# Why Are Indian Children So Short?*

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**Abstract**

The child stunting rate in India is amongst the highest in the world, exceeding that of many poorer African countries. In this paper we argue that a culture of eldest son preference plays a key role in perpetuating the height deficit among Indian children. Data for over 174,000 Indian and Sub-Saharan African children show that Indian firstborns are taller than African firstborns; the Indian height disadvantage emerges with the second child and then increases with birth order. This pattern persists when we only compare height between siblings, and also holds for health inputs such as vaccinations. Several patterns in the data point to the Hindu norm of eldest son preference as the underlying reason. First, the Indian firstborn height advantage exists only among sons. Second, an Indian son with an older sibling is taller than his Africa counterpart if and only if he is the eldest son. Third, the India-Africa height deficit is largest among daughters with no older brothers, which reflects that fact that their families are the ones most likely to exceed their desired fertility in order to have a son.

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# 1 Introduction

One in four children under age five worldwide is so short as to be classified as stunted (UNICEF, 2014).[1] Roughly half of the world's stunted children live in Asia and one third in Africa. Child stunting, a key marker of child malnutrition, casts a long shadow over an individual's life; shorter children grow up to earn less and lead unhealthier lives, on average.[2]

In contrast to the rapid increases in average height that accompanied economic growth in western economies (Fogel, 1994), economic growth and height have failed to move in tandem in Africa and Asia (Deaton, 2007). India, the world's second most populous country and projected to have the world's youngest population by 2020, provides a particularly stark example. Between 1992 and 2005, India's economic growth exceeded 6% per year, yet stunting declined by just 0.77 percentage points per year (Masset and Haddad, 2013). In 2005, 40 percent of Indian children under age 5 remained stunted (IIPS, 2010). Thus, despite having a GDP per capita higher than roughly a hundred countries in the world, India has the fifth highest stunting rate in the world (UNICEF, 2013). Figure 1 shows that Indian children are, on average, shorter than those born in Sub-Saharan Africa. This pattern is puzzling given that India performs better than Africa on most other health and economic indicators ranging from infant mortality, maternal mortality and life expectancy to food security, poverty incidence, and educational attainment (Ramalingaswami, Jonsson, and Rohde, 1997; Gwatkin et al., 2007).

In this paper, we use data on over 174,000 children drawn from 25 Sub-Saharan African countries and the most recent Indian Demographic and Health Survey (DHS) to document several facts that suggest that cultural norms which shape parents' investments in their children underlie India's height disadvantage. Our first set of findings relates to birth order. We observe a much greater height drop-off for later-born children in India than in Africa: Height-for-age is actually *higher* in India than in Africa for firstborn children. The Indian

[1]Stunting is defined as having child height-for-age at least 2 standard deviations below the worldwide reference population median for one's gender and age in months.

[2]Studies document that taller people have greater cognitive skills (Glewwe and Miguel, 2007), fewer functional impairments and better immunocompetence (Barker and Osmond, 1986; Barker et al., 1993; Falkner and Tanner, 1989), and higher earnings (Strauss and Thomas, 1998; Case and Paxson, 2008). Hoddinott et al. (2013) track a cohort of Guatemalan children for over 30 years and find that taller Guatemalans had more schooling and cognitive skills, increased household per capita expenditure and a lower probability of living in poverty. An individual's adult height is highly correlated with her height as a child (Tanner, Healy, Lockhart, MacKenzie, and Whitehouse, 1956).

height disadvantage materializes for second-born children and increases for third and higher order births, at which point Indian children have a mean height-for-age lower than that of African children by 0.3 standard deviations of the worldwide distribution. We see the same pattern – a much steeper birth order gradient in child height in India than in Africa – when the estimation is limited to between-sibling variation. Thus, birth order is not just proxying for family background differences between smaller and larger families. We also consider an array of prenatal and postnatal health inputs and, as with height, observe a stronger drop-off with birth order in India than Africa.[3]

Indian children of both genders exhibit a sharper birth order gradient relative to Africans. However, averaged across birth orders, the Indian height disadvantage only holds among girls. This is consistent with the fact that the Indian firstborn height advantage only holds for sons.

We propose that a preference for eldest sons in India – both to have at least one son and for the eldest son to be healthy – generates a starkly unequal allocation of resources within families in India. This, in turn, underlies the observed birth order and gender patterns in child height. Eldest son preference can be traced to (at least) two aspects of Hindu religion. First, Hinduism prescribes a patrilineal and patrilocal kinship system (Dyson and Moore, 1983; Gupta, 1987). Second, Hindu religious texts place a strong emphasis on post-death rituals which can only be conducted by a male heir. These include lighting the funeral pyre, taking the ashes to Ganges and organising death anniversary ceremonies (Arnold et al., 1998)).

Eldest son preference will generate the observed birth order gradient among boys simply because a lower birth order son is more likely to be the family's first son. Consistent with this argument, we show that a son born at birth order 2 is taller in India than Africa if and only if he is the family's eldest son.[4]

Among girls, eldest son preference generates a birth order gradient through a more subtle mechanism, namely fertility stopping rules. Families who start off only having daughters are likely to exceed their desired fertility as they repeatedly try for a son; in other words, the birth

[3]We also observe a steeper birth order drop-off in hemoglobin levels among children age 5 and younger in India than Africa as well as, later in life, in children's schooling.

[4]Other papers examining gender variation in height in India include Mishra, Roy, and Retherford (2004) who used the two earlier National Family Health Survey (NFHS) rounds to show that stunting in India varies with the gender composition of siblings. Tarozzi and Mahajan (2007) show that child height improved more for boys than girls between the first two NFHS waves. Also related is Coffey, Spears, and Khera (2013) who compare first cousins living in the same Indian joint household and show that children born to the younger brother in the household do worse, potentially due to their mother facing greater discrimination.

of a late-parity girl is akin to an expenditure shock to the family, and fewer resources will be expended on her. Consistent with this behavior, the India-Africa height gap is particularly large for daughters who only have girls as elder siblings. This pattern is the opposite of the "sibling rivalry" prediction where having older sisters is associated with better outcomes for a child (Garg and Morduch, 1998). Sibling rivalry is also occurring – as mentioned above, boys born at birth order 2 fare better if competing with an older sister than older brother – but endogenous fertility can push in the opposite direction. For example, by comparing prenatal and postnatal investments in girls, we show that the sibling rivalry effect is the dominant effect when child gender is unknown, i.e. in utero; female fetuses benefit from not being in competition with an older brother and from their parents hoping that they might be the family's eldest son. However, once gender is revealed at birth causing parents to revise their fertility plans, postnatal investments and, further along, educational investments fall off.

Religious and regional variation in the birth order gradient within India is also consistent with our eldest-son hypothesis. Comparing across Indian Hindus and Muslims, we only observe the birth order gradient in height among Hindus. Comparing across states, the height gradient is absent in Kerala – an Indian state with a strong matrilineal traditions.

Explanations for the Indian birth order patterns that are unrelated to son preference are unlikely to also explain the observed patterns by child gender and siblings' gender. That said, we provide evidence that disfavors several alternative explanations. First, we rule out other health- and environment-related explanations such as India's higher child survival rate, worse maternal health and worse sanitation. Second, comparing outcomes for pregnant and non-pregnant Indian mothers with either their African counterparts or their husbands (across different birth orders) suggests that differential time profiles of income across Indian and Africa does not explain our findings. Finally, other cultural factors, including greater communal care-giving in Africa and historic preference for more family labor in Africa (related to greater land abundance), cannot explain the observed patterns.

Our results also suggest that the prevalence of malnutrition in India is not an artifact of using child height to measure malnutrition, with low child height in India simply reflecting genetics. Genotypes do not vary with birth order or siblings' gender, so a genetic predisposition to be short likely cannot generate these very significant birth order and gender

composition effects that we see.[5] Even an epigenetic explanation, in which environmental factors affect gene expression, is hard to square with the patterns we see in health inputs and not just outcomes; in any case, eldest son preference would remain a root cause because the relevant environmental factor is own and siblings' gender. Our findings are complementary to papers that study specific environmental causes of height variation, such as Spears (2013) who focuses on open defecation as a cause of the Indian height disadvantage. We emphasize the importance of a different cultural norm – eldest son preference – which affects intrahousehold resource allocation and the take-up of services.

Cultural gender preferences, or gaps in perceived returns to investment, have also been invoked in the literature as an explanation for unequal resource allocation across siblings (Rosenzweig and Schultz, 1982; Behrman, 1988; Garg and Morduch, 1998; Oster, 2009). While several papers discuss the unintended consequences of the desire to have sons in India (Sen, 1990; Clark, 2000; Jensen, 2003; Jayachandran and Kuziemko, 2011), our contribution is to demonstrate how dynamic fertility considerations, i.e., revisions to parents' fertility decisions based on the gender of children born, causes inequality in health outcomes not just between genders or between brothers, but even among sisters. Finally, we contribute to the literature on birth order patterns, which has documented gradients in outcomes as varied as IQ, schooling, height, and personality (Behrman and Taubman, 1986; Sulloway, 1996; Black, Devereux, and Salvanes, 2007; Savage, Derraik, Miles, et al., 2013). To the best of our knowledge, no prior studies have sought to explain cross-country differences in birth order effects or shown how birth order preferences, at least in some societies, are entwined with and potentially derive from gender preferences. We believe this is the first paper to empirically link the literatures on birth order and quantity-quality trade-offs in fertility behavior (Becker and Lewis, 1973).

The remainder of the paper is organized as follows. Section 2 describes the data and presents descriptive statistics for the sample. Section 3 presents evidence on the birth order gradient in the Indian height disadvantage, and Section 4 presents evidence on eldest son preference as the root cause. Section 5 tests alternative explanations for the within-family

[5]One approach in the literature to test for the role of genetics examines whether wealthy and well-fed Indian children are short by international standards. The findings are mixed (Bhandari et al., 2002; Tarozzi, 2008; Panagariya, 2013). Another approach is to examine the height of Indian children who migrate to rich countries, with most authors finding that the gap between the Indian-born children and worldwide norms narrows but does not close (Tarozzi, 2008; Proos, 2009).

patterns. Section 6 concludes.

# 2 Background

## 2.1 Data and descriptive statistics

Our analysis is based on Demographic and Health Surveys for Sub-Saharan African countries plus India's National Family Health Survey, which uses the Demographic and Health Survey questionnaire (throughout, we refer to this set of surveys as the DHS). For India, we focus on the most recent round from 2005-6 (NFHS-3). As a comparison group, we use all 27 Sub-Saharan African surveys (from 25 countries) that collected child anthropometric data and were conducted between 2004 and 2010 (to ensure a comparable time period to NFHS-3). In robustness checks, we also use DHS surveys from other regions. The data appendix provides details.

The surveys sample and interview mothers who are 15 to 49 years old at the time of survey, and measure height and weight for their children age five years and under. [6] Our sample comprises the 174,157 children with non-missing anthropometric data. Appendix Table 1 provides summary statistics for the Indian and African samples. The average child age in our sample is 30.1 months in India and 28.1 months in Africa. The mother's average age at birth is 24.8 years in India and 27.0 years in Africa.

A key variable of interest is birth order. We define birth order based on all children ever born, currently alive or deceased. As African women have more children (3.9) than their Indian counterparts (2.7), we observe a higher fraction of high birth order children in Africa relative to India.

To make appropriate height comparisons across children, we combine data on child height with information on the date of measurement and the child's date of birth to create the child's height-for-age z-score based on World Health Organization (WHO) guidelines. A z-score of 0 is the median of the reference population.[7] A z-score of -1 indicates that the child is 1 standard deviation below the reference-population median for his or her gender and

[6] Due to high incidence of missing data for children in their 60th month of life, we limit the sample to children who are 59 months old or younger.

[7] For each combination of gender and age in months, the WHO provides the distribution of these measures for a reference population of children from Brazil, Ghana, India, Norway, Oman and the United States with no known health or environmental constraints to growth and who were given recommended nutrition and health inputs (WHO Multicentre Growth Reference Study Group, 2006).

age. A height-for-age z-score of -2 is the cutoff for being considered stunted. The average height-for-age z-score in India and Africa are -1.58 and -1.44, respectively.[8]

We also use data on prenatal and postnatal health-related behaviors. On prenatal behavior, which includes the number of prenatal care visits and incidence of iron supplementation, India typically outperforms Africa. (For example, 69 percent of the time, pregnant women in India took iron supplements, compared to 62 percent in Africa.). Data on health inputs and outcomes for young children include whether he or she was given iron supplementation and the total number of vaccinations.[9] India has higher vaccination rates while child iron supplementation is more common in Africa.

