive growth, and 15 experience insignificantly small growth, averaging over the period.

The Unconditional Non-Parametric Relationship

Let us now examine the unconditional relationship between maternal and child health. Since infant mortality is recorded as a discrete variable (0/1), we obtain a continuous prediction of individual risk that lies in the range 0-1 from a non-parametric (lowess) regression. Since lowess on the full sample is computationally very intensive, this is done using a random sample of 20% of observations. Predicted infant mortality risk is then plotted against the height of the mother (Figure 3). It is clear that infant mortality risk is declining in maternal height, consistent with a positive intergenerational correlation of health. Interestingly, the effect appears to level out after mean height. This is evidence of the asymmetry that we hypothesised may exist, whereby maternal height and child survival are more closely tied for short than for tall women. The corresponding country-specific plots are in Figure 4. A positive intergenerational correlation of health is evident in *every* country in the sample. A striking feature of these graphs is that they show greater cross-country variation in health amongst children born to shorter women. This is suggestive of greater SES effects on the gradient for shorter women, as SES varies across countries (and there is no *a priori* reason that endowment effects will vary systematically across countries). The following section investigates this relationship more carefully.

V. Empirical Results

In this section, we examine whether the unconditional correlation of health across generations that we have noted is apparent in the data persists after conditioning upon other variables and, in particular, year and country fixed effects.

Baseline Estimates

Table 3A shows estimates of equation (1). Note that a positive intergenerational correlation of health implies $\beta<0$ because infant mortality is an “inverse” measure of health. Column 1 shows estimates that condition upon country dummies, and we see the correlation takes the expected negative sign and is well determined. Columns 2 and 3 add time dummies and country-specific trends. Column 4 adds variables which are plausibly exogenous – child gender, rural residence, and religion. Column 5 adds variables which may be endogenous since fertility is endogenous - maternal age at birth, child birth month and child birth order. Columns 6 and 7 add controls for mother’s and father’s education. Infant mortality risk is lower for each level increase in parental education, and the gains associated with maternal education are much larger than those associated with father’s education (for example, twice as large for secondary and higher education). This tendency has been noted in several previous studies but it is interesting to document this for this possibly unprecedentedly large sample. Controlling for parental education brings the marginal effect of maternal height down from -0.106 to -0.087.

Aggregate time variation as, for example, in GDP, is held constant in this specification because it includes country-year dummies. In order to identify directly the effects of GDP shocks, we replace the country-year dummies with additive country and year dummies and country-specific linear trends and then add GDP as a regressor. The coefficient on height remains at -0.087 (col. 8). The coefficient on GDP is negative, as expected, but poorly determined[6]. GDP behaved quite erratically in this sample (Section II). Also, when we interact (linear) GDP with height, then the total effect of GDP is significant (Tables 7, 8 below). For our immediate purposes the exact specification of GDP in col. 8 is unimportant as a completely general specification appears in the preceding columns that include country-year fixed effects. Our interest here is in how the intergenerational coefficient changes when we include additive controls for SES. Overall, there is a 20% reduction in the correlation coefficient when education and income controls are added, which indicates the extent to which persistence is correlated with SES. Below we investigate further whether there is an SES *gradient* to the correlation. This will indicate more clearly the extent to which improvements in SES can diminish persistence.

Table 4B reproduces column 8 but using birthweight as an alternative measure of infant health. We see the expected positive intergenerational correlation of health. We lose around 85% of observations when we use birthweight, since it is only

[6] We tried several other functional forms but were unable to identify accurately the effect of GDP.

available for recent births. It is also interesting to note that around 20% of our sample is classified as low birth weight which is much higher than found in developed countries see for example Currie and Moretti (2007), for which the incidence of low birthweight in their sample is only 6%.

Asymmetry and Nonlinearity in the Levels Effect

Table 4A shows the results of replacing height in metres with six dummies indicating positive and negative standard deviations of height relative to the country-mean. As before, we see that being tall reduces infant mortality risk whilst being short raises it, but we now also observe that these effects are strongest at the tails of the height distribution. In addition, consistent with our hypothesis, the disadvantage associated with having a short mother is much greater than the advantage of having a tall mother. Currie and Moretti (2007) find a similar asymmetry in the transmission of birth weight in Californian families; we know of no other similar results.

Holding all other variables at their mean and moving from within half a standard deviation above mean height (the omitted category in the regressions) to between a half and one standard deviation above mean height lowers infant mortality by 0.39 percentage points. This is 3.98% of the sample mean infant mortality rate (IMR). Being between one and two standard deviations above mean height is associated with infant mortality being lower by 0.53 percentage points, 5.41% of the sample IMR. Amongst women greater than two standard deviations above mean height, infant mortality is lower by 0.57 percentage points, or 5.81% of sample mean. The analogous effects of being short are increases in mortality risk of 0.47 percentage points for between half and one standard deviation below mean height, 1.16 for between one and two standard deviations, and 1.93 for those less than two standard deviations below mean height. These are 4.80%, 11.84% and 19.69% of the sample mean, respectively. These effects are large, particularly when we note that the trend in infant mortality calculated earlier is of an average fall of 0.2% a year.

Overall, there are nonlinearities, with larger effects at more extreme heights (tails). There are asymmetries, with larger effects amongst shorter women. And the asymmetries are more pronounced at the tails of the height distribution.

Table 4B investigates whether there are asymmetries and/or non-linearities in the effect of mother height when we use birthweight as our measure of child health.

We can see that non-linearities are still present, but asymmetries are only present at the very tails of the height distribution.

Table 4C also investigates whether the observed correlation is driven by higher fertility amongst shorter women who tend to marry earlier, leading to higher infant mortality. If fertility is an important mechanism, than we should see a smaller intergenerational correlation for first-borns (See Section III above). We estimate our baseline model with height, and our height dummies, for first born children only. The estimated intergenerational coefficient is significantly larger amongst first born children, compared to the full sample. This suggests that fertility differentials between tall and short women are not driving our results.

Interactions with Individual Socioeconomic Status: Education and Urban Location

Family-level persistence in health is of much greater interest if it signifies social disadvantage. We therefore investigate how the intergenerational correlation of health varies with the socioeconomic status of the mother by interacting her height with her years of education (Table 5A) and with an indicator for whether the mother has at least secondary education and is urban (Table 5B). Although the height of a woman is positively correlated with education, there is enough variation in height within educational level to do this. Total effects with standard errors are in Table 7A. The interaction terms suggest that an increase of 1 year in mother's education reduces the correlation by 0.005, which is about 5% of the estimated total effect, and that if the mother has at least secondary education and is urban, the correlation is smaller by 0.055, which is about 62% of the total effect. The first effect is well-determined but the second is only weakly significant.

Tables 5A and 5B report similar interaction effects for the specification that uses dummies indicating the mother's place in the height distribution of her country, with total effects in Table 7B. This reveals the interesting fact that the average interaction effects rely entirely upon interaction effects below the mean. Moreover, the size of these effects is larger, the greater is the deviation of height below the mean. For women between a half and one standard deviation below mean height, the interaction term with education years is significant but very small. For women between 1 and 2 standard deviations below mean height, an additional year of education reduces the intergenerational correlation coefficient by 8.3% of the estimated total effect. For women shorted than 2 standard deviations below mean height, an additional year of education reduces the intergenerational correlation by 4.5%. Using the alternative indicator of SES, that is, being highly educated and urban (16.8% of women), the only significant interaction is for women between 1 and 2 standard deviations below mean height. This effect is very large, lowering the intergenerational correlation by 0.012, which is as much as the increased infant mortality risk associated with having a mother that short.

Overall, we find some evidence to support our hypothesis that the health of children of more educated parents (who will tend to have higher permanent income) and those in urban areas (who are more able to access health services) is less tied to the health of their parents, but that this SES gradient is evident only amongst short women. In other words, we see nonlinearity and asymmetry not only in the main effect of maternal height on infant mortality but also in the SES interaction effects.

Since it is plausible that the mother's education does not change once she initiates fertility, her education will reflect her SES at the birth of the child. We investigated using the father's education as well, and we get similar results (see Table 5C). Since partnerships are not stable, at least in some of the countries in the sample, we prefer to use mother's education and to rely upon assortative mating to reflect the father's contribution to actual income. The DHS surveys do not contain information on household income or consumption. They do contain data on ownership of assets, but this is available at the time of the survey and so cannot be matched, across some 30-35 years, to birth year. We therefore investigated further the impact of GDP shocks.