We also examine children's schooling as an outcome, using a sample of children age 7 to 14.[10] Average years of schooling is 3.6 years in India and 2.0 years in Africa. The appendix tables include specifications using other outcome variables, such as the incidence of child diarrhea, mother's food consumption, and infant mortality. We describe these auxiliary variables in the data appendix.

# 3 Birth Order and Child Outcomes

## 3.1 Child height

Figure 2 illustrates visually the differences in height by birth order between India and Africa. The figure plots average child height-for-age (HFA) z-scores in India and Africa, separately by birth order. Among firstborn children, HFA in India exceeds that in Africa. An Indian deficit emerges at birth order 2 and widens for birth order 3 and higher.

Table 1 examines this pattern via regression analysis. To begin, in column (1) we show the average India-Africa gap, pooling all children. Indian children are, on average, 0.11 standard deviations shorter than African children.

In column (2) we disaggregate this height disadvantage by birth order. The outcome

[8]The DHS also collects data on the mother's height and hemoglobin level. On average, Indian women are 7 centimeters shorter than African women and have lower hemoglobin levels (11.6 versus 12.0).

[9]We restrict attention to vaccinations for which the DHS collects data (BCG, three doses of DPT, four doses of polio, and measles); this analysis is restricted to children age one year and older who should have completed their course of vaccinations.

[10]Age 7 is the typical school-entry age, and we exclude children over age 14 years because those living at home will be a non-random sample.

variable remains HFA for child $i$ born to mother $m$ in country $c$.

$$\begin{aligned} HFA_{imc} &= \alpha_1 I_c + \alpha_2 I_c \times 2^{nd}Child_{imc} + \alpha_3 I_c \times 3^{rd+}Child_{imc} + \beta_1 2^{nd}Child_{imc} \\ &\quad + \beta_2 3^{rd+}Child_{imc} + \gamma X_{imc} + \epsilon_{imc} \end{aligned} \tag{1}$$

The variable $I_c$ is an indicator for Indian children. $\alpha_1$ is the India gap for firstborn children (omitted birth order category) and $\alpha_2$ and $\alpha_3$ capture how the gap differs for second-born children and third-and-higher birth order children. $X_{imc}$ is a vector of controls: In all cases it includes linear, quadratic and cubic terms for a continuous survey month-year variable (to control for differences in survey timing) and child age dummy variables (in months, to control for any sampling differences between India and Africa and to improve precision). In some specifications it also includes mother's age and household covariates, and their interactions with the India dummy. Throughout, standard errors are clustered at the mother level.

As seen from the India main effect in Table 1, column (2), among firstborns, Indians are significantly taller than Africans. The India height disadvantage opens up at birth order 2: The interaction of India and secondborn is $-0.17$ and highly significant. The Indian disadvantage then grows larger, with third and higher births having an HFA z-score gap of $-0.32$ compared to African children (sum of main effect and interaction term).

Households where a second- or third-born child is observed in the data will, on average, have a larger family size than households where a firstborn child is observed, and households with higher fertility differ along several dimensions. Thus, a key omitted variable concern is that the birth order variable in between-household comparisons could be proxying for high-fertility families. In column (3) we include three household covariates and their interactions with the India dummy: a household wealth index, whether the mother is literate, and whether the household is rural. The coefficients on $I_c \times 2ndChild$ and $I_c \times 3rd+Child$ diminish in magnitude but remain strongly significant, suggesting differential correlation of total fertility and household socioeconomic status with malnutrition across India and Africa.

Another set of concern relate to mother and child age. Higher birth order children are born to older mothers, so the birth order gradient might actually reflect an India-Africa gap in the effect of maternal age on child height. In addition, birth order and child age are correlated; among siblings the higher birth order child will, by definition, be younger. We thus test the robustness to controlling for $I_c \times MotherAge$ and $I_c \times ChildAge$, where both

mother and child age are measured continuously (we continue to additionally control for child age dummies).[11] Column (4) shows that the coefficients on $I_c \times 2^{nd}Child$ and $I_c \times 3^{rd+}Child$ are essentially unchanged when adding these controls.

Finally, in column (5) we include mother fixed effects and therefore only use within-family variation for identification. (Birth order and child's age are even more strongly correlated within a family, so we continue to control for $I_c \times ChildAge$). The Indian birth order gradient remains statistically significant, and the results are quite similar to the unadjusted results in column (2). The fact that the India birth order gradient is larger in magnitude in column (5) than in columns (3) and (4) suggests that, conditional on the household covariates, unobserved differential selection of Indian households into higher fertility is positive. Note that the mother fixed effect specification also demonstrates a negative and significant birth order gradient in Africa (the coefficients on $2^{nd}Child$ and $3^{rd+}Child$ are negative and significant), consistent with findings in many settings that low-parity children have better outcomes. But the birth order gradient in child height is twice as large in India as in Africa.

Height-for-age is a continuous measure of height, but one might care specifically about stunting, which is used as a proxy for malnutrition when calculating malnutrition prevalence. Column (6) presents the mother fixed-effects results using stunting (HFA z-score $\leq -2$) as the outcome. Relative to their African counterparts, the disadvantage for Indian second borns is 11 percentage points, and for third borns, 14 percentage points. Thus, for stunting, the high birth order penalty is two to three times as large in India as in Africa. Appendix Table 2, column (1) shows a similar pattern using height in centimeters as the outcome.

Appendix Table 2 also presents additional robustness checks. To confirm that our results are not driven by the higher fertility in Africa relative to India, in column (2) we show our mother fixed effect specification is robust to restricting the sample to children who are birth order 4 and below. In column (3) we show the results are also robust to restricting the African sample to primary sampling units with fertility below the median fertility for Africa so that fertility is more similar between India and Africa. In both cases, sample restrictions imply less precisely estimated coefficients, but the point estimates remain very similar to the column (5) specification in Table 2. Another potential concern is sex-selective abortion in India. In column (4), we only keep the 25 percent of Indian observations that are in primary

[11] De facto we are also controlling for the mother's age at birth, which is a linear combination of the child's current age and mother's current age.

sampling units where the rate of mothers reporting using ultrasound during pregnancy is below 5 percent. (There are no ultrasound data in the African DHS data.). Again, the standard errors become larger but the point estimates remain similar.[12]

We use Sub-Saharan Africa as the comparison group for India, both because it is a region whose is similar to (but on average lower than) India, and because it has been the comparison group in the previous literature on the Indian height puzzle (Ramalingaswami, Jonsson, and Rohde, 1996). One potential concern is that what we are interpreting as an abnormally steep birth order gradient in India could really be an abnormally shallow gradient in Africa. Thus, Appendix Table 3 examines considers alternative comparison groups. In columns (1)-(3) we consider the group of 25 countries which conducted a DHS survey between 2004 and 2010 and whose GDP per capita in the survey year was within 10% (either higher or lower) of India's 2005-06 GDP per capita. In columns (4)-(6) we consider the 8 European and West Asian countries with DHS surveys. Given the relative paucity of surveys in this region we expand the time period to cover 1995 to 2012. In both cases, we continue to see a relatively stronger birth order gradient in India. The one difference is that we no longer see a firstborn advantage in India, which is not too surprising because these comparisons are on average richer than our main Sub-Saharan Africa comparison group.

## 3.2 Child investments

The fact that the birth order gradient in height in India is relatively steeper than in Africa (and also other comparison groups) casts doubt on a genetic-based explanation for Indian stunting, since no obvious genetic theory suggests that genes express themselves differently by birth order; any purely genetic difference would likely materialize in children of all birth orders. Moreover, the persistent of this pattern even when we only compare across siblings suggests that take-up of services not access *per se* underlies the patterns. In Table 2 we directly show this: The decline in pre- and post-natal investments in children is relatively faster in India.[13]

[12]Another potential confounding factor is that polygamy and polygyny are more common in Africa. Polygamy would generally work against our findings, but if a woman is polygynous, then a third birth could be her first birth with a particular partner. However, Appendix Table 2, column (5) shows similar results when we restrict the sample to mothers who have only had children with one partner. Finally, column (6) shows our results are robust to considering an alternative (but more endogenous) definition of birth order, namely birth order among currently living children.

[13]The purpose of analyzing health inputs is to directly show that the resources parents allocate to their children falls sharply with birth order in India, not to claim causality.

In columns (1) to (4) the outcome variables are based on retrospective information about health inputs in utero and at childbirth. Since most questions are asked only for the youngest child in the family, our sample is smaller and mother fixed effect specifications are infeasible. To address selection concerns, all regressions include the set of three household covariates (wealth index, female literacy, and rural residence), child age, and mother's age plus their interactions with the India dummy (the same specification as column (4) of Table 1).

On average, Indian women are more likely to obtain prenatal care during pregnancy, take iron supplements and receive tetanus shots during pregnancy but are less likely to deliver at a health facility. However, for most of these outcomes (3 out of 4) we observe a sharper decline with birth order in India relative to Africa. For instance, column (1) shows that prenatal visits decline faster among Indian mothers for later births relative to their African counterparts. We find a similar pattern for iron supplements and delivery at a facility, but no differential birth order gradient for tetanus shots. The magnitude of these gradients is large enough that for two of the three inputs where the India average exceeds the Africa average (prenatal visits and iron supplementation), later-born Indian children actually get fewer inputs than their African counterparts.[14]

Columns (5) to (7) considers three postnatal investments. The prevalence of having a postnatal checkup is much lower in India than Africa (perhaps related to a social norm of Indian women's confinement to the home after birth) and child iron pill consumption is also lower in India, while Indian children are more likely to get vaccinated. For the first two outcomes, we do not find a birth order gradient. For vaccinations, we see a strong negative India birth order gradient.[15] Column (8) shows the average effect when we pool the inputs used in columns (1) to (7).

The birth order gradient in the health investments that parents make in their children suggests a behavioral basis for the height birth order gradient. This parental behavior would likely affect other dimensions of child health, and column (9) shows this is the case. Children's hemoglobin level also exhibits a much stronger birth order gradient in India than

[14]The tables do not report the gap among firstborns (i.e., the main effect for India) because we are controlling for household covariates interacted with India. This comparison of absolute levels is based on a specification without household covariates.

[15]We do not examine breastfeeding as an outcome because while parents choose how long to breastfeed partly based on its health benefits, this input is also largely determined by subsequent fertility (Jayachandran and Kuziemko, 2011).

Africa.

Finally, in column (10) we examine a non-health outcome, namely schooling, as further evidence that there seems to be a broad-based preference for earlier born children in India. Here we examine a sample of children of school-going age, specifically those age 7 to 14 years old at the time of the survey. The regression specification controls for child age in years rather than months (due to data availability) but is otherwise the same. Years of schooling also show a stronger birth order gradient, although only beginning with third-borns.

# 4 Culture and Height Deficits

A striking fact about the height deficit of Indian children is the concentration of this deficit among later-born children. What might lead Indian parents to choose to have additional children but drastically reduce investments in them? Below, we provide evidence that points to the Hindu norms that prioritize having at least one son as an explanation.

## 4.1 Child gender and height deficits

### 4.1.1 India versus Africa

We start by examining whether the relatively steeper birth order gradient in India varies with child gender. In Table 3, column (1) we estimate a regression of the form reported in Equation (1) but expanded to include interactions with a dummy for whether the child is a girl. We learn two things from the regression results. First, unlike with boys, the firstborn height advantage is absent for Indian girls (relative to their African counterparts). Specifically, the main effect for India tells us that firstborn Indian boys are on average 0.15 z-score points taller than their African counterparts. However, among girls this effect is absent as the coefficient on $India \times Girl$ is $-0.15$. The second fact we learn is that the subsequent steeper birth order gradient for Indian children is similar for boys and girls; the triple interactions of India, higher birth order, and the girl dummy, while negative are statistically insignificant. In column (2) we include household covariates, child's age, and mother's age and their interactions with India. The patterns for the birth order gradient remain similar but the significance of the $India \times Girl$ coefficient decreases. In column (3), we include mother fixed effects and therefore compare children within the same household. While the coefficients are fairly similar, the standard errors increase considerably; we do not appear to have enough statistical power to examine the interaction of gender and birth order

within families.