Interactions with GDP: Income Shocks and Asymmetry in the Income Gradient

GDP shocks, unlike maternal education, are exogenous. Also, it is of wide interest to consider whether short or long run growth alters intergenerational persistence. To the baseline model in the last column of Table 3, we add an interaction term between GDP and maternal height (see eq. 2). Conditional upon country and year dummies and country-specific trends, the coefficient on GDP will reflect the effects of annual changes in GDP within-country. Results are in Table 6. Resolving the additive and interaction terms at the sample means, we report the total effects of each of height and GDP in Table 6.

Consistent with our hypothesis that the intergenerational correlation of health is stronger in poorer countries, the interaction term is positive and significant (column 1, Table 6). A one standard deviation (10.8%) increase in log p.c. GDP reduces the correlation by 26.4%. The total effect of maternal height on infant mortality rises by a factor of 2.5 and the total effect of GDP on infant mortality is now significantly negative (Table 7A). We also investigated interacting GDP with height in the specification that uses dummies to indicate relative height (column 2, Table 6). The total effect of height is now not significantly different relative to the baseline regression in Table 4. In this model, which allows for both nonlinearity and asymmetry in the effect of height, we find that income (GDP) is most effective in weakening the intergenerational correlation coefficient for short women; indeed the interaction term is insignificant for the two tallest categories of women. For example, for women whose height is between a half and one standard deviation below mean height in their country, a one standard deviation (10.8%) increase in p.c. GDP creates a 41% reduction in the size of the intergenerational coefficient. Asymmetry in the interaction effect is consistent with the notion that negative GDP shocks are more likely to cause liquidity constraints to bind for shorter women, and that this has the consequence that they are less able to invest in their children's health.

We also estimated country specific regressions that included interactions of GDP with maternal height. Estimated marginal effects are in Table 11A, and total effects obtained by solving the interaction term at sample mean values are shown in Table 11B. The total effect of GDP is significant in 13 countries, height is significant in 23 countries, and the intergenerational correlation varies between -0.058 and -0.176. There is a tendency for countries with significant positive intergenerational coefficients to be poorer (Figure 5);

The Role of Growth: Country and Cohort Variation

We initially investigated whether the intergenerational correlation of health has weakened over time, estimating decade-specific regressions, with observations pooled over countries. We found no systematic variation over time. But this is not inconsistent with expectation because, although we may tend to presume that living standards improve with time, they did not for a large fraction of countries in our sample (Table 2). We therefore exploit the diversity of growth experiences by dividing the sample into countries with positive and negative growth of greater than

1.5%, and those with insignificant growth, where growth is the average linear rate over the entire period. We find that in all samples of countries, the coefficient increases between birth cohorts 1970-75 and 1990-95 (Table 8). However, in countries with positive growth, the increase is significantly smaller than both that seen amongst the negative growth and insignificant growth samples. Consistent with the effects of economic development that we hypothesise, the largest increase in the correlation between cohorts is seen in the group of countries that experienced negative growth.

Country-specific equations are in Table 10, displaying estimated marginal effects. Of the 38 countries in the sample, 24 show a significant effect of height on mortality. The marginal effects range between -0.174 in Rwanda and -0.052 in Haiti. Figure 6 plots the density of GDP for countries with significant and insignificant intergenerational coefficients and also shows countries with significant intergenerational coefficients tend to be poorer.

Environmental Conditions in the Mother's Birth Year : IV Estimates

As discussed in Section II, maternal height is predetermined. In order to isolate the non-genetic elements of the observed correlation between maternal and child health, we now instrument mother's height using an index of environmental conditions in her birth year (see section III above). We lose 22.6% of our observations in this way, due to lack of data on mother birth year conditions. Results are in Table 9, alongside LPM estimates of the baseline model on the IV sample. The F-test from the first stage regression strongly rejects the null that the instruments are jointly insignificant and the Hansen-J test fails to reject the null that they are valid.[7]

The coefficient on height is larger when we use IV, and remains significant. A possible interpretation of the increase in this coefficient is that the instrument is isolating the marginal effect for the fraction of the sample that is sensitive to it (i.e. to infant mortality); see Imbens and Angrist (2001) for a discussion of the LATE interpretation of IV. We have already noted evidence of asymmetry in the OLS estimates, with the intergenerational correlation of health being larger and more

[7] We also investigated using GDP in the mother' birth year but found, using the Hansen J test, that this rejected the null, i.e. GDP is an invalid instrument. It is interesting to find that GDP in the mother's birth year has a direct effect on child survival conditional upon mother's height. It suggests that maternal health may be scarred in a way that is not entirely captured in height- for example, she may be physiologically weaker or thinner, at a given (adult) height.

sensitive to SES amongst shorter women. And it is plausible if not almost definitional that infant mortality has the largest effects on women who grow up to be relatively short. These results confirm that the intergenerational correlation of health is not simply a measure of the genetic transmission of health from mother to child.

Discussion and Previous Studies

Previous studies of the intergenerational correlation of health have found, as we have, a positive correlation, mostly using birth weight; see Conley and Bennet (2000), Royer (2008) and Currie and Moretti (2007), all of which use US data. Currie and Moretti (2007; p.247) also investigate infant mortality and congenial malformations but find no intergenerational correlation for these alternative indicators of health. We are aware of two studies for poorer countries (Thomas et al. (1990) for Brazil, Kebede (2005), for Ethiopia), both of which document a positive association of mother-child height.[8] However data on child height are subject to survival selection (e.g. Lee et al. 1997) and if, as we show, infant mortality rates are higher amongst shorter women and it is their smaller babies who are most vulnerable, then these studies may under-estimate the intergenerational correlation. The results of this study extend the yet small evidence base and provide what appear to be the first unbiased estimates for developing countries.

The only studies previous to this that consider asymmetry are the two studies of birth weight transmission in California (Royer 2008, Currie and Moretti 2007). An important contribution of this paper is that it investigates an SES gradient in the intergenerational transmission of health. The only previous study that does this is Currie and Moretti (2007). Using Californian data, they document a positive correlation of birth weight between mothers and children, which persists when sisters are compared. To investigate a gradient with SES, they interact each of mother's education or poverty in the zip code of residence at the time the child is born with mother's birth weight, and find that the relationship is stronger amongst less educated women and women living in poor areas. This is similar to our model where mother's height is interacted with mother's education or urban residence, and our results point in the same direction. CM (p.252) show that their education interaction largely reflects permanent differences in SES, with short run variations having little effect.

[8] Bhalotra (2007) documents a positive influence of maternal height on infant survival in India but this is not the main focus of the paper.

Using exogenous GDP shocks we find evidence that short run variation in SES matters too. CM also estimate an alternative model in which the interaction is with poverty in the zip code of the hospital in which the mother was born, but this interaction is insignificant. This specification of theirs is similar to our IV strategy, as both employ a measure of environmental conditions in the mother's birth year. We use different indicators of health in an entirely different setting, a larger and much more diverse data set, and some different specifications. Ours appears to be the first study to consider birth order or fertility effects. We also have, with our sample, an unprecedented opportunity to compare the extent of intergenerational transmission across countries and cohorts.

VI. Conclusion

We have analysed household survey data from 38 developing countries that provide unprecedented scope to study the intergenerational correlation of health and its variation with economic development. There is very limited evidence in this area in general. It is a particularly important and under-studied aspect of persistent inequality in developing countries, where underdeveloped markets and states result in children being unable to escape from the family circumstances that they are born into.

We find that (a) maternal stature has a positive and substantial influence on infant survival. (b) this persists even after purging omitted endowments [IV with environmental conditions in mother's birth year], (c) the intergenerational transmission is stronger for less healthy women [asymmetry], (d) stronger at the tails of the maternal height distribution [nonlinearity], (e) the asymmetry is more pronounced at the tails [asymmetry and nonlinearity], (f) fertility differences between tall and short women do not explain much of intergenerational persistence [sample of first-borns] (g) the intergenerational correlation of health is weakened by maternal education as well as by short and long run improvements in aggregate income [interaction effects, cohorts], and (h) the weakening of the correlation induced by income and education is stronger amongst less healthy women [asymmetry in interaction effects].

The SES gradient in intergenerational persistence, together with the spatial and cohort variation and an instrument that isolates environmental factors all suggest that the correlation we identify does not simply reflect heritability. Interventions that relax liquidity constraints on human capital investment will weaken the tie between child and maternal health, allowing children of less healthy (and less well-off) mothers to move on to higher lifetime trajectories of income and wellbeing. Previous research has shown that childhood health has consequences for later life health, education and earnings (e.g. Currie and Madrian 1999, Case et al. 2003, Royer 2008, Oreopolous et al. 2008). We have extended this evidence, showing that the benefits of early childhood health extend to future generations. We also show that improvements in income and education help to override the effects of weak genetic endowments.

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Figures and Tables

Figure 1: Country Averaged Trends on IMR and Mother's Height

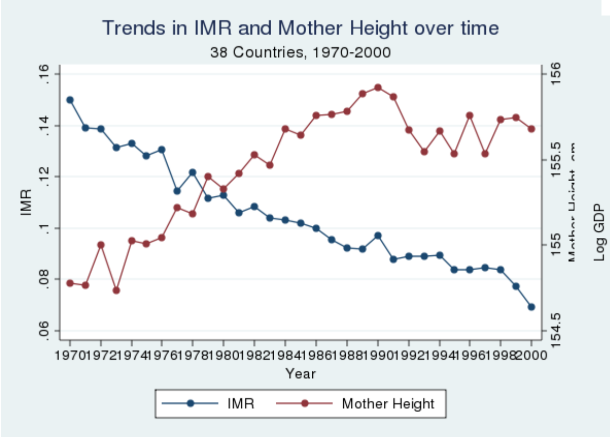


Figure 2: Country Averaged Trend in Log GDP

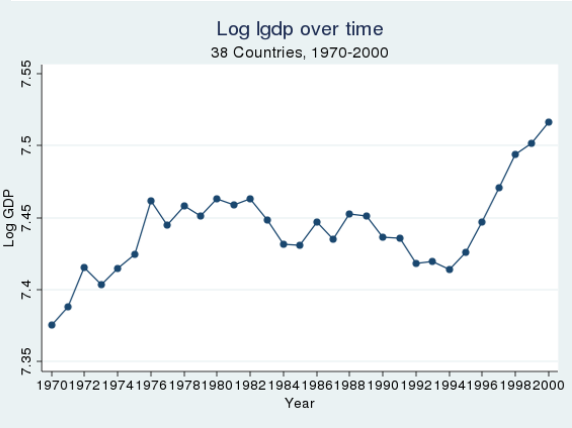


Figure 3: Infant mortality against mother's height: lowess predictions

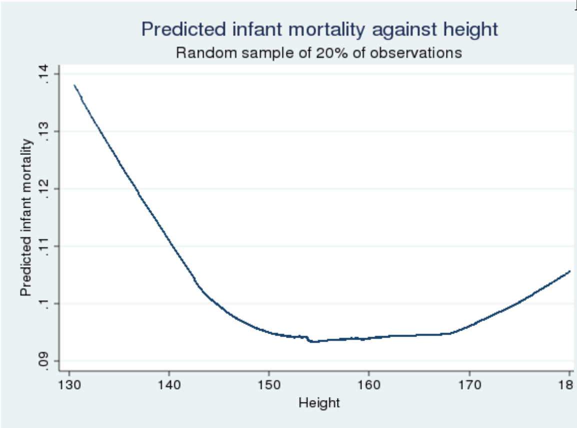


Figure 4: Country-specific plots of infant mortality against mother's height: lowess predictions

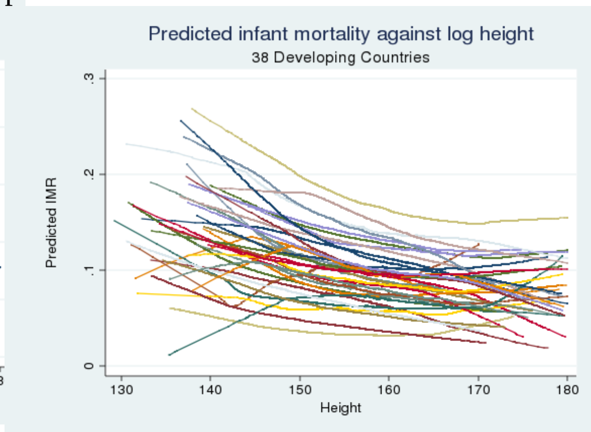


Figure 5: Country-specific intergenerational correlation coefficient against average Log GDP

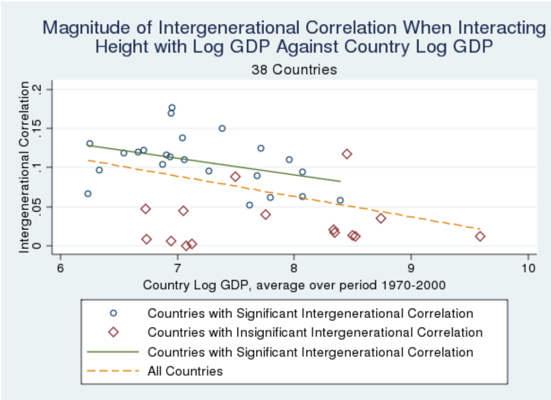


Figure 6: Density of Log p.c. GDP, by significance of the intergenerational coefficient

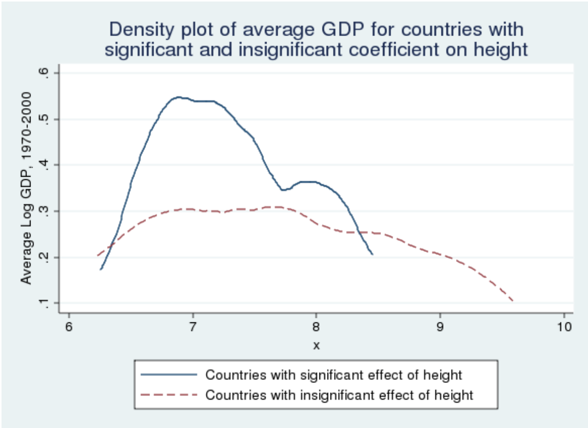


Table 1: Country Names and Codes by Continent

Country	Country Code	Country	Country Code
African Countries			
Benin	BE	Madagascar	MD
Burkina Faso	BF	Malawi	MW
CAR	CR	Mali	ML
Cameroon	CM	Morocco	MO
Chad	CH	Mozambique	MZ
Comoros	CO	Namibia	NB
Cote d'Ivoire	CI	Niger	NG
Egypt	EG	Rwanda	RW
Ethiopia	ET	Senegal	SE
Gabon	GB	Tanzania	TZ
Ghana	GH	Togo	TO
Guinea	GU	Uganda	UG
Kenya	KE	Zambia	ZB
Lesotho	LE	Zimbabwe	ZW
Latin American Countries			
Brazil	BR	Honduras	HO
Colombia	CB	Nicaragua	NC
Dominican Republic	DR	Peru	PE
Haiti	HA		
Asian Countries			
Cambodia	CD	Turkey	TK
India	IN		

Table 2: Country Characteristics and Survey Details

Country	GDP growth, 1970-2000	IMR trend, 1970-2000	Possible child birth-year range	Interview Dates
Benin	0.103	-2.067**	1960-2001	1996, 2001
Brazil	1.367*	-4.220**	1959-1996	1996
Burkina Faso	0.955*	-2.257**	1955-2003	1992-1993, 1998-1999, 2003
CAR	-0.927*	-1.427*	1958-1995	1994-1995
Cambodia	-2.275*	-1.911**	1965-2000	2000
Cameroon	0.682	-1.311**	1960-2004	1998, 2004
Chad	-0.044	-1.113**	1960-2004	1996-1997, 2004
Colombia	1.781*	-4.327**	1958-2005	1995, 2000, 2004-2005
Comoros	-0.312	-3.389**	1961-1996	1996
Cote d'Ivoire	0.123	-2.056**	1956-1999	1994, 1998-1999
Dominican Republic	2.277*	-3.281**	1952-1996	1991, 1996
Egypt	3.126*	-5.316**	1954-2005	1992-1993, 1995-1996, 2000, 2005
Ethiopia	1.018*	-3.554**	1955-1997	1992, 1997
Gabon	-1.722*	-2.634**	1962-2000	2000-2001
Ghana	0.188	-2.000**	1957-2003	1993-1994, 1998-1999
Guinea	-0.098	-2.223**	1961-2005	1999, 2005
Haiti	-0.120	-3.752**	1957-2000	1994-1995, 2000
Honduras	0.471*	-3.783**	1969-2006	2005-2006
India	2.831*	-3.070**	1961-2000	1998-2000, 2005-2006
Kenya	0.338*	-0.980*	1954-2003	1993, 2003
Lesotho	2.889*	-1.366*	1967-2005	2004-2005
Madagascar	-1.860*	-1.027	1962-2004	1997, 2003-2004
Malawi	1.210*	-1.913**	1954-2005	1992, 2000, 2004-2005
Mali	1.557*	-2.226**	1960-2001	1995-1996, 2001
Morocco	1.659*	-4.319**	1953-2004	1992, 2003-2004
Mozambique	-0.270	-1.437**	1960-2004	1997, 2003-2004
Namibia	-0.139	-1.791*	1957-1992	1992
Nicaragua	-2.984*	-5.453**	1961-2001	1997-1998, 2001
Niger	-0.931*	-2.299**	1954-1998	1992, 1998
Peru	-0.964*	-4.473**	1956-2000	1991-1992, 2000
Rwanda	-0.688	0.052	1963-2005	2000, 2005
Senegal	-0.091	-1.805**	1954-2005	1992-1993, 2005
Tanzania	0.353	-0.856**	1953-2005	1991-1992, 1996, 2004-2005
Togo	-1.965*	-2.516**	1958-1998	1998
Turkey	2.068*	-5.598**	1957-1998	1993, 1998
Uganda	-0.492	-1.095**	1959-2001	1995, 2000-2001
Zambia	-1.861*	0.372	1954-2002	1992,1996-1997, 2001-2002
Zimbabwe	-0.057	-0.311	1957-1999	1994, 1999