In column (4) we pool children across birth order and summarize the average gender bias in the Indian height deficit. The India dummy is small and insignificant and the coefficient on $India \times Girl$ is $-0.18$. Thus, in aggregate the relative child height disadvantage is only present among Indian girls. In column (5) we include household covariates and in column (6) we estimate a regression which includes mother fixed effects. The coefficient of $India \times Girl$ decreases somewhat across columns but remains significant.

Columns (7) and (8) show the same specifications with the pooled prenatal and postnatal investments. Girls receive relatively fewer inputs in India, and the differential Indian birth order gradient in inputs is seen for both boys and girls. Note that we show the specifications with household covariates and child and mother's age because, for most inputs, data were only collected for the youngest child in the family (and we have low statistical power when estimating the interaction of birth order and gender within families).

### 4.1.2 Within-India comparisons

The results so far have shown that in India child height drops off strongly with birth order and that, on average, the height deficit is concentrated among girls. Our hypothesis is that these two facts are related via son preference. As prima facie evidence, Table 4 examines whether the birth order gradient in height is stronger among religions and regions in India that have a tradition of stronger son preference.

In column (1) we compare the birth order gradient between Indian Hindus and Muslims. Relative to Hinduism, Islam places less emphasis on needing a son for religious ceremonies, and Islamic inheritance rules disfavor women less. Several papers provide evidence that suggests that son preference, in turn, is weaker among Muslims; for example the sex ratio is less skewed among Muslims than Hindus (Borooah and Iyer, 2005) and the gender gap in child mortality is smaller (Bhalotra, Valente, and Soest, 2010). Column (1) shows that, relative to Indian Hindus, Indian Muslims have a much more muted birth order gradient.

Next, we compare the birth order gradient in Kerala relative to the rest of India. Historically, a distinctive feature of the social organization of Kerala has been the prevalence of matrilineality. Several authors have noted the absence of son preference in Kerala. Kerala leads Indian states in the child sex ratio; according to the 2011 census, Kerala had 92 men for every 100 women (against the Indian average of 113 men for every 100 women). In column

(2) we observe that the birth order gradient in height observed in the rest of India is absent for Kerala. Finally, we examine heterogeneity by the child sex ratio, calculated for each state-by-urban cell (which is the finest level of administrative detail at which we can merge the sex ratio data from the 2011 census). The sex ratio is calculated as the ratio of males to females, so the prediction is that low-sex-ratio regions should have a smaller birth order gradient, or positive interaction terms. Here we do not find evidence of heterogeneity.[16]

We also test for heterogeneity within India in the birth order gradient in prenatal and postnatal investment, shown in columns (4) to (6). Again, Muslim families exhibit less steep investment drop-offs with birth order than Hindu families, and Kerala has a less steep gradient than other Indian states. Using the child sex ratio as a proxy gives mixed results: states with less skewed sex ratios have a smaller relative disadvantage for birth order 2, as predicted, but a larger disadvantage for birth order 3 and higher.[17]

## 4.2 Eldest son preference and height deficits: Predictions

Roughly four-fifths of India's population are born Hindu. Hinduism is a religion that emphasizes the importance of male heirs – for propagating the bloodline, for inheritance, for old-age care of parents, and for cremation rituals. Consequently, Hindu parents place high value on having a son, which leads to a culture of eldest son preference. That is, parents both desire to have at least one son and then, once born, prioritize their eldest son relative to his siblings. Below we provide evidence that supports the thesis that this cultural norm underlies the observed birth order and gender patterns in child height.

Among boys, eldest son preference automatically generates a birth order gradient since the eldest son is, by definition, lower birth order than his brothers. Among girls, the mechanism is more subtle and relates to fertility stopping rules. To see this, consider a family with finite (and fixed) resources that has a desired fertility of two children but wants at least one son. Prior to any children being born, these two goals are compatible, because the likelihood of any child being male is (very close to) 50%. Now suppose their firstborn child is a daugh-

[16] Jayachandran (2014) discusses the limitations of using the sex ratio as a proxy for son preference. Because of eldest son preference, the sex ratio decreases sharply with the desired fertility level, so it measures a mixture of son preference and desired fertility.

[17] The *3rd+child* interaction term seems to be driven by the composition of birth order within the birth order 3 and above category. If we restrict the sample to children birth order 3 and below, the positive birth order 2 interaction remains, but the birth order 3 interaction becomes 0.

ter.[18] The parents will recognize that they may have to go beyond two children to have a son and will possibly cut back on some resources that they had planned to spend on their first-born. The birth of a second daughter (at birth order 2) makes it certain that they will exceed their desired fertility. Moreover, in expectation, their expected fertility increases from 3 to 4. Thus, each additional daughter's birth (in a sequence of only daughters) causes parents to revise their fertility plans upward and reduce expenditures on the last born daughter to save for their prospective eldest son. Assuming finite household resources (that do not vary with realized fertility), this fertility stopping rule predicts increasingly reduced investments in subsequent daughters. If parents are myopic and do not fully update their fertility plans when the first daughter is born, then this amplifies the extent to which the birth of the second daughter is a positive shock to expected family size and thus to future expenses. In summary, even though parents do not favor their first-born daughter over their second-born daughter per se, changing fertility plans combined with fixed household resources imply that later born daughters receive fewer investments.

In this model, having an elder brother (especially one born at birth order 1) is advantageous for a later-born girl. This prediction is the opposite of the "sibling rivalry" prediction where having older brothers is associated with worse outcomes for a child (Garg and Morduch, 1998). Below we show that while this standard mechanism of sibling competition is indeed at play, in terms of child height, it can be outweighed by the fertility stopping rule mechanism. One feature that distinguishes the two channels is that the fertility-stopping mechanism only materializes once child gender is known, i.e. after birth, whereas the competition mechanism exists before and after birth. Indeed, a prenatal competition advantage of no older brothers is that parents may invest heavily in the pregnancy given a 50% chance that the mother is pregnant with the family's eldest son. In summary, we take the following predictions to the data:

**Prediction 1.** *Relative to African counterparts, later parity girls with no older brothers in India will*

*a. Show larger height deficits.*

*b. Face larger disadvantages in postnatal than prenatal investments.*

[18] In our data, the majority of Indian mothers report an ideal family size of 2 children.

The fertility stopping behavior we describe also suggests that while eldest sons in India should do well regardless of birth order, those born at very late parity may suffer from the fact that parents had to significantly exceed their desired fertility. For instance, if a family has a desired fertility of two children and their eldest son is born at birth order 1 or 2, then the family need not exceed its desired fertility. By contrast, an eldest son born at birth order 3 might fare better than his sisters (or any subsequent sons), but across families, he might be disadvantaged relative to eldest sons born at earlier birth order because his family expended resources on his two older sisters. This generates additional testable predictions related to eldest sons:

**Prediction 2.** *Relative to African counterparts, outcomes for eldest sons born in India will vary with their birth order as follows:*

a. *Eldest sons born within their family's desired family size, even if not at birth order 1, should be favored.*

b. *High birth order eldest sons born beyond the family's (ex ante) desired family size will do worse than eldest sons born at lower birth order.*

## 4.3 Elder-sibling composition and height deficits: Evidence

To test the predictions laid out above we examine how, conditional on birth order, the composition of one's older siblings affects outcomes. Specifically, we estimate:

$$\begin{aligned} Y_{icm} &= \alpha_1 I_c + \alpha_2 I_c \times 2^{nd}Child_{imc} + \alpha_3 I_c \times 3^{rd+}Child_{imc} + \delta_1 I_c \times Girl + \delta_2 I_c \times NoElderBro \\ &\quad + \delta_3 I_c \times Girl \times NoElderBro + \beta_1 2^{nd}Child_{imc} + \beta_2 3^{rd+}Child_{imc} + \phi Girl \times NoElderBro \\ &\quad + \gamma X_{imc} + \epsilon_{imc} \end{aligned} \tag{2}$$

This is an expanded form of equation (1), where the control vector $X_{imc}$ includes additional dummies for child gender ($Girl$) and for having no older brother ($NoElderBro$). In addition, we include the interactions of these two variables with the India dummy. We are interested in $\delta_2$ which captures the differential outcome for a family's eldest son in India and $\delta_3$ which captures the differential outcome for a girl who is either the firstborn or all of her older siblings are girls.

Table 5 reports the results. We begin by showing, in column (1), how the gender composition of children affects parents' fertility plans. Here, we use the sample of mothers,

and the outcome of interest is whether she wants more children. The coefficient on $I_c \times NoElderBro$ is negative indicating that a Indian mother that has just had her eldest son has a reduced desire for more children. Meanwhile, the coefficient on $I_c \times Girl \times NoElderBro$ is large, positive, and statistically significant. Thus, the birth of a girl, when the family only has daughters, leads to relatively higher desire for more children among Indian mothers. Since the specification controls for birth order and its interaction with India, these results do not simply recast the birth order patterns: Conditional on birth order, the gender composition of children influences mothers preferences over fertility continuation. In column (2) we show these findings are robust to controlling for household covariates, child age, and mother's age interacted with India.

Next, we consider child height as the outcome variable. In column (3) we observe a positive and significant coefficient on $I_c \times NoElderBro$: relative to their African counterparts, an Indian eldest son has a 0.12 z-score height advantage. The coefficient on $I_c \times Girl \times NoElderBro$ tells us that the opposite holds for girls: having no older brother is worse than having an older brother. The net effect for girls of having an elder brother is lower in India than Africa ($I_c \times NoElderBro + I_c \times Girl \times NoElderBro$), but insignificant. The addition of controls in column (4) weakens the significance of these interaction coefficients, but the worse height outcomes for girls in India who only have sisters as elder siblings remains reasonably strong.

This pattern is at odds with the standard "sibling rivalry" hypothesis which predicts that having sisters (relative to brothers) increases the resources enjoyed by a girl. Our results suggest that the "sibling rivalry" hypothesis is incomplete in that it fails to account for the fact that family size is endogenous to the gender composition of siblings.

Further evidence on the offsetting positive and negative effects for girls from having a brother come from comparing patterns across pre- and post-natal investments. In general, child gender becomes known at birth. Prior to this (i.e. at the prenatal stage), girls without older brothers benefit from the absence of sibling rivalry and also enjoy inputs intended for the (possible) eldest son. Post-birth, the negative effects of being born a daughter in a family with no sons materialize as the parents re-optimize fertility and expenditure decisions. Thus, daughters without an older brother should be advantaged in terms of prenatal inputs relative to postnatal inputs. To test this prediction, we use the data on the prenatal and postnatal inputs ( first examined in Table 2) and restrict the sample to girls (because the

hypothesis we are testing refers to the treatment of daughters). Consistent with the negative effect of having no older brother materializing after birth (Prediction 1b), the coefficient on $I_c \times Prenatalinputs \times NoElderBro$ is positive and significant.

We next turn to the predictions for eldest sons. Column (3) sheds some light on our Prediction 2a, which is that eldest sons born at later parity should also be favored, at least as long as they were born within their family's desired family size. The relative Indian advantage for an eldest son at birth order 2 in India is given by $I_c + I_c \times 2^{nd}Child + I_c \times NoElderBro$ , which is positive and significant (p-value of 0.048 reported in column 3). Meanwhile, consistent with Prediction 2b assuming families want two children (the modal preference in India), an eldest son born at birth order 3 does worse in India than Africa (p-value of 0.004).

It is important to note that eldest son preference does not explain all of the patterns we observe. For example, in unreported results, we find that there is a birth order gradient even between the family's second and third sons. Nonetheless, we have shown several patterns consistent with eldest son preference determining resource allocation and fertility stopping behaviors, which suggests that this preference is a key factor behind the strong birth order gradient and overall low level of child height in India.

# 5 Alternative Explanations

We argue that cultural norms that privilege the eldest son in India can explain the observed birth order gradient among Indian children, and the resulting high rates of child stunting. Below, we examine the empirical support for three classes of alternative explanations - other health-related explanations, economic conditions, and other norms related to child-rearing practices.