Table 3: Baseline Regressions

	(1) Country dummies	*(2)* (1) + Time dummies	*(3)* (2) + Country-time trends	*(4)* (3) + Exogenous variables	*(5)* (4) + Variables possibly endogenous to fertility	*(6)* (5) + Mother education	*(7)* (6) + Father education	*(8)* (7) + Log GDP
height100	-0.138**	-0.131**	-0.129**	-0.116**	-0.106**	-0.090**	-0.087**	-0.087**
	[0.015]	[0.014]	[0.014]	[0.014]	[0.012]	[0.011]	[0.011]	[0.011]
Mother Education								
Primary Education						-0.017**	-0.014**	-0.014**
						[0.002]	[0.001]	[0.001]
Secondary Education						-0.037**	-0.030**	-0.030**
						[0.001]	[0.001]	[0.001]
Higher Education						-0.049**	-0.040**	-0.040**
						[0.001]	[0.002]	[0.002]
Father Education								
Primary Education							-0.006**	-0.006**
							[0.001]	[0.001]
Secondary Education							-0.016**	-0.016**
							[0.001]	[0.002]
Higher Education							-0.021**	-0.021**
							[0.003]	[0.003]
GDP Variables								
Log GDP								-0.012
								[0.009]
Mean Sample Height	0.097	0.097	0.097	0.097	0.097	0.097	0.097	0.097
Sample IMR	1.559	1.559	1.559	1.559	1.559	1.559	1.559	1.559
Sample s.d. Log GDP								0.718
Observations	2237173	2237173	2237169	2237169	2237169	2237169	2234768	2234772

Robust standard errors in brackets, allowing for clustering within country

* significant at 5%; ** significant at 1%

The dependant variable is 1 if the index child dies before his or her first birthday. Sample is restricted to children born at least 12 months before the date of the survey. Mother's height is in m. The estimator is probit and these are marginal effects. Incremental changes to the specification are noted in the column head and are cumulative in moving from left to right except that, when we include GDP then we replace country-time dummies with time dummies and country-specific trends. The child-level controls are birth month, gender and mother's age at birth. The household level controls are mother's education, father's education, religion and whether living in a rural or urban area. Religion is controlled for by dummy variables for Christian, Muslim, other, no religion, and religion missing The number of observations change as we add more controls due to missings present in these controls.

Table 4A: Investigating Nonlinearity and Asymmetry

	(1)
Tall: Indicators for height above country mean	
Height between 0.5 and 1 s.d. above mean	-0.004**
	[0.001]
Height between 1 and 2 s.d. above mean	-0.005**
	[0.001]
Height 2 s.d. above mean	-0.006*
	[0.002]
Short: Indicators for height below country mean	
Height between 0.5 and 1 s.d. below mean	0.005**
	[0.001]
Height between 1 and 2 s.d. below mean	0.012**
	[0.001]
Height 2 s.d. below mean	0.019**
	[0.004]
log p.c. GDP	-0.012
	[0.009]
Observations	2038291
Sample mean of infant mortality rate	0.984
Sample % mothers height between 1 and 2 s.d. above mean	10.7
Sample % mothers height greater than 2 s.d. above mean	1.3
Sample % mothers height between 0.5 and 1.s.d above mean	14.9
Sample % mothers height between 1 and 2 s.d below mean	11.1
Sample % mothers height less than 2 s.d. below mean	1.2
Sample % mothers height between 0.5 and 1 s.d. below mean	15.7

Robust standard errors in brackets, allowing for clustering within country

* significant at 5%; ** significant at 1%

See notes to Table 3.

Table 4B: Using birthweight as our measure of child health

	Height	Height Dummies
Height, m	-0.209**	
	[0.027]	
Tall: Indicators for height above country mean		
Height between 0.5 and 1 s.d. above mean		-0.011**
		[0.002]
Height between 1 and 2 s.d. above mean		-0.019**
		[0.002]
Height 2 s.d. above mean		-0.025**
		[0.010]
Short: Indicators for height below country mean		
Height between 0.5 and 1 s.d. below mean		0.013**
		[0.003]
Height between 1 and 2 s.d. below mean		0.022**
		[0.005]
Height 2 s.d. below mean		0.042**
		[0.014]
Mother Education		
Primary Education	-0.015**	-0.015**
	[0.005]	[0.005]
Secondary Education	-0.038**	-0.038**
	[0.006]	[0.006]
Higher Education	-0.070**	-0.069**
	[0.007]	[0.007]
Father Education		
Primary Education	-0.020**	-0.020**
	[0.006]	[0.006]
Secondary Education	-0.032**	-0.032**
	[0.006]	[0.006]
Higher Education	-0.043**	-0.043**
	[0.006]	[0.006]
Log Real GDP per capita, chain index	-0.037	-0.037
	[0.030]	[0.030]
Observations	333375	333376
Sample proportion low birthweight	0.204	0.204
Mean Sample Height	1.569	
Sample s.d. Log GDP	0.766	0.766
Sample % mothers height between 1 and 2 s.d. above mean		0.105
Sample % mothers height greater than 2 s.d. above mean		0.011
Sample % mothers height between 0.5 and 1.s.d above mean		0.153
Sample % mothers height between 1 and 2 s.d below mean		0.104
Sample % mothers height less than 2 s.d. below mean		0.009
Sample % mothers height between 0.5 and 1 s.d. below mean		0.16

Robust standard errors in brackets, allowing for clustering within country

* significant at 5%; ** significant at 1%

See notes to table 3A. The dependant variable is 1 if the index child was classified by the interviewd mother as being of either low or very low birthweight. Mother's height is in m. The estimator is probit and these are marginal effects.

Table 4C : Sample of first born children only

	Height	Height Dummies
Height, m	-0.128**	
	[0.017]	
p.c. log GDP	-0.006	-0.007
	[0.008]	[0.008]
Tall: Indicators for height above country mean		
Height between 0.5 and 1 s.d. above mean		-0.005**
		[0.001]
Height between 1 and 2 s.d. above mean		-0.010**
		[0.002]
Height 2 s.d. above mean		-0.013**
		[0.004]
Short: Indicators for height below country mean		
Height between 0.5 and 1 s.d. below mean		0.007**
		[0.001]
Height between 1 and 2 s.d. below mean		0.015**
		[0.001]
Height 2 s.d. below mean		0.030**
		[0.007]
Observations	566614	566620
Sample IMR	0.097	0.097
Mean Sample Height	1.557	
Sample s.d. log GDP	0.708	0.708
Sample % mothers height between 1 and 2 s.d. above mean		0.117
Sample % mothers height greater than 2 s.d. above mean		0.015
Sample % mothers height between 0.5 and 1.s.d above mean		0.154
Sample % mothers height between 1 and 2 s.d below mean		0.11
Sample % mothers height less than 2 s.d. below mean		0.012
Sample % mothers height between 0.5 and 1 s.d. below mean		0.156

Robust standard errors in brackets

* significant at 5%; ** significant at 1%

Table 5A: Interacting mother's height with her years of education

	(1) Height	(2) Height Dummies
Mother's Height	-0.104**	
	[0.013]	
Mother's Height * Mother's years of education	0.005**	
	[0.001]	
Tall Variables for mother's height		
Height between 0.5 and 1 s.d. above mean		-0.004**
		[0.001]
Height between 1 and 2 s.d. above mean		-0.006**
		[0.001]
Height 2 s.d. above mean		-0.006
		[0.004]
Interaction terms		
Height between 0.5 and 1 s.d. above mean* mother's education		0.000
		[0.000]
Height between 1 and 2 s.d. above mean* mother's education		0.000
		[0.000]
Height 2 s.d. above mean* mother's education		0.000
		[0.000]
Short variables for mother's height		
Height between 0.5 and 1 s.d. below mean		0.007**
		[0.001]
Height between 1 and 2 s.d. below mean		0.015**
		[0.001]
Height 2 s.d. below mean		0.028**
		[0.006]
Interaction terms		
Height between 0.5 and 1 s.d. below mean* mother's education		-0.000
		[0.000]
Height between 1 and 2 s.d. below mean* mother's education		-0.001**
		[0.000]
Height 2 s.d. below mean* mother's education		-0.001*
		[0.001]
Mother's years of education	-0.010**	-0.003**
	[0.002]	[0.000]
Observations	2264684	2233163
Sample mean of Infant mortality rate	0.097	0.095
Sample mean of Mother's height	1.558	
Sample mean of Mother's years of education	3.139	3.157
Sample % mothers height between 1 and 2 s.d. above mean		0.110
Sample % mothers height greater than 2 s.d. above mean		0.013
Sample % mothers height between 0.5 and 1.s.d above mean		0.150
Sample % mothers height between 1 and 2 s.d below mean		0.115
Sample % mothers height less than 2 s.d. below mean		0.013
Sample % mothers height between 0.5 and 1 s.d. below mean		0.161

Robust standard errors in brackets, allowing for clustering within country .
See notes to Tables 3 and 5.

Table 5B: Interacting height with indicator for mother having secondary education and urban location

	(1) Height	(2) Height Dummies
Mother's Height	-0.097**	
	[0.011]	
Mother's height*(secondary education & urban)	0.040**	
	[0.013]	
Tall Variables		
Height between 0.5 and 1 s.d. above mean		-0.004**
		[0.001]
Height between 1 and 2 s.d. above mean		-0.006**
		[0.001]
Height 2 s.d. above mean		-0.005
		[0.003]
Interaction terms		
Height between 0.5 and 1 s.d. above mean*(ma sec educ & urban)		0.001
		[0.001]
Height between 1 and 2 s.d. above mean*(ma sec educ & urban)		0.002
		[0.001]
Height 2 s.d. above mean*(ma sec educ & urban)		0.002
		[0.004]
Short Variables		
Height between 0.5 and 1 s.d. below mean		0.006**
		[0.001]
Height between 1 and 2 s.d. below mean		0.014**
		[0.001]
Height 2 s.d. below mean		0.024**
		[0.006]
Interaction terms		
Height between 0.5 and 1 s.d. below mean*(ma sec educ & urban)		-0.001
		[0.001]
Height between 1 and 2 s.d. below mean*(ma sec educ & urban)		-0.012**
		[0.001]
Height 2 s.d. below mean*(ma sec educ & urban)		-0.004
		[0.006]
Mother is educated and urban	-0.055*	0.007**
	[0.022]	[0.002]
Observations	2265482	2337415
Sample mean IMR	0.097	0.095
Sample Mean Height	1.558	
Sample Mean (Mother has secondary educ & is urban)	0.129	0.129
Sample % mothers height between 1 and 2 s.d. above mean		0.110
Sample % mothers height greater than 2 s.d. above mean		0.013
Sample % mothers height between 0.5 and 1.s.d above mean		0.150
Sample % mothers height between 1 and 2 s.d below mean		0.115
Sample % mothers height less than 2 s.d. below mean		0.013
Sample % mothers height between 0.5 and 1 s.d. below mean		0.161

Robust standard errors in brackets, allowing for clustering within country .
See notes to Tables 3 and 4.

Table 5C: Interacting mother's height with her partner's years of education

	(1) Height	(2) Height Dummies
Mother's Height	-0.096**	
	[0.010]	
Mother's Height * Partner's years of education	0.003	
	[0.007]	
Tall Variables for mother's height		
Height between 0.5 and 1 s.d. above mean		-0.004**
		[0.001]
Height between 1 and 2 s.d. above mean		-0.005**
		[0.001]
Height 2 s.d. above mean		-0.006
		[0.005]
Interaction terms		
Height between 0.5 and 1 s.d. above mean* mother's education		0.001
		[0.001]
Height between 1 and 2 s.d. above mean* mother's education		0.000
		[0.001]
Height 2 s.d. above mean* mother's education		0.001
		[0.002]
Short variables for mother's height		
Height between 0.5 and 1 s.d. below mean		0.007**
		[0.001]
Height between 1 and 2 s.d. below mean		0.014**
		[0.001]
Height 2 s.d. below mean		0.026**
		[0.005]
Interaction terms		
Height between 0.5 and 1 s.d. below mean* mother's education		-0.002**
		[0.000]
Height between 1 and 2 s.d. below mean* mother's education		-0.002*
		[0.001]
Height 2 s.d. below mean* mother's education		-0.003
		[0.004]
Partners' education level†	-0.013	-0.008**
	[0.011]	[0.001]
Observations	2190619	2258721
Sample mean of Infant mortality rate	0.097	0.096
Sample mean of Mother's height	1.558	
Sample mean of Partners' years of education	0.987	0.990
Sample % mothers height between 1 and 2 s.d. above mean		0.110
Sample % mothers height greater than 2 s.d. above mean		0.013
Sample % mothers height between 0.5 and 1.s.d above mean		0.150
Sample % mothers height between 1 and 2 s.d below mean		0.115
Sample % mothers height less than 2 s.d. below mean		0.013
Sample % mothers height between 0.5 and 1 s.d. below mean		0.161

Robust standard errors in brackets, allowing for clustering within country
See notes to Tables 3 and 5. †Partner education is categorised as follows: 1 if none, 2 if primary, 3 if secondary, 4 if higher

Table 6: Interacting maternal height with log p.c. GDP.

	(1) Height	(2) Height Dummies
Mother's height	-0.364**	
	[0.077]	
Mother's height*lgdp	0.037**	
	[0.101]	
Tall Variables		
Height between 0.5 and 1 s.d. above mean		-0.026**
		[0.008]
Height between 1 and 2 s.d. above mean		-0.008
		[0.010]
Height 2 s.d. above mean		-0.031
		[0.030]
Interaction Terms		
Height between 0.5 and 1 s.d. above mean*lgdp		0.003**
		[0.001]
Height between 1 and 2 s.d. above mean*lgdp		0.000
		[0.001]
Height 2 s.d. above mean*lgdp		0.004
		[0.004]
Short variables		
Height between 0.5 and 1 s.d. below mean		0.023**
		[0.007]
Height between 1 and 2 s.d. below mean		0.047**
		[0.011]
Height 2 s.d. below mean		0.089**
		[0.033]
Interaction Terms		
Height between 0.5 and 1 s.d. below mean*lgdp		-0.002**
		[0.001]
Height between 1 and 2 s.d. below mean*lgdp		-0.005**
		[0.001]
Height 2 s.d. below mean*lgdp		-0.009*
		[0.004]
log p.c. GDP	-0.072**	-0.013
	[0.019]	[0.011]
Observations	2265482	2110145
Sample mean IMR	0.097	0.097
Sample mean height	1.558	
Sample s.d. of log GDP	0.718	0.753
Sample % mothers height between 1 and 2 s.d. above mean		0.106
Sample % mothers height greater than 2 s.d. above mean		0.012
Sample % mothers height between 0.5 and 1.s.d above mean		0.149
Sample % mothers height between 1 and 2 s.d below mean		0.111
Sample % mothers height less than 2 s.d. below mean		0.012
Sample % mothers height between 0.5 and 1 s.d. below mean		0.156

Robust standard errors in brackets, allowing for clustering within country
See notes to Table 3 and 5. These regressions refer to LPM rather than probits due to the presence of interactions terms which makes interpretation less straightforward (for a discussion, see Norton, Wang and Ai, 2004)

Table 7A: Estimated 'total effects' from interaction regressions

	Height			
	(1) GDP	(2) Mother education	(3) Educated and urban	(4) Partner's education
Height, m	-0.092**	-0.092**	-0.089**	-0.092**
	[0.011]	[0.012]	[0.011]	[0.012]
p.c. log GDP††*	-0.015			
	[0.010]			
Indicator for secondary educated and urban mothers ††*		0.007**		
		[0.002]		
Years of mother education††*			-0.003**	
			[0.000]	
Partner education †††				-0.008**
				[0.001]
Observations	2265482	2265482	2225393	2190619
Sample IMR	0.097	0.097	0.097	
Sample Mean Height	1.558	1.558	1.558	1.557
Sample s.d. log GDP	0.718			
Sample % mothers educated and urban		0.129		
Sample mean years of mother education			3.139	
Sample mean partner education †††				0.987

Robust standard errors in brackets, allowing for clustering within country

* significant at 5%; ** significant at 1%

See notes to Tables 3. 5. 6. 'Total effects' give estimated effects when we take into account interaction terms. † Interaction term evaluated at mean of SES measure (GDP, edurb or educf) †† Interaction term evaluated at mean height ††*Interaction term evaluated at means of all height dummies. ††† partner education is categorised as follows: 1 if none, 2 if primary, 3 if secondary, 4 if higher