**Health**

Mortality selection among children. Infant mortality is lower in India than Sub-Saharan Africa. It is therefore natural to expect that relatively weak (and short) children are more likely to survive through childhood in India than Africa. This, in turn, would lower observed average child heights in India relative to Africa. For mortality selection to further explain the steeper birth order gradient in India, infant survival in India would need to be especially high for later-born children (where the largest Indian height disadvantage is observed). In column (1) of Appendix Table 4 we show the opposite holds; infant mortality among later

birth order children is significantly higher in India than Africa. This fact militates against the possibility that mortality selection underlies the steeper height gradient in India. Moreover, it is consistent with later-born Indian children being relatively more malnourished and, more generally, is additional evidence that later-born Indian children fare poorly.

Maternal health. Indian mothers are, on average, seven centimetres shorter than African mothers (1.51 versus 1.58), and this, arguably, reflects the fact that women's predetermined health is worse in India than in Africa. It is plausible that across successive childbirths, Indian mother's health deteriorates more rapidly to the detriment of infant health. This possibility is related to Deaton and Drèze's (2009) gradual catch-up hypothesis which posits that it could take generations to close the height gap in India if a mother's malnutrition and poor health as a child in turn affect her children's size.

To test this hypothesis, we ask whether mothers' childhood malnutrition and poor health, as proxied by their height, has differential effects by birth order. Column (1) of Appendix Table 5 presents interactions between the mother's height and birth order. We ask, not whether there is a differential effect of height by birth order in India, but rather whether there is an effect of height by birth order which can "knock out" the stronger birth order gradient in India. The key coefficients are on $Mother'sHeight \times BirthOrder$ dummies. The coefficients are positively signed but small and statistically insignificant and leave unaffected the coefficients on India interacted with higher birth order dummies.

Disease environment Another possibility is that later born Indian children face a worse disease environment, related to poor sanitation. The likelihood that a household reports open defection is 45% in India and 32% in Africa. (Spears, 2013) points to the high rate of open defecation in India as a contributor to the prevalence of child stunting. Even if a household's sanitation infrastructure does not change over time, later-born children may have more exposure to disease because older siblings expose them to pathogens or they receive care from inferior caregivers. Appendix Table 4, column (2) examines whether there is a stronger birth order gradient for diarrhea in India. Mothers' responses suggest an increase in the likelihood that 3rd and later-born children in have had diarrhea in last two weeks in India, but the effect size is very small. Column (3) directly examines whether open defecation can (statistically) explain the India birth order gradient. The point estimates suggest that the prevalence of open defecation has, if anything, smaller consequences for height for higher birth order children; in any case, controlling for the rate of open defecation does not diminish

the magnitude of the India-Africa birth order gradient in child height. Needless to add, it remains possible that open defecation contributes to low child height in India; absent open defecation, the intercept term for India could be higher.

**Economic conditions**

Higher birth order children are born later in their parents' lives, on average, and the resources available to spend on them may vary with the time profile of household income. Limited ability to intertemporally smooth consumption would, then, cause resources available for each child to vary with this time profile. If Indian parents have relatively less income than African parents when later parity children are born, then these children may receive relatively fewer resources and have worse outcomes. (Here, age, or more specifically marriage duration, is the relevant "time" profile dimension, not calendar time.) A related idea, which seems less plausible but is technically possible, is differences in the time profile of prices. If relative prices in India rise more with time, then Indian parents will be able to invest relatively less in later born children.

This is perhaps the most challenging alternative to test; while we can compare child height across siblings, we lack time-varying measures of household income or wealth that capture the family's resources when those siblings were born. Instead, we provide an indirect test: we examine mothers' nutritional inputs and outcomes, comparing pregnant versus not pregnant women. If Indian households have less income over time, then womens' food consumption should decline in India relative to Africa, when they both are and are not pregnant. In contrast, our explanation based on preferences rather than budget constraints predicts that the Indian decline should be especially pronounced among pregnant women.

Recall data on mothers' food consumption was collected for Indian and African mothers who have given birth in the last three years (hence, our sample excludes women who have no children or are pregnant with their first child). We create a consumption index which averages across five indicator variables for whether the mother reports consuming specific food items. The data are fairly crude, asking whether the mother consumed a type of food in the recall window, but they give an indication of dietary diversity and the nutritional inputs for women. Almost everyone has consumed starchy foods, so we focus on the categories with variation (and which are important sources of protein and vitamins), namely leafy vegetables, fruit, dairy, and meat/fish/eggs. We allow effects to vary depending on whether

the woman is currently pregnant.

Appendix Table 6, column (1) shows that for pregnant women (the omitted category) we see a sharper birth order gradient among Indians (i.e, a greater drop-off in food consumption across successive pregnancies). Indian women pregnant with their third or higher birth order child are disadvantaged nutritionally. (Note that the consumption level of Indian women is typically higher than that of African women across all pregnancies; it is just that the gradient is sharper for Indians.) The point estimates also suggest a much smaller relative decline in consumption among non-pregnant Indian mothers (positive triple interaction term for India, has 2 or more children, and not pregnant). This evidence weighs against different time profiles of income which likely would lead to similar patterns for both pregnant and non-pregnant women. In column (2) we consider mother's hemoglobin levels as the outcome and again observe a differential India-Africa gradient among women as they have more children. And as with food consumption, this gradient differs depending on whether the woman is pregnant. Specifically, across successive pregnancies the drop off for Indian mothers exceeds that for African mothers (negative coefficients for India interacted with number of children), but the gradient is much smaller among non-pregnant women (positive triple interactions). This evidence also casts doubt on financial resources of Indian households dropping off (or prices rising) more steeply over the lifecycle compared to African households as the explanation for the birth order patterns.

A complementary way of examining whether pregnant Indian mothers do particularly badly is to consider the sample of Indian couples where we observe outcomes for both the husband and wife.[19] The results in columns (3) and (4) are noisy but mirror those in columns (1) and (2). Consumption declines in India as family size increases are concentrated among women and do not extend to their husbands. Again, the gender gap in consumption widens during pregnancies, suggesting differential investment in children rather than a general decline in the way women are treated over time. A similar pattern is seen for hemoglobin.

### Other cultural norms

Communal child-rearing In addition to income, another constrained resource is time. Parents might have less time to take care of later-born infants because they also have older children to

[19] A number of papers have shown that women receive fewer household resources, such as food and health care, than men in India (Dandekar, 1975; Agarwal, 1986; Sudo, Sekiyama, Watanabe, et al., 2004). The module on men's consumption is unfortunately fielded in very few of the African surveys.

look after. One reason this scarcity of time might be more acute in India than in Africa is if relatives and neighbors help out raising children in Africa (Goody, 1982; Akresh, 2009). We test for this by creating a proxy for the extent of "communal child-rearing" in the primary sampling unit, namely the proportion of women's children under age 10 years who are non-resident in their household. This factor, however, does not seem to be the explanation for the India-Africa differential birth order gradient. As seen in Appendix Table 5, column (2), the extent of communal child-rearing indeed seems to dampen the birth order gradient, but the effect size and gap in this practice between Africa and India are too small to explain much if any of the stronger birth order gradient in India.

Land scarcity A final possibility we consider is that the high relative investment in earlier born children in India is because of historical land scarcity. In Africa, where land is more abundant, later born children were more valuable in helping with agriculture. We test this idea by using the 1961 ratio of population to land area as a proxy for historical land scarcity. By this metric, land is indeed more scarce in India than Africa. However, as Appendix Table 5, column (3), shows, this factor does not explain why height drops off so steeply with birth order in India.

# 6 Conclusion

This paper compares child height-for-age in India and Sub-Saharan Africa to shed light on the puzzlingly high rate of stunting in India. We present three facts that support "environment" as the explanation in the genes-versus-environment debate and, more specifically, point to parents' intra-family allocation decisions as the underlying factor driving malnutrition in India. First, among firstborns, Indians are actually taller than Africans; the height disadvantage appears with the second child and increases with birth order. The particularly strong birth order gradient in height in India is robust to including family fixed effects, which helps rule out most selection concerns. Second, investments in successive pregnancies and higher birth order children decline faster in India than Africa. Third, the India-Africa birth order gradient in child height is larger for boys if the family has a son already; Indian parents seem to disinvest in their subsequent children once their eldest son is born. Meanwhile, for Indian girls, secondborns are relatively disadvantaged by having no elder brothers, consistent with the family conserving resources in anticipation of having another child to try for a son. These facts suggest that parental preferences regarding higher birth order children, driven

by eldest son preference, underlie much of India's child stunting.

There are two reasons one might expect these patterns to fade as India develops. The first is that even if the preference for eldest sons persists, with greater financial resources, all children will be well nourished enough to achieve their height potential. The second is that eldest son preference could fade, for example as women catch up to men in terms of education and labor force participation and gain more bargaining power. Unfortunately, neither of these patterns seem to be true when we make within-India comparisons today. Table 6 shows that the birth order gradient is actually larger among wealthier households, and while there is some suggestive evidence that maternal education might reduce the problem, the evidence is weak. Thus, the problem of malnutrition in India might be slow to fade, even as India develops, without policies that correct for the intrahousehold allocation decisions that parents are making.

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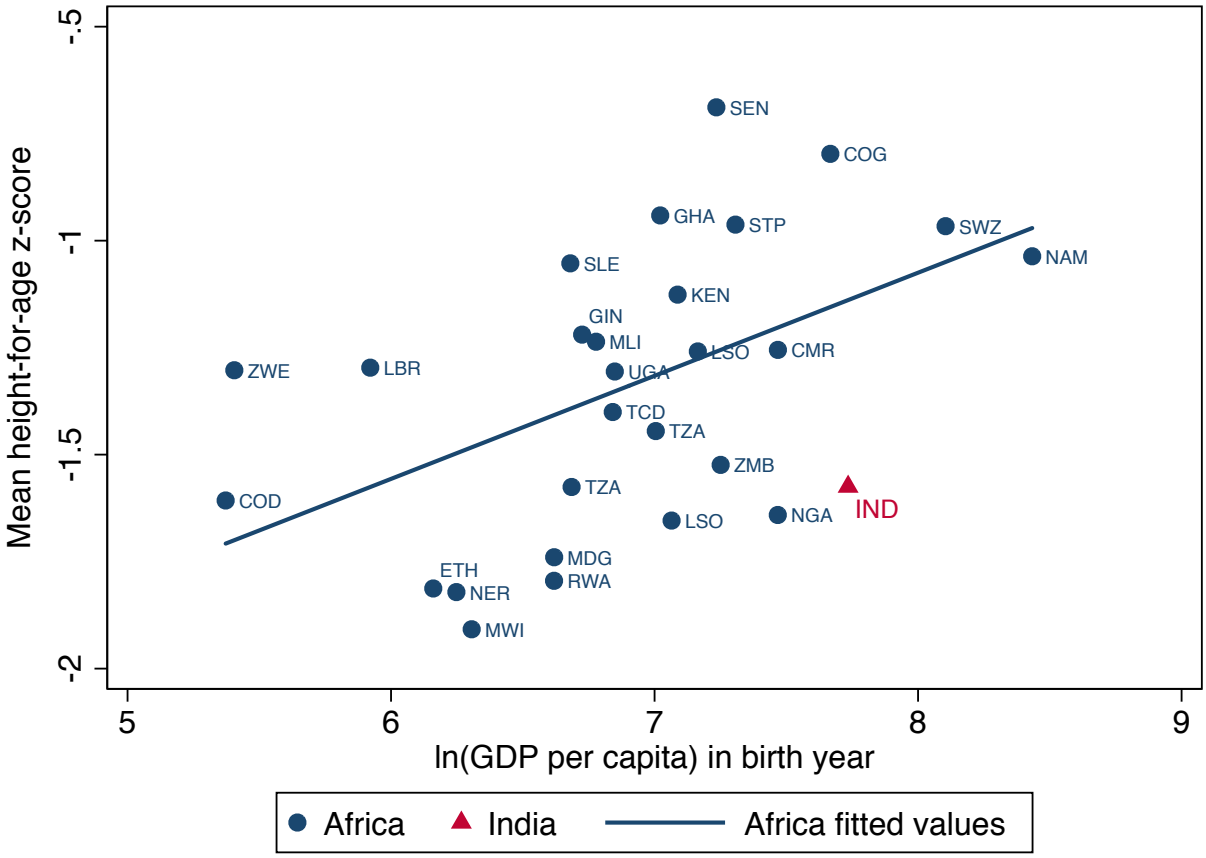
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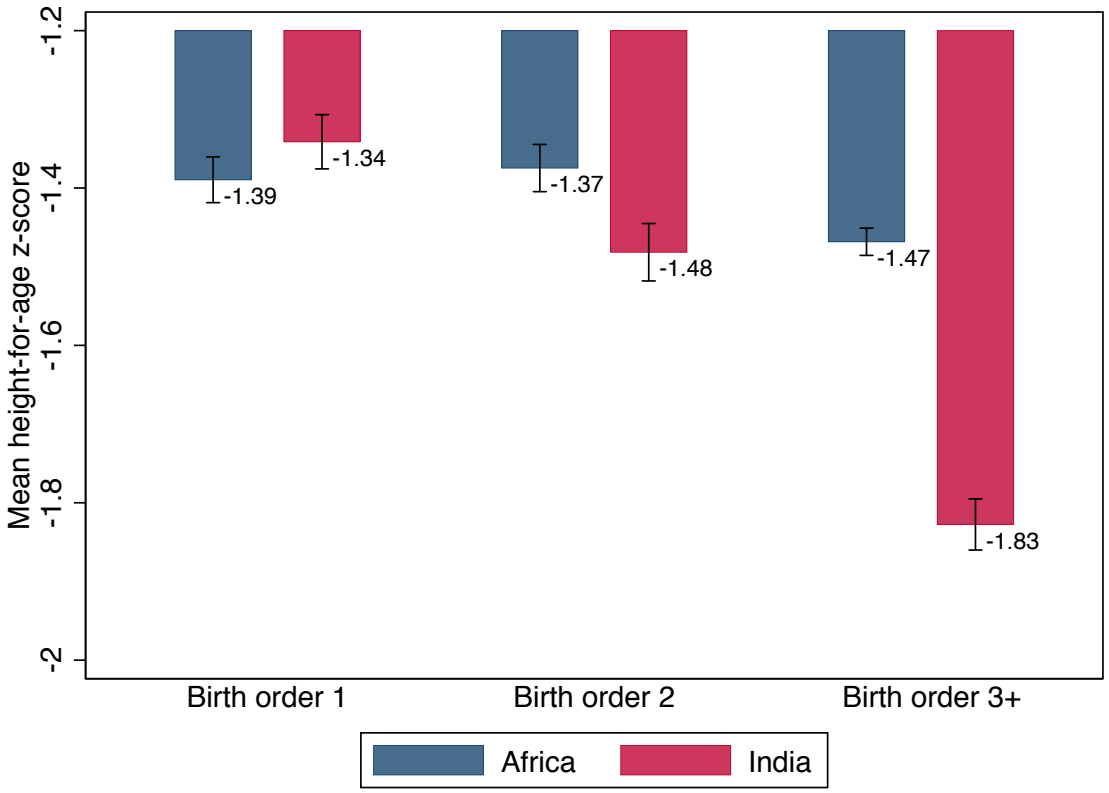
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Figure 1: Child height versus national GDP