Table 7B: Estimated 'total effects' from interaction regressions

	Height Dummies			
	(1) GDP	(2) Mother education	(3) Educated and urban	(4) Partner's education
Tall				
Height between 0.5 and 1 s.d. above mean	-0.003**	-0.003**	-0.003**	-0.003**
	[0.001]	[0.001]	[0.001]	[0.001]
Height between 1and 2 s.d. above mean	-0.005**	-0.005**	-0.005**	-0.005**
	[0.001]	[0.001]	[0.001]	[0.001]
Height 2 s.d. above mean	-0.005	-0.005	-0.005	-0.005
	[0.003]	[0.003]	[0.003]	[0.003]
Short				
Height between 0.5 and 1 s.d. below mean	0.006**	0.006**	0.005**	0.005**
	[0.001]	[0.001]	[0.001]	[0.001]
Height between 1 and 2 s.d. below mean	0.013**	0.012**	0.012**	0.012**
	[0.001]	[0.001]	[0.001]	[0.001]
Height 2 s.d. below mean	0.025**	0.024**	0.022**	0.024**
	[0.006]	[0.006]	[0.006]	[0.007]
p.c. log GDP†† *	-0.014			
	[0.011]			
Indicator for secondary educated and urban mothers †† *		0.006**		
		[0.002]		
Years of mother education††*			-0.003**	
			[0.000]	
Partner education †††				-0.008**
				[0.001]
Observations	2337415	2337415	2336559	2258721
Sample mean IMR	0.095	0.095	0.095	0.096
Sample s.d. log GDP	0.110	0.110	0.110	0.110
Sample % mothers height between 1 and 2 s.d. above mean	0.013	0.013	0.013	0.013
Sample % mothers height greater than 2 s.d. above mean	0.150	0.150	0.150	0.150
Sample % mothers height between 0.5 and 1.s.d above mean	0.115	0.115	0.115	0.115
Sample % mothers height between 1 and 2 s.d below mean	0.013	0.013	0.013	0.013
Sample % mothers height less than 2 s.d. below mean	0.161	0.161	0.161	0.161
Sample % mothers height between 0.5 and 1 s.d. below mean	0.72			
Sample % mothers educated and urban		0.129		
Sample mean years of mother education			3.157	
Sample mean partner education †††				0.990

Robust standard errors in brackets, allowing for clustering within country

* significant at 5%; ** significant at 1%

See notes to Tables 3. 5. 6 and 7. 'Total effects' give estimated effects when we take into account interaction terms. † Interaction term evaluated at mean of SES measure (GDP, edurb or educf) †† Interaction term evaluated at mean height ††* Interaction term evaluated at means of all height dummies. ††† partner education is categorised as follows: 1 if none, 2 if primary, 3 if secondary, 4 if higher

Table 8: Cohort specific regressons by growth regime

	Growth > 1.5%		Growth < -1.5%		Insignificant Growth	
	1970-1975	1990-1995	1970-1975	1990-1995	1970-1975	1990-1995
Height, m	-0.078**	-0.095**	-0.015	-0.093**	-0.061**	-0.089**
	[0.021]	[0.008]	[0.035]	[0.016]	[0.018]	[0.008]
p.c. Log GDP	-0.015	-0.045	-0.116	-0.003	-0.011	-0.022**
	[0.066]	[0.025]	[0.077]	[0.027]	[0.031]	[0.008]
Observations	67854	262256	19147	77016	86452	306292
Sample IMR	0.139	0.074	0.111	0.085	0.133	0.095
Sample mean height	1.544	1.544	1.557	1.554	1.564	1.573
Sample s.d. Log GDP	0.502	0.504	0.877	0.903	0.844	0.668

Robust standard errors in brackets, allowing for clustering within country
* significant at 5%; ** significant at 1%

Table 9: Instrumenting Mother's Height With Environmental Conditions In Mother's Birth Year

	LPM	IV
Height, m	-0.103**	-7.020**
	[0.012]	[1.689]
Observations	1729034	1729034

Robust standard errors in brackets, allowing for clustering within country
* significant at 5%; ** significant at 1%

Hansen-J test statistic		2.01
P-value		0.156
F-statistic from first stage		13.67
P-value		0.000

Instruments are infant mortality in year of mother birth, and it's interaction with cohort average education of the mothers giving birth in that year.

Table 10: Country specific regressions, marginal effects

	BE	BR	BF	CR	CD	CM	CH	CB	CO	CI	DR	EG
Height, m	-0.135**	-0.039	-0.111**	-0.093*	-0.071**	-0.059**	-0.041	0	-0.045	-0.091**	-0.006	-0.098**
	[0.027]	[0.022]	[0.020]	[0.037]	[0.024]	[0.023]	[0.026]	[0.009]	[0.055]	[0.029]	[0.021]	[0.011]
LGDP	0.013	0.027	-0.107**	0.095**	0.051**	-0.01	-0.014	-0.002	-0.012	0.028	-0.056*	-0.047*
	[0.036]	[0.020]	[0.028]	[0.029]	[0.008]	[0.009]	[0.015]	[0.020]	[0.047]	[0.027]	[0.023]	[0.019]
Observations	35354	23847	73912	14405	40076	36138	39693	98873	7366	27928	31507	183702
Sample IMR	0.117	0.073	0.127	0.104	0.103	0.093	0.127	0.035	0.310	0.101	0.062	0.096
Sample Mean Height	1.584	1.545	1.615	1.580	1.525	1.601	1.627	1.543	0.063	1.591	1.560	1.574
Sample s.d. log GDP	0.047	0.12	0.078	0.11	0.175	0.17	0.114	0.125	0.075	0.068	0.144	0.234

	ET	GB	GH	GU	HA	HO	IN	KE	LE	MD	MW	ML
Height, m	-0.138**	-0.011	-0.038	-0.036	-0.052*	-0.100**	-0.133**	-0.001	-0.044	-0.082**	-0.099**	-0.112**
	[0.018]	[0.030]	[0.022]	[0.025]	[0.026]	[0.018]	[0.007]	[0.016]	[0.038]	[0.024]	[0.021]	[0.021]
LGDP	-0.026**	0.016	-0.025	-0.006	-0.028	-0.001	0.025*	-0.01	-0.002	-0.263**	-0.036*	-0.034
	[0.010]	[0.016]	[0.021]	[0.026]	[0.016]	[0.026]	[0.012]	[0.029]	[0.035]	[0.046]	[0.015]	[0.026]
Observations	74360	14791	37317	42055	36781	38309	472904	60867	11419	36712	78176	79283
Sample IMR	0.117	0.064	0.085	0.146	0.107	0.047	0.085	0.075	0.083	0.093	0.137	0.159
Sample Mean Height	1.573	1.581	1.589	1.587	1.579	1.514	1.516	1.595	1.571	1.540	1.561	1.616
Sample s.d. log GDP	0.119	0.163	0.068	0.063	0.109	0.037	0.221	0.044	0.189	0.13	0.11	0.125

Robust standard errors in brackets

* significant at 5%; ** significant at 1%

See notes to Table 3. Every equation includes a linear trend. Country name acronymns in the column heads are expanded in Table 1.

Table 10: continued

	MO	MZ	NB	NC	NG	PE	RW	SE	TZ	TO	TK	UG
Height, m	-0.059**	-0.171**	0.023	-0.096**	-0.117**	-0.055**	-0.174**	-0.090**	-0.087**	-0.008	0.007	0.001
	[0.021]	[0.025]	[0.038]	[0.015]	[0.026]	[0.011]	[0.023]	[0.020]	[0.019]	[0.028]	[0.022]	[0.022]
LGDP	-0.026	-0.009	0.032	-0.001	0	-0.012	-0.078**	-0.018	0.001	-0.058**	0.035	-0.035**
	[0.023]	[0.017]	[0.049]	[0.010]	[0.015]	[0.007]	[0.007]	[0.031]	[0.009]	[0.022]	[0.032]	[0.009]
Obs	48059	53646	11300	65417	47041	162861	48934	47443	69019	24472	33254	41402
Sample IMR	0.081	0.145	0.072	0.061	0.142	0.075	0.114	0.097	0.104	0.096	0.088	0.096
Sample Mean Height	1.576	1.560	1.610	1.533	1.606	1.498	1.580	1.623	1.561	1.591	1.548	1.585
Sample s.d. log GDP	0.131	0.091	0.05	0.264	0.128	0.136	0.214	0.044	0.137	0.162	0.152	0.165

	ZB	ZW
Height, m	-0.101**	-0.095**
	[0.020]	[0.022]
LGDP	0.062**	0.009
	[0.016]	[0.015]
Observations	61275	27310
Sample IMR	0.105	0.06
Sample Mean Height	1.58	1.601
Sample s.d. log GDP	0.169	0.09

Robust standard errors in brackets

* significant at 5%; ** significant at 1%

See notes to Table 3. Every equation includes a linear trend. Country name acronymns in the column heads are expanded in Table 1.

Table 11a: Country-Specific regressions including interactions of height with log GDP. Marginal Effects.

	BE	BR	BF	CR	CD	CM	CH	CB	CO	CI	DR	EG
Height, m	-2.946	-3.02	-1.565	0.27	-0.517	-0.212	-1.344	-1.977**	-5.857	-0.89	1.263	-0.698
	[4.089]	[1.882]	[1.825]	[2.378]	[0.949]	[1.070]	[1.567]	[0.738]	[6.672]	[3.654]	[1.313]	[0.430]
Height*LGDP	0.399	0.341	0.217	-0.054	0.072	0.019	0.193	0.231**	0.769	0.104	-0.154	0.074
	[0.581]	[0.215]	[0.272]	[0.345]	[0.156]	[0.136]	[0.233]	[0.086]	[0.881]	[0.474]	[0.158]	[0.053]
Log GDP	-0.597	-0.517	-0.483	0.161	-0.047	-0.043	-0.33	-0.380**	-1.276	-0.177	0.161	-0.238**
	[0.923]	[0.333]	[0.441]	[0.549]	[0.239]	[0.219]	[0.380]	[0.135]	[1.374]	[0.756]	[0.247]	[0.088]
Observations	34118	23032	71875	13651	38353	35523	38453	97260	6974	26568	30211	178138
Sample IMR	0.119	0.074	0.129	0.107	0.104	0.094	0.129	0.035	0.11	0.103	0.063	0.098
Sample Mean Height	1.584	1.545	1.615	1.58	1.525	1.601	1.627	1.543	1.554	1.591	1.56	1.574
Sample s.d. log GDP	0.047	0.122	0.078	0.098	0.177	0.171	0.116	0.124	0.068	0.066	0.141	0.231

	ET	GB	GH	GU	HA	HO	IN	KE	LE	MD	MW	ML
Height, m	-1.135	-1.2	2.713	-0.009	3.787	-4.972	-1.186**	-1.265	2.031	2.817*	-1.663	-1.115
	[0.924]	[1.987]	[2.365]	[3.286]	[2.020]	[4.330]	[0.260]	[2.702]	[1.496]	[1.255]	[1.335]	[1.200]
Height*LGDP	0.161	0.124	-0.391	-0.004	-0.504	0.629	0.140**	0.177	-0.287	-0.423*	0.236	0.148
	[0.149]	[0.209]	[0.336]	[0.425]	[0.265]	[0.560]	[0.035]	[0.379]	[0.207]	[0.183]	[0.202]	[0.178]
Log GDP	-0.251	-0.177	0.599	0.049	0.756	-0.993	-0.158**	-0.3	0.445	0.409	-0.419	-0.275
	[0.236]	[0.330]	[0.534]	[0.675]	[0.420]	[0.854]	[0.054]	[0.604]	[0.329]	[0.288]	[0.317]	[0.289]
Observations	70771	14139	36020	41083	35007	38309	464802	58871	11419	35705	75158	75634
Sample IMR	0.119	0.065	0.086	0.148	0.109	0.047	0.085	0.076	0.083	0.094	0.139	0.163
Sample Mean Height	1.573	1.581	1.589	1.587	1.579	1.514	1.516	1.594	1.571	1.54	1.561	1.616
Sample s.d. log GDP	0.11	0.157	0.069	0.062	0.109	0.037	0.219	0.045	0.189	0.131	0.108	0.123

Robust standard errors in brackets
* significant at 5%; ** significant at 1%
See notes to Table 10

Table 11a: continued

	MO	MZ	NB	NC	NG	PE	RW	SE	TZ	TO	TK	UG
Height, m	-0.359	-2.373	0.89	1.848**	1.207	-0.112	-0.132	-1.947	0.728	-1.28	-0.771	0.045
	[1.471]	[1.922]	[6.176]	[0.544]	[1.426]	[0.685]	[0.779]	[3.431]	[0.862]	[1.280]	[1.389]	[0.939]
Height*LGDP	0.037	0.317	-0.103	-0.232**	-0.192	0.006	-0.006	0.255	-0.13	0.185	0.094	-0.008
	[0.181]	[0.277]	[0.724]	[0.065]	[0.205]	[0.082]	[0.112]	[0.472]	[0.137]	[0.186]	[0.167]	[0.141]
Log GDP	-0.126	-0.509	0.193	0.345**	0.29	-0.02	-0.07	-0.45	0.2	-0.317	-0.065	-0.015
	[0.286]	[0.434]	[1.169]	[0.101]	[0.331]	[0.124]	[0.178]	[0.769]	[0.215]	[0.298]	[0.262]	[0.223]
Observations	47108	52477	10611	63999	44537	156333	47199	46451	66429	23124	31980	39108
Sample IMR	0.081	0.147	0.075	0.062	0.146	0.077	0.115	0.099	0.106	0.099	0.09	0.098
Sample Mean Height	1.575	1.56	1.61	1.533	1.606	1.498	1.58	1.623	1.561	1.591	1.547	1.585
Sample s.d. log GDP	0.130	0.091	0.051	0.263	0.126	0.136	0.218	0.044	0.139	0.164	0.143	0.161

	ZB	ZW
Height, m	-2.039*	-1.465
	[0.867]	[2.016]
Height*LGDP	0.273*	0.17
	[0.123]	[0.250]
Log GDP	-0.381	-0.261
	[0.196]	[0.402]
Observations	58968	26084
Sample IMR	0.106	0.06
Sample Mean Height	1.580	1.6
Sample s.d. log GDP	0.166	0.092

Robust standard errors in brackets

* significant at 5%; ** significant at 1%

See notes to Table 10

Table 11b: Country-specific regressions including interactions of height with log GDP. Total Effects, by country.

	BE	BR	BF	CR	CD	CM	CH	CB	CO	CI	DR	EG
Height, m	-0.140**	-0.314	-0.113**	-0.106**	-0.077**	-0.061**	-0.048	-0.000	-0.039	-0.086**	-0.012	-0.107**
	[0.028]	[0.025]	[0.021]	[0.039]	[0.025]	[0.023]	[0.027]	[0.010]	[0.060]	[0.031]	[0.022]	[0.012]
LGDP	0.035	0.010	-0.133**	0.075*	0.063**	-0.012	-0.016	-0.023	-0.081	-0.011	-0.079**	-0.121**
	[0.039]	[0.244]	[0.028]	[0.031]	[0.010]	[0.009]	[0.016]	[0.026]	[0.057]	[0.030]	[0.025]	[0.027]
Observations	34118	23032	71875	13651	38353	35523	38453	97260	6974	26568	30211	178138
Sample IMR	0.119	0.074	0.129	0.107	0.104	0.094	0.129	0.035	0.11	0.103	0.063	0.098
Sample Mean Height	1.584	1.545	1.615	1.58	1.525	1.601	1.627	1.543	1.554	1.591	1.56	1.574
Sample s.d. log GDP	0.047	0.122	0.078	0.098	0.177	0.171	0.116	0.124	0.068	0.066	0.141	0.231

	ET	GB	GH	GU	HA	HO	IN	KE	LE	MD	MW	ML
Height, m	-0.142**	-0.020	-0.041	-0.040	-0.058*	-0.106**	-0.137**	-0.01	-0.044	-0.085**	-0.107**	-0.118**
	[0.019]	[0.032]	[0.024]	[0.026]	[0.028]	[0.019]	[0.007]	[0.017]	[0.039]	[0.025]	[0.022]	[0.022]
LGDP	0.001	0.019	-0.022	0.042	-0.041*	-0.041	0.055**	-0.017	-0.006	-0.242**	-0.050**	-0.036
	[0.010]	[0.020]	[0.023]	[0.028]	[0.019]	[0.035]	[0.013]	[0.030]	[0.037]	[0.047]	[0.016]	[0.027]
Observations	70771	14139	36020	41083	35007	38309	464802	58871	11419	35705	75158	75634
Sample IMR	0.119	0.065	0.086	0.148	0.109	0.047	0.085	0.076	0.083	0.094	0.139	0.163
Sample Mean Height	1.573	1.581	1.589	1.587	1.579	1.514	1.516	1.594	1.571	1.54	1.561	1.616
Sample s.d. log GDP	0.11	0.157	0.069	0.062	0.109	0.037	0.219	0.045	0.189	0.131	0.108	0.123

Robust standard errors in brackets

* significant at 5%; ** significant at 1%

See notes to Table 8a. Total effects are calculated for Height at the mean of Log GDP, and for Log GDP, at the mean of Height.