The blue dots and red triangles indicate survey-specific means for Sub-Saharan Africa and South Asia surveys, respectively. The mean is calculated over all children less than 60 months old with anthropometric data. The blue line is the best linear fit for Sub-Saharan Africa.

Figure 2: Child height in India and Africa, by child's birth order




The figure depicts the mean child height-for-age z-scores for Sub-Saharan Africa and India, by the birth order of the child. The mean is calculated over all children less than 60 months old with anthropometric data.

Table 1: Birth order gradient in the India height gap

| | HFA z-score (1) | HFA z-score (2) | HFA z-score (3) | HFA z-score (4) | HFA z-score (5) | Stunted (6) |
|---|---|---|---|---|---|---|
| India | -0.110*** | 0.080*** | | | | |
| | [0.014] | [0.023] | | | | |
| India*2nd child | | -0.168*** | -0.144*** | -0.158*** | -0.263** | 0.105*** |
| | | [0.030] | [0.030] | [0.030] | [0.110] | [0.027] |
| India*3rd+ child | | -0.401*** | -0.211*** | -0.231*** | -0.414** | 0.141*** |
| | | [0.029] | [0.029] | [0.036] | [0.193] | [0.046] |
| 2nd child | | 0.038** | 0.067*** | 0.021 | -0.208*** | 0.045*** |
| | | [0.019] | [0.019] | [0.019] | [0.066] | [0.014] |
| 3rd+ child | | -0.063*** | 0.057*** | -0.106*** | -0.465*** | 0.093*** |
| | | [0.017] | [0.017] | [0.021] | [0.106] | [0.023] |
| Africa mean of outcome | -1.435 | -1.435 | -1.435 | -1.435 | -1.435 | 0.390 |
| HH covariates*India | No | No | Yes | Yes | No | No |
| Child age*India | No | No | No | Yes | Yes | Yes |
| Mother's age at birth*India | No | No | No | Yes | No | No |
| Mother FEs | No | No | No | No | Yes | Yes |
| Observations | 174,157 | 174,157 | 174,157 | 174,157 | 174,157 | 174,157 |

Notes: Standard errors are clustered by mother and appear in brackets. Asterisks denote significance: * $p < .10$, ** $p < .05$, *** $p < .01$. *2nd child* is an indicator for children whose birth order is 2. *3rd+ child* is an indicator for children whose birth order is 3 or higher. Control variables included are survey month controls and child age dummies. Survey month controls are a cubic in a continuous variable representing the month and year of the survey. In Column 3, the main effect of *India* is included in the regression but is not shown. In Columns 4-6, the main effect of *India* is absorbed by a full set of *Mother's age*×*India* or *Child's age*×*India* or mother fixed effects. *Household covariates* in Columns 3 and 4 include DHS wealth index, mother's literacy, rural, dummies for missing values of DHS wealth index and literacy, and household covariates×India. In Column 4, a linear variable for mother's age at first birth and mother's age at first birth×India are included in the regression. See Data Appendix for further details.

Table 2: Child health inputs

| | *Prenatal inputs* | | | | *Postnatal inputs* | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Total prenatal visits | Mother took iron supple-ments | Mother's total tetanus shots | Delivery at health facility | Postnatal check within 2 months | Child taking iron pills | Child's total vacci-nations | Pooled inputs | Child's Hb level | Years of schooling |
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) |
| India*2nd child | -0.448*** | -0.012 | 0.028 | -0.035*** | -0.010 | -0.002 | -0.073* | -0.005 | -0.103*** | 0.019 |
| | [0.056] | [0.008] | [0.017] | [0.006] | [0.013] | [0.005] | [0.042] | [0.004] | [0.029] | [0.016] |
| India*3rd+ child | -1.140*** | -0.095*** | 0.009 | -0.107*** | 0.012 | 0.003 | -0.342*** | -0.050*** | -0.146*** | -0.106*** |
| | [0.059] | [0.009] | [0.019] | [0.008] | [0.013] | [0.006] | [0.055] | [0.004] | [0.033] | [0.018] |
| 2nd child | -0.123*** | -0.005 | -0.095*** | -0.077*** | 0.020** | -0.004 | -0.064** | -0.033*** | -0.024 | 0.008 |
| | [0.031] | [0.005] | [0.012] | [0.004] | [0.010] | [0.004] | [0.028] | [0.002] | [0.021] | [0.010] |
| 3rd+ child | -0.536*** | -0.014*** | -0.204*** | -0.143*** | -0.019** | -0.022*** | -0.378*** | -0.079*** | -0.101*** | -0.041*** |
| | [0.032] | [0.005] | [0.013] | [0.004] | [0.010] | [0.005] | [0.032] | [0.003] | [0.023] | [0.009] |
| Africa mean of outcome | 3.828 | 0.617 | 1.406 | 0.469 | 0.293 | 0.112 | 6.187 | 0.627 | 10.145 | 1.999 |
| India mean of outcome | 4.031 | 0.687 | 1.867 | 0.449 | 0.090 | 0.055 | 6.593 | 0.754 | 10.271 | 3.613 |
| Household & age controls | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Observations | 120,570 | 122,977 | 122,530 | 173,772 | 39,248 | 95,986 | 127,544 | 802,627 | 91,505 | 265,352 |

Notes: Standard errors are clustered by household and appear in brackets. Asterisks denote significance: * $p < .10$, ** $p < .05$, *** $p < .01$. Control variables included are survey month controls, child age dummies, child age × India, household covariates, households covariates × India, mother's age at first birth, and mother's age × India (Column 10 does not include mother's age at first birth). In Columns 1-9, the sample includes children ages 1-59 months; the sample in Column 10 is comprised of children 7-14 years old. Total prenatal visits, mother took iron supplements, mother's total tetanus shots, and postnatal check within 2 months are only available for the youngest living child in the family; postnatal check within 2 months is collected in only 13 African surveys. Delivery at health facility, child taking iron pills, and total vaccinations are available for all births in the past 5 years; child taking iron pills is collected in only 10 African surveys; total vaccinations is only available for children ages 13-59 months. In Column 8, dummies for 4 prenatal and 3 postnatal inputs are pooled together to create the outcome. The dummies are: 1) total prenatal visits >4; 2) mother took iron supplements; 3) mother's total tetanus shots >1; 4) child was delivered at a health facility; 5) child is taking iron pills; 6) total vaccinations >7; 7) child had postnatal check within 2 months of birth. See Data Appendix for further details.

Table 3: Child gender and the birth order gradient in height

| | HFA z-score (1) | HFA z-score (2) | HFA z-score (3) | HFA z-score (4) | HFA z-score (5) | HFA z-score (6) | Pooled inputs (7) | Pooled inputs (8) |
|---|---|---|---|---|---|---|---|---|
| India | 0.151*** | | | -0.020 | -0.024 | | | -0.051*** |
| | [0.032] | | | [0.018] | [0.018] | | | [0.002] |
| India*Girl | -0.146*** | 0.039 | -0.144 | -0.182*** | -0.164*** | -0.128* | -0.041** | -0.008*** |
| | [0.044] | [0.133] | [0.167] | [0.023] | [0.023] | [0.071] | [0.016] | [0.003] |
| India*Girl*2nd child | -0.077 | -0.054 | 0.039 | | | | -0.005 | |
| | [0.063] | [0.062] | [0.220] | | | | [0.008] | |
| India*Girl*3rd+ child | -0.057 | -0.024 | 0.019 | | | | -0.008 | |
| | [0.056] | [0.069] | [0.198] | | | | [0.009] | |
| India*2nd child | -0.131*** | -0.132*** | -0.127 | | | | -0.003 | |
| | [0.044] | [0.044] | [0.139] | | | | [0.005] | |
| India*3rd+ child | -0.373*** | -0.217*** | -0.107 | | | | -0.047*** | |
| | [0.040] | [0.050] | [0.164] | | | | [0.006] | |
| Africa mean of outcome | -1.435 | -1.435 | -1.435 | -1.435 | -1.435 | -1.435 | 0.448 | 0.448 |
| Household & age controls | No | Yes | No | No | Yes | No | Yes | Yes |
| Mother FEs | No | No | Yes | No | No | Yes | No | No |
| Observations | 174,157 | 174,157 | 174,157 | 174,157 | 174,157 | 174,157 | 802,627 | 802,627 |

Notes: Standard errors are clustered by household and appear in brackets. Asterisks denote significance: * $p < .10$, ** $p < .05$, *** $p < .01$. Control variables included in all columns are survey month controls and child age dummies. Columns 2, 5, 7, and 8 additionally control for household covariates and mother's age at birth. Columns 2 and 7 also include household covariates, child age, and mother's age at birth interacted with *Girl*, *India*, and *Girl* × *India*. The main effect of *India* is included in Columns 2 and 7 but is not shown. In Columns 1-3 and 7, coefficients for *Girl*, *2nd child* and *3rd+ child* birth order dummies, the birth order dummies × *Girl* are included in the regression but are not shown. In Columns 4-6 and 8, the main effect of *Girl* is included in the regression but is not shown.