Table 11b: continued

	MO	MZ	NB	NC	NG	PE	RW	SE	TZ	TO	TK	UG
Height, m	-0.062**	-0.175**	0.012	-0.103	-0.123**	-0.058**	-0.176**	-0.095**	-0.093**	-0.005	0.013	-0.008
	[0.022]	[0.025]	[0.040]	[0.017]	[0.027]	[0.012]	[0.024]	[0.021]	[0.019]	[0.031]	[0.023]	[0.024]
LGDP	-0.068**	-0.014	0.027	-0.012	-0.018	-0.011	-0.080**	-0.037	-0.003	-0.023	0.081*	-0.027**
	[0.025]	[0.017]	[0.049]	[0.012]	[0.016]	[0.007]	[0.009]	[0.032]	[0.008]	[0.026]	[0.037]	[0.009]
Observations	47108	52477	10611	63999	44537	156333	47199	46451	66429	23124	31980	39108
Sample IMR	0.081	0.147	0.075	0.062	0.146	0.077	0.115	0.099	0.106	0.099	0.09	0.098
Sample Mean Height	1.575	1.56	1.61	1.533	1.606	1.498	1.58	1.623	1.561	1.591	1.547	1.585
Sample s.d. log GDP	0.130	0.091	0.051	0.263	0.126	0.136	0.218	0.044	0.139	0.164	0.143	0.161

	ZB	ZW
Height, m	-0.109**	-0.093**
	[0.021]	[0.023]
LGDP	0.051**	0.011
	[0.165]	[0.016]
Observations	58968	26084
Sample IMR	0.106	0.06
Sample Mean Height	1.580	1.6
Sample s.d. log GDP	0.166	0.092

Robust standard errors in brackets

* significant at 5%; ** significant at 1%

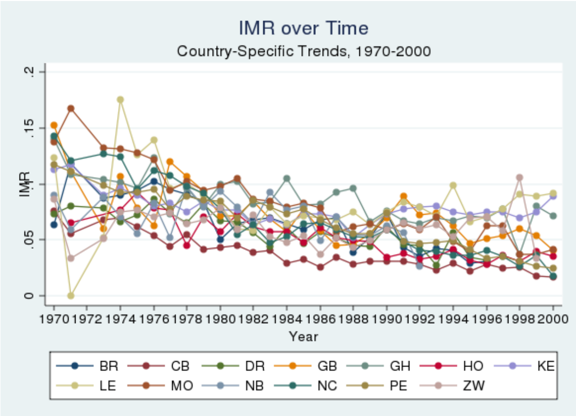
See notes to Table 8a. Total effects are calculated for Height at the mean of Log GDP, and for Log GDP, at the mean of Height.

Appendix Tables

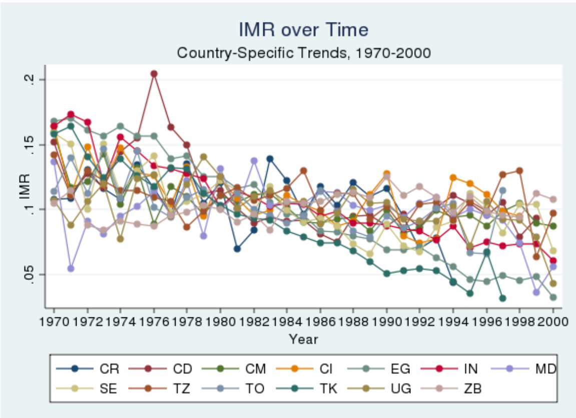
Figure A1: Country-Specific Trends in the Infant Mortality Rate

There are three figures, with countries grouped according to average infant mortality 1970-2000.

Group A – Lowest IMR over time



Group B- Mid-level IMR over time



Group C- Highest IMR over time

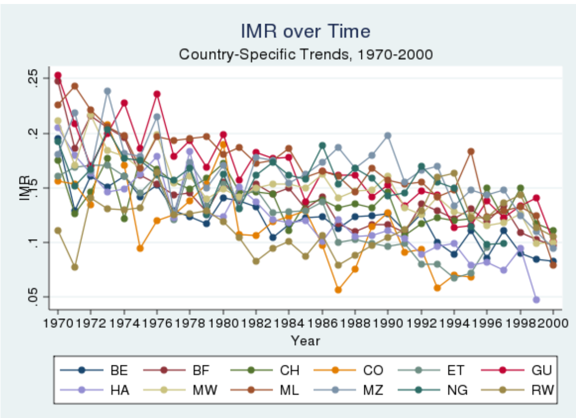
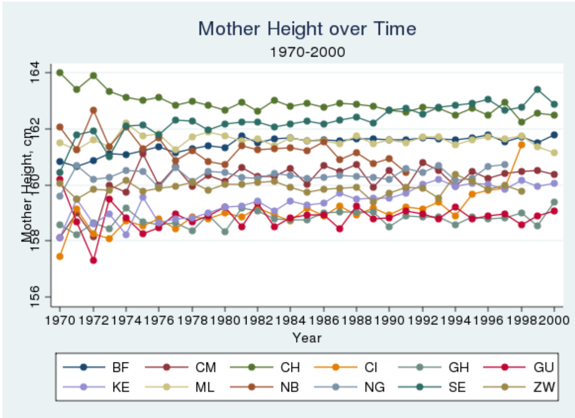


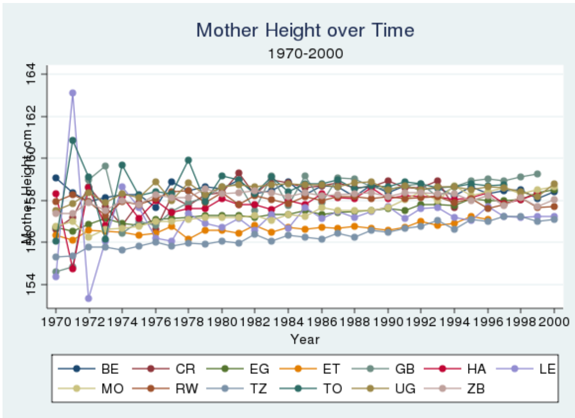
Figure A2: Country-Specific Trends in Mother's Height

There are three figures, with countries grouped according to average maternal height between 1970-2000.

Group A – Tallest women over time



Group B- Mid-height women over time



Group C- Shortest women over time

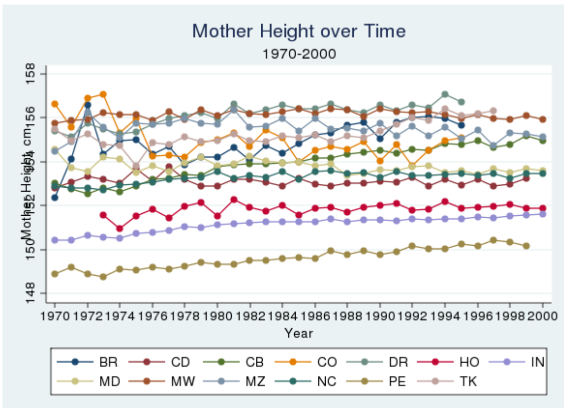
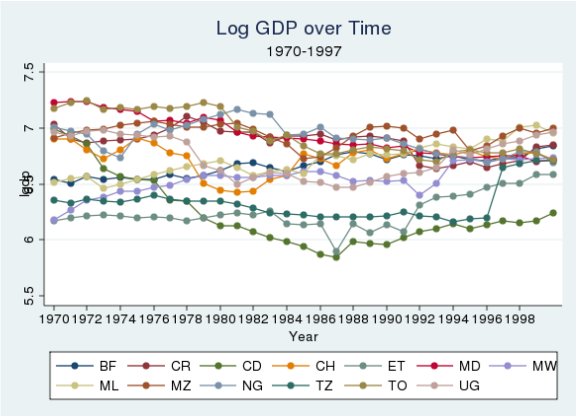


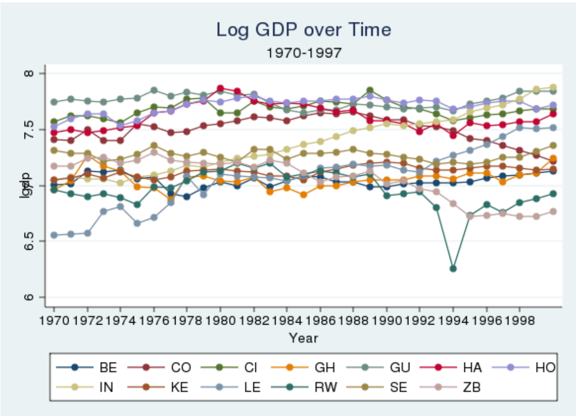
Figure A3: Country-Specific Trends in log per capita GDP at constant prices

There are three figures, with countries grouped according to average GDP over the period 1970-2000.

Group A- Poorest Countries



Group B- Mid-range countries



Group C- Richest countries