Table 4: Heterogeneity within India by son preference

| *Gender preference proxy:* | *Muslim* | *Kerala* | *Below-median child sex ratio* | *Muslim* | *Kerala* | *Below-median child sex ratio* |
|---|---|---|---|---|---|---|
| | HFA z-score | HFA z-score | HFA z-score | Pooled inputs | Pooled inputs | Pooled inputs |
| | (1) | (2) | (3) | (4) | (5) | (6) |
| Gender pref proxy*2nd child | 0.147** | 0.223* | 0.050 | 0.007 | 0.042*** | 0.018*** |
| | [0.067] | [0.132] | [0.046] | [0.008] | [0.009] | [0.005] |
| Gender pref proxy*3rd+ child | 0.203** | 0.249 | -0.061 | 0.032*** | 0.081*** | -0.021*** |
| | [0.081] | [0.206] | [0.057] | [0.009] | [0.014] | [0.007] |
| 2nd child | -0.153*** | -0.138*** | -0.153*** | -0.030*** | -0.030*** | -0.036*** |
| | [0.027] | [0.023] | [0.031] | [0.003] | [0.003] | [0.004] |
| 3rd+ child | -0.363*** | -0.325*** | -0.267*** | -0.117*** | -0.117*** | -0.100*** |
| | [0.033] | [0.029] | [0.038] | [0.004] | [0.003] | [0.004] |
| p-value: Gender pref proxy*2nd child + 2nd child=0 | 0.934 | 0.514 | 0.003 | 0.001 | 0.182 | 0.000 |
| p-value: Gender pref proxy*3rd+ child + 3rd+ child=0 | 0.031 | 0.710 | 0.000 | 0.000 | 0.010 | 0.000 |
| Sample | Hindus & Muslims | India | India | Hindus & Muslims | India | India |
| Household & age controls | Yes | Yes | Yes | Yes | Yes | Yes |
| Observations | 36,657 | 43,043 | 43,043 | 214,400 | 250,702 | 250,702 |

Notes: Standard errors are clustered by household and appear in brackets. Asterisks denote significance: * $p < .10$, ** $p < .05$, *** $p < .01$. The sample is restricted to India and control variables included are survey month controls, child age dummies, household covariates, mother's age at first birth, and household covariates, child age, and mother's age at birth × *Gender pref proxy*. The main effect of *Gender pref proxy* is included in all regressions but is not shown. *Child sex ratio* is defined as the number of boys aged 0-6 years over the number of girls aged 0-6 years in the respondent's state-by-region. In Columns45-6, dummies for 4 prenatal and 3 postnatal inputs are pooled together to create the outcome. See Data Appendix for further details.

Table 5: Heterogeneity by the gender of older siblings

| | Wants more children (1) | Wants more children (2) | HFA z-score (3) | HFA z-score (4) | Pooled inputs (5) | Pooled inputs (6) |
|---|---|---|---|---|---|---|
| India | -0.145*** | | 0.028 | | -0.120*** | |
| | [0.012] | | [0.056] | | [0.009] | |
| India*2nd child | -0.409*** | -0.427*** | -0.074 | -0.106** | -0.025*** | -0.016** |
| | [0.011] | [0.011] | [0.049] | [0.049] | [0.008] | [0.008] |
| India*3rd+ child | -0.314*** | -0.453*** | -0.281*** | -0.179*** | -0.091*** | -0.043*** |
| | [0.012] | [0.013] | [0.055] | [0.060] | [0.009] | [0.009] |
| India*Girl | -0.164*** | -0.118*** | 0.017 | 0.166 | | |
| | [0.019] | [0.033] | [0.078] | [0.151] | | |
| India*No older brother | -0.031*** | 0.013 | 0.123*** | 0.060 | -0.010 | -0.009 |
| | [0.010] | [0.009] | [0.045] | [0.044] | [0.008] | [0.007] |
| India*Girl*No older brother | 0.235*** | 0.224*** | -0.163** | -0.115* | | |
| | [0.015] | [0.015] | [0.064] | [0.064] | | |
| India*Prenatal input | | | | | 0.215*** | 0.163*** |
| | | | | | [0.011] | [0.020] |
| India*Prenatal input*No older brother | | | | | 0.019** | 0.015* |
| | | | | | [0.009] | [0.009] |
| Africa mean of outcome | 0.670 | 0.670 | -1.435 | -1.435 | 0.447 | 0.447 |
| p-value: India*No older brother + India*Girl*No older brother=0 | 0.000 | 0.000 | 0.412 | 0.247 | | |
| p-value: India + India*2nd child + India*No older brother=0 | | | 0.048 | | | |
| p-value: India + India*3rd+ child + India*No older brother=0 | | | 0.004 | | | |
| Sample | Mothers | Mothers | Children | Children | Girls | Girls |
| Household & age controls | No | Yes | No | Yes | No | Yes |
| Observations | 124,537 | 124,537 | 174,157 | 174,157 | 392,180 | 392,180 |

Notes: Standard errors are clustered by household and appear in brackets. Asterisks denote significance: * $p < .10$, ** $p < .05$, *** $p < .01$. Control variables included are survey month controls and child age dummies. Even columns control for mother's age at birth, household covariates, and household covariates, child age, and mother's age at birth × India. Columns 2 and 4 additionally include household covariates, child age, and mother's age at birth × *Girl* and *India*× *Girl*. Column 6 also includes household covariates, child age, and mother's age × *Prenatal input* and *Prenatal input*× *India*. The main effect of *India* is included in even columns but is not shown. All other main effects (*2nd child*, *3rd+ child*, *Girl*, *No older brother*, *Prenatal input*, and interactions) in addition to *India* × *Prenatal input* × *2nd child* and *India* × *Prenatal input* × *3rd+ child* are included but not shown. The sample in Columns 1-2 is mothers, and the child and sibling gender variables refer to the youngest child in the household (in the case that the youngest child is a twin or a triplet, the latest born is used). The sample in Columns 3-4 are all children aged 1-59 months. The sample in Columns 5-6 is children is girls aged 1-59 months. In Columns 5-6, dummies for 4 prenatal and 3 postnatal inputs are pooled together to create the outcome. See Data Appendix for further details.

Table 6: Heterogeneity by wealth and female empowerment

| *Heterogeneity:* | *Above-median wealth index* | *Above top 20% wealth index* | *Urban* | *Women's empowerment index* | *Mother completed primary educ.* | *Mother is employed* |
|---|---|---|---|---|---|---|
| | HFA z-score | HFA z-score | HFA z-score | HFA z-score | HFA z-score | HFA z-score |
| | (1) | (2) | (3) | (4) | (5) | (6) |
| India*Heterogeneity | -0.181 | -0.060 | -0.453*** | 0.356* | 0.268 | 0.181 |
| | [0.145] | [0.186] | [0.146] | [0.196] | [0.180] | [0.154] |
| India*2nd child*Heterogeneity | -0.278*** | -0.134* | -0.229*** | -0.059 | 0.017 | 0.027 |
| | [0.061] | [0.069] | [0.063] | [0.085] | [0.078] | [0.066] |
| India*3rd+ child*Heterogeneity | -0.216*** | -0.098 | -0.152** | -0.022 | 0.128 | -0.036 |
| | [0.071] | [0.089] | [0.075] | [0.099] | [0.092] | [0.076] |
| India*2nd child | -0.015 | -0.128*** | -0.066* | -0.129** | -0.162*** | -0.144*** |
| | [0.047] | [0.035] | [0.038] | [0.058] | [0.036] | [0.044] |
| India*3rd+ child | -0.158*** | -0.251*** | -0.162*** | -0.217*** | -0.253*** | -0.189*** |
| | [0.053] | [0.040] | [0.044] | [0.068] | [0.042] | [0.053] |
| Africa mean of outcome | -1.435 | -1.435 | -1.435 | -1.435 | -1.435 | -1.435 |
| Household & age controls | Yes | Yes | Yes | Yes | Yes | Yes |
| Observations | 174,157 | 174,157 | 174,157 | 139,248 | 174,149 | 171,156 |

Notes: Standard errors are clustered by household and appear in brackets. Asterisks denote significance: * $p < .10$, ** $p < .05$, *** $p < .01$. Control variables included are survey month controls, child age dummies, mother's age at birth, household covariates, and household covariates, child age, and mother's age at birth × *Heterogeneity*, *India*, and *India* × *Heterogeneity*. The main effect of *India*, *Heterogeneity*, the birth order dummies, the birth order dummies × *Heterogeneity* and *Heterogeneity*×*India* are included in the regression but are not shown. *Above-median wealth index* indicates that the child is from an African or Indian household that has a higher DHS wealth index value than the African or Indian sample median, respectively. Similarly, *Above top 20% wealth index* indicates that the child is from a household with a wealth index in the top 20% of the subsample median. *Woman's empowerment index* is the average of whether or not the mother has a say in decisions regarding own health care, large household purchases, household purchases for daily needs, and visits to see family or friends. See the Data Appendix for further details.

Appendix Table 1: Summary statistics

| | India subsample | Africa subsample | | India subsample | Africa subsample |
|---|---|---|---|---|---|
| Mother's age at birth (years) | 24.767 | 26.954 | Child's age (months) | 30.051 | 28.062 |
| | [5.239] | [6.857] | | [16.872] | [17.026] |
| Preceding birth interval | 36.075 | 39.363 | Girl | 0.479 | 0.496 |
| | [20.803] | [22.071] | | [0.500] | [0.500] |
| Mother's total children born | 2.745 | 3.876 | HFA z-score | -1.575 | -1.435 |
| | [1.829] | [2.543] | | [2.114] | [2.466] |
| Mother's height | 1.519 | 1.583 | Child stunted | 0.414 | 0.390 |
| | [0.058] | [0.069] | | [0.493] | [0.488] |
| Mother's consumption index (non-pregnant) | 1.924 | 2.246 | Child's hemoglobin level | 10.271 | 10.145 |
| | [1.096] | [1.331] | | [1.568] | [1.680] |
| Mother's consumption index (pregnant) | 1.861 | 2.265 | Child deceased | 0.050 | 0.072 |
| | [1.085] | [1.302] | | [0.217] | [0.259] |
| Mother's hemoglobin level | 11.582 | 12.023 | Child's years of schooling | 3.613 | 1.999 |
| | [1.731] | [1.829] | | [2.556] | [2.097] |
| Total prenatal visits | 4.031 | 3.828 | Child taking iron pills | 0.055 | 0.112 |
| | [3.483] | [3.095] | | [0.228] | [0.315] |
| Took iron supplements | 0.687 | 0.617 | Child's total vaccinations | 6.593 | 6.187 |
| | [0.464] | [0.486] | | [2.809] | [3.149] |
| Total tetanus shots | 1.867 | 1.406 | No diarrhea in last 2 weeks | 0.905 | 0.843 |
| | [0.941] | [1.202] | | [0.293] | [0.364] |
| Delivery at health facility | 0.449 | 0.469 | Open defecation | 0.456 | 0.322 |
| | [0.497] | [0.499] | | [0.498] | [0.467] |
| Postnatal check within 2 mos. | 0.090 | 0.293 | Urban dweller | 0.368 | 0.281 |
| | [0.287] | [0.455] | | [0.482] | [0.449] |
| Woman's empowerment index | 0.614 | 0.499 | ln(GDP/cap, birth year) | 7.735 | 6.891 |
| | [0.389] | [0.411] | | [0.125] | [0.653] |
| Mother is literate | 0.584 | 0.492 | Child sex ratio (India only) | 1.087 | – |
| | [0.493] | [0.500] | | [0.044] | – |
| Mother completed primary educ. | 0.144 | 0.376 | % non-resident among children | 0.023 | 0.098 |
| | [0.351] | [0.484] | | [0.039] | [0.086] |
| Mother is employed | 0.358 | 0.669 | Land scarcity | 5.035 | 2.617 |
| | [0.479] | [0.471] | | – | [1.143] |

Notes: The mean of the specified variables is calculated separately for the India subsample and the Africa subsample. Standard deviations appear in brackets. *Mother's total children born*, *Mother's height*, *Mother's hemoglobin level*, *Mother's consumption index*, *Women's empowerment induex*, *Mother is literate*, *Mother completed primary educ.*, *Mother is employed*, *DHS wealth index*, *% non-resident among children*, and *land scarcity* are summarized at the mother level.

Appendix Table 2: Birth order gradient in the India height gap: Robustness checks

| | Height in cm (1) | HFA z-score (2) | HFA z-score (3) | HFA z-score (4) | HFA z-score (5) | HFA z-score (6) |
|---|---|---|---|---|---|---|
| India*2nd child | -1.283*** | -0.244* | -0.269* | -0.155 | -0.259** | -0.314*** |
| | [0.341] | [0.143] | [0.156] | [0.185] | [0.122] | [0.111] |
| India*3rd+ child | -1.838*** | -0.375 | -0.453* | -0.416 | -0.363* | -0.507** |
| | [0.595] | [0.264] | [0.267] | [0.311] | [0.219] | [0.200] |
| 2nd child | -0.840*** | -0.386*** | -0.211* | -0.206*** | -0.245*** | -0.230*** |
| | [0.202] | [0.089] | [0.125] | [0.065] | [0.078] | [0.065] |
| 3rd+ child | -1.834*** | -0.830*** | -0.443** | -0.463*** | -0.553*** | -0.487*** |
| | [0.322] | [0.157] | [0.205] | [0.104] | [0.131] | [0.107] |
| Africa mean of outcome | 81.006 | -1.402 | -1.187 | -1.435 | -1.422 | -1.435 |
| Mother FEs | Yes | Yes | Yes | Yes | Yes | Yes |
| Child age*India | Yes | Yes | Yes | Yes | Yes | Yes |
| Sample | All | Birth order $\leq 4$ | Below median fertility | India PSU ultrasound mean<5% | Children have the same father | Birth order among living siblings |
| Observations | 174,157 | 126,003 | 82,441 | 141,750 | 112,794 | 174,157 |

Notes: Standard errors are clustered by mother and appear in brackets. Asterisks denote significance: * $p < .10$, ** $p < .05$, *** $p < .01$. Control variables included are survey month controls and child age dummies. The main effect of *India* is absorbed by a full set of *Child age*×*India* or mother fixed effects. In Columns 2-5, the sample restrictions are as follows: children of birth order 4 or less; children from African countries with below median fertility, plus India; children in Indian PSUs where less than 5 percent of mothers reported using ultrasound during pregnancy, plus Africa; children whose mothers (presumably) had children with only one partner. In Column 6, birth order is defined as the birth order among currently living siblings. See Data Appendix for further details.

Appendix Table 3: Alternate comparison samples: Similar GDP and Europe & West Asia

| *Comparison sample:* | *Countries with similar GDP* | | | *Europe & West Asia* | | |
|---|---|---|---|---|---|---|
| | HFA z-score (1) | HFA z-score (2) | HFA z-score (3) | HFA z-score (4) | HFA z-score (5) | HFA z-score (6) |
| India | -0.125*** | | | -1.021*** | | |
| | [0.022] | | | [0.031] | | |
| India*2nd child | -0.101*** | -0.090*** | -0.216** | -0.059* | -0.039 | -0.282** |
| | [0.028] | [0.029] | [0.107] | [0.034] | [0.034] | [0.124] |
| India*3rd+ child | -0.270*** | -0.113*** | -0.395** | -0.280*** | -0.095** | -0.633*** |
| | [0.028] | [0.034] | [0.191] | [0.033] | [0.040] | [0.226] |
| 2nd child | -0.031* | -0.050*** | -0.257*** | -0.073*** | -0.101*** | -0.207** |
| | [0.017] | [0.017] | [0.060] | [0.025] | [0.025] | [0.085] |
| 3rd+ child | -0.197*** | -0.226*** | -0.492*** | -0.187*** | -0.240*** | -0.286* |
| | [0.015] | [0.019] | [0.100] | [0.023] | [0.028] | [0.154] |
| Omitted group mean of outcome | -1.345 | -1.345 | -1.345 | -0.572 | -0.572 | -0.572 |
| HH covariates*India | No | Yes | No | No | Yes | No |
| Child age*India | No | Yes | Yes | No | Yes | Yes |
| Mother's age at birth*India | No | Yes | No | No | Yes | No |
| Mother FEs | No | No | Yes | No | No | Yes |
| Observations | 194,288 | 194,288 | 194,288 | 80,785 | 80,785 | 80,785 |

Notes: Standard errors are clustered by mother and appear in brackets. Asterisks denote significance: * $p < .10$, ** $p < .05$, *** $p < .01$. Control variables included are survey month controls and child age dummies. The main effect of *India* is included but not shown in Columns 2 & 5. In Columns 1-3, the omitted category includes DHS surveys (2004-2010) of countries with height data that had a log GDP per capita within in a 10% upper and lower bound of India's 2005-6 log GDP per capita in its survey year: Benin 2006, Bolivia 2008, Burkina Faso 2010, Cambodia 2005, Cambodia 2010, Cameroon 2004, Chad 2004, Egypt 2005, Ghana 2008, Haiti 2005, Honduras 2005, Kenya 2008, Lesotho 2004, Lesotho 2009, Mali 2006, Moldova 2005, Nigeria 2008, Sao Tome and Principe 2008, Senegal 2005, Senegal 2010, Tanzania 2010, Timor-Leste 2009, Zambia 2007, Zimbabwe 2005, Zimbabwe 2010. In Columns 4-6, the omitted category includes DHS surveys (1995-2012) of European/West Asian countries with height data available: Albania 2008-2009, Jordan 2012,2007 & 2002, Moldova 2005, Turkey 2003 & 1998, Kazakhstan 1999 & 1995, Kyrgyz Republic 2012 & 1997, Tajikistan 2012, and Uzbekistan 1996. In the Europe & West Asia sample, mother's literacy is only available for 5 countries, so we use mother completed grade 4 or higher as a control instead of mother's literacy in Column 5. This variable is coded as 0 if mother's literacy is available and the mother is illiterate.

Appendix Table 4: Alternative explanations: Mortality selection and open defecation

| | Deceased | No diarrhea in last 2 weeks | HFA z-score |
|---|---|---|---|
| | (1) | (2) | (3) |
| India*2nd child | 0.006* | -0.002 | -0.171*** |
| | [0.003] | [0.005] | [0.031] |
| India*3rd+ child | 0.011*** | -0.011** | -0.237*** |
| | [0.004] | [0.005] | [0.037] |
| 2nd child | -0.019*** | 0.001 | 0.007 |
| | [0.002] | [0.003] | [0.022] |
| 3rd+ child | -0.018*** | -0.010*** | -0.118*** |
| | [0.002] | [0.003] | [0.024] |
| 2nd child*Open defecation | | | 0.048 |
| | | | [0.034] |
| 3rd+ child*Open defecation | | | 0.032 |
| | | | [0.037] |
| Africa mean of outcome | 0.072 | 0.843 | -1.435 |
| Household & age controls | Yes | Yes | Yes |
| Observations | 199,665 | 173,570 | 168,840 |

Notes: Standard errors are clustered by mother and appear in brackets. Asterisks denote significance: * $p < .10$, ** $p < .05$, *** $p < .01$. Control variables included in all regressions are survey month controls, child age dummies, mother's age at birth, household covariates, and household covariates, child age, and mother's age at birth interacted with *India*. Column 3 additionally controls for household covariates, child age, and mother's age at birth × *Open defecation*. *Open defecation* is a dummy variable that equals 1 if the mother reports that the household has no toilet facility. In Column 1, the sample is restricted to children ages 13-59 months, as infant mortality is only defined for children over 1 year of age. See Data Appendix for further details.

Appendix Table 5: Alternative explanations: Maternal health, communal child-rearing, and land scarcity

| | HFA z-score (1) | HFA z-score (2) | HFA z-score (3) |
|---|---|---|---|
| India*2nd child | -0.144*** | -0.134*** | -0.178*** |
| | [0.033] | [0.034] | [0.055] |
| India*3rd+ child | -0.197*** | -0.204*** | -0.220*** |
| | [0.039] | [0.040] | [0.061] |
| 2nd child | -0.221 | -0.012 | 0.000 |
| | [0.391] | [0.029] | [0.046] |
| 3rd+ child | -0.579 | -0.145*** | -0.090* |
| | [0.439] | [0.032] | [0.050] |
| 2nd child*Mother's height | 0.151 | | |
| | [0.247] | | |
| 3rd+ child*Mother's height | 0.293 | | |
| | [0.277] | | |
| 2nd child* % non-resident among children | | 0.339 | |
| | | [0.209] | |
| 3rd+ child* % non-resident among children | | 0.458** | |
| | | [0.230] | |
| 2nd child*Land scarcity | | | 0.008 |
| | | | [0.017] |
| 3rd+ child*Land scarcity | | | -0.005 |
| | | | [0.019] |
| Africa mean of outcome | -1.435 | -1.435 | -1.435 |
| Household & age controls | Yes | Yes | Yes |
| Observations | 172,630 | 174,157 | 174,157 |

Notes: Standard errors are clustered by mother and appear in brackets. Asterisks denote significance: * $p < .10$, ** $p < .05$, *** $p < .01$. Control variables included in all regressions are survey month controls, child age dummies, mother's age at birth, household covariates, and household covariates, child age, and mother's age at birth interacted with *India*. Column 1 additionally controls for household covariates, child age, and mother's age at birth × *Mother's height*; Column 2 for household covariates, child age, and mother's age at birth × *% non-resident among children*; and Column 3 for household covariates, child age, and mother's age at birth× *Land scarcity*. *Land scarcity* is defined as the log of the respondent's country's total population in 1961 divided by its land area in square km in 1961.

Appendix Table 6: Mothers' food consumption and hemoglobin

| | Food consumption index (1) | Hemoglobin level (2) | Food consumption index (3) | Hemoglobin level (4) |
|---|---|---|---|---|
| India*Has 1 child | | -0.618*** | | |
| | | [0.199] | | |
| India*Has 2+ children | -0.140* | -0.952*** | | |
| | [0.081] | [0.238] | | |
| India*Has 1 child*Not pregnant | | 0.263 | | |
| | | [0.208] | | |
| India*Has 2+ children*Not pregnant | 0.093 | 0.509** | | |
| | [0.085] | [0.248] | | |
| Mother*Has 1 child | | | -0.053 | -0.483 |
| | | | [0.165] | [0.348] |
| Mother*Has 2+ children | | | -0.243 | -0.825** |
| | | | [0.195] | [0.420] |
| Mother*Has 1 child*Not pregnant | | | 0.053 | -0.139 |
| | | | [0.174] | [0.366] |
| Mother*Has 2+ children*Not pregnant | | | 0.228 | 0.053 |
| | | | [0.205] | [0.438] |
| Africa mean of outcome | 2.248 | 12.023 | | |
| p-value: India*Has 2+ children*Not preg | 0.069 | 0.000 | | |
| p-value: India*Has 1 child*Not preg | | 0.000 | | |
| p-value: Mother*Has 1 child*Not preg | | | 0.991 | 0.000 |
| p-value: Mother*Has 2+ children*Not preg | | | 0.803 | 0.000 |
| Sample | All | All | India | India |
| Household & age controls | Yes | Yes | Yes | Yes |
| Observations | 59,928 | 148,408 | 40,076 | 34,240 |

Notes: Standard errors are clustered by household and appear in brackets. Asterisks denote significance: * $p < .10$, ** $p < .05$, *** $p < .01$. In Columns 1-2, control variables included are survey month controls, household covariates, mother's age at birth, household covariates and mother's age at birth interacted with *India*, *Not pregnant*, and *India*Not pregnant*. In Column 1, the sample includes mothers who have given birth to at least 1 child in the last 3 years; data to construct the mother's food consumption index in a comparable way to India is available in 10 African surveys. In Column 2, the sample includes mothers who have given birth in the last 5 years or have never given birth; data on mother's hemoglobin level is available in 21 African surveys. In Column 3-4, the control variables included are household covariates, mother's age at birth, household covariates and mother's age at birth interacted with *India*, *Mother*, and *India* $\times$*Mother*. The sample includes Indian women who have given birth to at least 1 child in the past 5 years or have never given birth and their husbands, if both answered consumption questions. The omitted category is men whose wives have never given birth. See Data Appendix for further details.

# Data Appendix

## DHS surveys used

The data sets included from Sub-Saharan Africa are Democratic Republic of the Congo 2007 (V), Republic of the Congo (Brazzaville) 2005 (V), Cameroon 2004 (IV), Chad 2004 (IV), Ethiopia 2005 (V), Ghana 2008 (V), Guinea 2005 (V), Kenya 2008-9 (V), Liberia 2007 (V), Lesotho 2004 (IV), Lesotho 2009 (VI), Madagascar 2003-4 (IV), Mali 2006 (V), Malawi 2004 (IV), Niger 2006 (V), Nigeria 2008 (V), Namibia 2006-7 (V), Rwanda 2005 (V), Sierra Leone 2008 (V), Senegal 2005 (IV), Sao Tome 2008 (V), Swaziland 2006-7 (V), Tanzania 2004-5 (IV), Tanzania 2010 (VI), Uganda 2006 (V), Zambia 2007 (V), and Zimbabwe 2005-6 (V). The DHS questionnaire version (IV, V, or VI) is given in parentheses. The data set included from India is India 2005-6 (NFHS-3). For the analysis on child's educational attainment, surveys do not need to contain anthropometric variables, so 2 additional surveys are included, Benin 2006 (V) and Madagascar 2008-9 (V). Chad 2004 (IV) and Kenya 2008-9(V) do not have the necessary information to match children's educational attainment to their birth order information, and hence are excluded from this analysis.

## Height-for-age z-score

For comparing height across children of different gender and age, we create normalized variables using the World Heath Organization (WHO) method (WHO Multicentre Growth Reference Study Group, 2006). The WHO provides the distribution of height separately for boys and girls, by age in months from a reference population of children from Brazil, Ghana, India, Norway, Oman and the United States. Since child height have a skewed distribution, the WHO recommends a restricted application of the LMS method using a Box-Cox normal distribution. The formula used is as follows:

$$\text{z-score} = \frac{(\text{observed value}/M)^{L-1}}{L \times S}$$

The WHO provides the values of $M$, $L$ and $S$ for each reference population by gender and age. $M$ is the reference median value for estimating the population mean, $L$ is the power used to transform the data to remove skewness, and $S$ is the coefficient of variation.

## Child age

For all children whose anthropometric data are recorded, the DHS also provides measurement date. Our child age variable is in months, and is constructed by calculating the number of days elapsed between child's birth and measurement date, and then converting this age into months. When we refer to a child as $n$ months old, we mean the child is in its $n^{th}$ month of life such that a child who is one week old is in its 1st month of life, hence 1 month old.

## Birth order

Children of multiple births, such as twins or triplets, are assigned the same birth order. For a child born subsequent to a multiple birth, birth order is incremented by the size of the multiple birth. For example, the next child born after firstborn twins is birth order 3. We construct birth order based on children ever born, not on only surviving children.

## Sample restriction

The main sample includes children of age 1-59 who have anthropometric data. In Appendix Table 2, *Birth order* $\leq 4$ is the sample restricted to the children of birth order 4 or less. *Below median fertility* indicates that children are either from India or from African countries with below median fertility. Fertility level is calculated as the mean number of children per mother for each African survey. Then the median value among the African surveys is used to determine which surveys have below median fertility values. *India PSU ultrasound mean<5%* indicates that the Indian sample has been restricted to children living in PSUs with an average ultrasound usage of $< 5\%$ as reported by the mother. *Children have the same father* is the sample restricted to households in which all children presumably have the same father. Such

households meet the following conditions: the mother's total number of unions is 1, the firstborn child's age in years is smaller than or equal to the number of years since the parents' marriage, and the mother is currently married. *Birth order among living siblings* includes the sample of children who have at least one sibling in the main sample, and birth order is redefined including only living siblings.

## Maternal outcomes

*Wants more children* is coded as 1 if the mother indicated that she wants more children within 2 years, after 2 years, or at an unspecified time. It is coded as 0.5 if the mother said she is undecided whether she wants to have more children and 0 if she responded that she wants no more children or that she has been sterilized. This variable is missing if the woman is infecund or indicated that she never had sex.

*Mother's food consumption index* is constructed based on the DHS and NFHS variables on mother's food consumption. Mother's food consumption is available in 10 African DHS's (Ghana 2008, Liberia 2007, Nigeria 2008, Namibia 2006-7, Sierra Leone 2008, Sao Tome 2008, Swaziland 2006-7, Uganda 2006, Zambia 2007, and Zimbabwe 2005-6). These surveys asked detailed questions about food and liquid items consumed in the last 24 hours to mothers who have given birth in the last three years. Based on this, we create indicators for whether mother consumed something from the following five food groups in the previous day: eggs/fish/meat, milk/dairy, fruits, pulses/beans, and leafy vegetables. For instance, for the eggs/fish/meat group, eggs, fish, meat are three separate questions, so we create an indicator for whether mothers consumed any of the three food items for those who answered all three questions. The consumption index is generated by adding the five indicators. The NFHS has related but different questions about mother's food consumption. The survey asked all women how frequently they consume a specified food item. Hence we code daily consumption as 1, weekly consumption as 1/7, and occasionally and never as 0 to make the variable comparable to the ones from the African surveys. We generate variables indicating consumption of the same 5 food groups, and sum them to generate the consumption index. For comparisons with African surveys, we restrict the sample to women who are living with a child younger than 36 months to ensure the sample inclusion criterion is consistent across surveys. The NFHS also asked the same set of consumption questions to fathers, so Indian father's consumption is coded the same way.

*Mother's hemoglobin level* is collected for all women in some DHS's and the NFHS, and is available for a smaller sample of women whose household is selected for hemoglobin testing in other DHS's. Mother's hemoglobin level is available in 21 African DHS's and the NFHS. It is adjusted by altitude in all surveys except for Republic of the Congo (Brazzaville) 2005 (V), and measured in g/dl. We restrict the sample to women who have given birth in the last 5 years or never given birth.

## Prenatal variables

*Total prenatal visits* is collected for the most recent birth in the past 5 years. Hence, our sample is restricted to youngest living child from each family for this variable. It is available in all 27 African DHS's and the NFHS. It is the mother's self-report of the total number of prenatal visits during the pregnancy. It is 0 if the mother never went for a prenatal visit, and the maximum number of visits is top-coded at 20.

*Mother took iron supplements* is collected for the most recent birth in the past 5 years. It is available in all 27 African DHS's and the NFHS. It is the mother's self-report of whether she took iron supplements during the pregnancy of her youngest living child.

*Mother's total tetanus shots* is collected for the most recent birth in the past 5 years. The exception is the Democratic Republic of the Congo (2007), which collected it for all births in the past 5 years; we restrict the sample to the most recent birth to ensure consistency. It is available in all 27 African DHS's and the NFHS. It is the mother's self-report of the number of tetanus toxoid injections given during the pregnancy to avoid convulsions after birth. The DHS recorded having more than 7 injections as 7.

*Delivery at health facility* is collected for all births in the past 5 years. It is available in all 27 African DHS's and the NFHS. It is calculated based on the mother's self-report of where child was delivered. Delivery at a home is defined as a delivery at any home, including the respondent's home, her parents' home, traditional birth attendant's home or some other home. All deliveries that did not occur at a home is considered a delivery at health facility.

## Postnatal variables

*Postnatal check within 2 months* is collected for the most recent birth in the past 5 years. It is available in 13 African DHS's (Ghana 2008, Kenya 2008-9, Liberia 2007, Lesotho 2009, Nigeria 2008, Namibia 2006-7, Sierra Leone 2008, Sao Tome 2008, Swaziland 2006-7, Tanzania 2010, Uganda 2006, Zambia 2007, and Zimbabwe 2005-6) as well as the NFHS. It is the mother's self-report of whether the child received a postnatal check within 2 months after it was born.

*Child taking iron pills* is collected for all births in the past 5 years. It is available in 10 African DHS's (Ghana 2008, Kenya 2008-9, Liberia 2007, Nigeria 2008, Namibia 2006-7, Sierra Leone 2008, Sao Tome 2008, Swaziland 2006-7, Tanzania 2010, and Uganda 2006) as well as the NFHS. It is the mother's self-report of whether the child is currently taking iron pills.

*Child's total vaccinations* is collected for all births in the past 5 years. It is available in all 27 African DHS's and the NFHS. It is the mother's self-report of the total number of vaccinations the child has received to date. The vaccines counted include BCG, 3 doses of DPT, 4 doses of polio, and measles, so child's total vaccinations is 9 if the child received all vaccines. The sample is restricted to children age 13-59 months since the recommended age for the vaccinations is up to age 12 months.

*Pooled inputs* is a dummy variable that pools together all four prenatal inputs and three postnatal inputs. For inputs that are continuous, we take the value closest to the median value in our sample to create the dummy. The dummies the make up the variable are: 1) total prenatal visits >4; 2) mother took iron supplements; 3) mother?s total tetanus shots >1; 4) child was delivered at a health facility; 5) child is taking iron pills; 6) total vaccinations >7; 7) child had postnatal check within 2 months of birth.

## Child morbidity variables

*Infant mortality* is an indicator for whether the child is deceased is collected for all births in the past 5 years. It is available in all 27 African DHS's and the NFHS. It is the mother's self-report of whether the child is deceased. The sample is restricted to children age 13-59, as infant mortality is only defined for children over 1 year of age.

*Diarrhea in last 2 weeks* is collected for all births in the past 5 years. It is available in all 27 African DHS's and the NFHS. It is the mother's self-report of whether the child had diarrhea in the 2 weeks before the survey.

## Other variables

*Child sex ratio* is calculated as the number of boys aged 0-6 years old over the number of girls aged 0-6 years old in the respondent's state-by-region (either urban or rural) and comes from the 2011 Indian census. Higher values indicate greater gender imbalance favoring boys, so *Below-median child sex ratio* suggests greater equality in the state-region.

*DHS wealth index* is calculated by the DHS as a measure of a household's cumulative living standard. It is based on a household's ownership of selected assets, such as televisions and bicycles; materials used for housing construction; sources of drinking water; and toilet facilities. Through principal components analysis, the DHS assigns a factor score to each of the assets, generating a standardized asset score specific to each survey. Then households in the survey are scored based on their ownership of assets using these standardized asset scores.

*Women's empowerment index* is constructed as the average of four dummies indicating whether or not the woman has sole or joint (either with the husband or with someone else) decision-making power in decisions regarding her own health care, large household purchases, household purchases for daily needs, and visits to see family or friends. It is available for India and 23 African DHS's. It is not available for the Republic of Congo 2005, Chad 2004, Tanzania 2010, and Liberia 2007.

*Preceding birth interval* is the number of months between the mother's second or higher birth and the birth directly preceding it. It is calculated using the age of the mother's children and is top-coded at 120 months.

*Open defecation* is available for all births in the past 5 years in the full sample of 27 African DHS's and the NFHS. It is the mother's self-report of whether the household has no toilet facility.

*Mother's height* is measured for mothers of children born in the 5 years preceding the survey. It is available in all 27 African DHS's and the NFHS. Mother's height is converted to meters and is coded as

missing if the height is less than 1.25 meters.

*% non-resident among children* is calculated as the percentage of children aged 10 years or lower who are living outside of the household, calculated at the level of primary sampling unit (PSU). Children's age and whether they are living in the household are available in the full sample of 27 African DHS's. Each mother's total number of living children 10 years old or younger are calculated, and summed at the PSU level. Then the percentage of such children living outside of the household is calculated.

*Land scarcity* is the calculated as the log of each country's total population in 1961 over its land area in square km in 1961 and comes from the Food and Agriculture Organization of the United Nations (FAO).

*Mother is literate* is available for all births in the past 5 years in the full sample of 27 African DHS's and the NFHS. It is the mother's self-report of whether she can read in any language.

*Children's years of education* uses DHS data on years of schooling of household members aged 7 to 14. This analysis includes 2 additional DHS data from Sub-Saharan Africa, which were previously excluded because they did not provide anthropometric data. Years of schooling data are obtained from the DHS Household Member Recode file, and birth order data are obtained the Birth Recode file. Only those children who can be linked across the two files (i.e., have non-missing values of their own and their mother's line number variable in both files) are included. Furthermore, if the reported age of the child in the two data sets differs by more than 3 years, we exclude the child from the analysis because either the age or line number variable is likely incorrect. Thus, the education sample includes children that can be matched across files whose age, gender, and years of education are not missing, who are aged 7-14 years, and who are from India or Sub-Saharan Africa. Age 6 or 7 is the standard school entry age in most of the countries in the sample. The DHS asks for each household member's highest education level attained, excluding preschool. Based on the highest level of schooling completed and the duration of each level of schooling by country, we compute the total years of schooling the child completed. If the difference between the child's age and his or her years of schooling is less than 4 years, implying he or she entered primary school before age 4, we top-code years of schooling at the child's age minus 4 because the reported value is likely erroneous.