Why Are Indian Children So Short?*

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Abstract

We examine height-for-age for 170,000 Indian and African children to understand why, despite two decades of sustained economic growth, the child malnutrition rate in India remains among the highest in the world. First, we show that Indian firstborns are actually taller than African firstborns; the Indian height disadvantage appears with the second child and increases with birth order. The patterns hold even when we only use between-sibling variation. Second, the birth order patterns vary with child gender and siblings' gender. Specifically, the Indian firstborn height advantage only exists for sons. In addition, daughters in India with no older brothers show the sharpest height deficit relative to African counterparts; their parents are likely to have more children than planned in order to try for a son. These patterns suggest that the cultural norm of eldest son preference, which causes parents to differentially allocate resources across children by birth order and gender, keeps the average Indian child short.

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1 Introduction

Taller children grow up to earn more and lead healthier lives, on average. These long-run advantages of child height are closely linked to childhood nutrition, which has a strong influence on cognitive development and later-life disease.[1]

These facts are troubling for the world's second most populous country, India. Half the country's population is under the age of 25 and much has been made of India's potential demographic dividend when these cohorts enter the labor force. But India also has the fifth highest stunting rate in the world (UNICEF, 2013). Between 1992 and 2005, stunting declined by just 0.77 percentage points per year (Masset and Haddad, 2013); the most recent estimates find that 40 percent of Indian children age five years and younger are stunted (IIPS, 2010).[2] Moreover, as Figure 1 shows, Indian (and more broadly South Asian) children are shorter than those born in other low-income regions such as Sub-Saharan Africa. This pattern is despite the fact that India outperforms Africa on most other health and socioeconomic indicators ranging from infant mortality, maternal mortality and life expectancy to food security, poverty incidence, and educational attainment (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 show the importance of birth order and gender in explaining the Indian case. Our first finding is 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 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

[1]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) tracked a cohort of Guatemalan children for over 30 years and find that taller individuals 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 et al., 1956).

[2]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.

differences between smaller and larger families.

Next, we examine the role of child gender. The firstborn height advantage in India only exists among sons. Further, later born children daughters who only have sisters as elder siblings have an especially high stunting rate. These differences are large enough to imply that, on average, the Indian height deficit (relative to Africa) is driven by girls. Note that this pattern is the opposite of the "sibling rivalry" prediction where having older sisters is associated with better outcomes for girls (Garg and Morduch, 1998).

The variation in child height within families casts doubt on either genetics or access to health-promoting infrastructure and services as the explanation; genotypes and access to services are unlikely to vary systematically with child birth order. Rather, our findings strongly point to a role for parental allocation of resources in driving child malnutrition in India. We use the DHS survey data to consider an array of prenatal and postnatal health inputs including prenatal checkups, maternal iron supplementation, and childbirth at a health facility as well as postnatal checkups and child vaccinations. As with child height, these investments exhibit a much stronger drop-off with birth order in India than Africa.[3]

We propose that a preference for eldest sons in India underlies these within-family patterns. Indian parents' favoritism for eldest sons is well-documented and has been attributed to the patrilineal and patrilocal kinship system (Dyson and Moore, 1983; Gupta, 1987) and the Hindu requirement that only a male heir can light the funeral pyre (Arnold et al., 1998).

Eldest son preference generates a birth order gradient among boys simply because a lower birth order son is more likely to be the family's first son. We also observe a birth order gradient among girls, and eldest son preference generates this pattern in a different, more subtle way, namely via fertility stopping rules. For a family seeking an eldest son, a girl born at late parity means they will likely try again for a son and have a larger family than expected; in other words, the birth of a late-parity girl is an expenditure shock to the family, and fewer resources are spent on her. Consistent with this behavior, the India-Africa height gap is particularly large for girls who only have girls as elder siblings.

Our explanation for the height patterns in India is about preferences—in particular eldest son preference. We also test several alternative explanations. First, we consider whether Indian women are less healthy at the onset of childbearing, with negative impacts

[3] In addition, later in life, we see a steeper birth order drop-off in parents' investment in their children's education among Indians relative to Africans.

on child health that compound with subsequent births. Using a mother's height as a measure of her health stock, we do not find support for this explanation.

A second alternative is that the patterns are due to budget constraints, either household income or prices. For example, if families have limited ability to borrow and save, then even with identical preferences, the child height patterns could emerge if the time profile of income declines more steeply (or increases less steeply) for families in India relative to Africa. Indian families might simply not have the financial resources to spend on later-born children. Two pieces of evidence militate against this explanation. First, we analyze food consumption patterns of Indian and African mothers and find a relatively greater decline in food consumption among Indian mothers as family size increases. However, this decline is concentrated among pregnant women, suggesting an explicit decline in investments in pregnant women rather than a generalized decrease in financial resources (or even treatment of women). Second, comparing the food consumption of Indian women and their husbands, we find that the pattern of food consumption declining as the family size increases is concentrated only among pregnant women and not their husbands.

A third hypothesis is that there are smaller economies of scale in care-giving in India. For example, child rearing is often more of a community affair in Africa, with extended family caring for an older child when a mother has a newborn. Using the proportion of children who live outside their biological parents' home as a measure of communal care-giving, we find that the practice is indeed higher in Africa and beneficial to later-born children, but quantitatively, it explains a negligible amount of the India-Africa height gap.[4]

This paper makes several contributions. First, we add to the literature on the causes of India's high rate of child malnutrition.[5] Our results on within-family patterns support the environment side of the the genes-versus-environment debate, and therefore are complementary to papers such as Spears (2013), which points to open defecation as an environmental

[4] We also show that mortality selection, whereby shorter Indian children survive at a higher rate than their African counterparts, cannot explain the results. Another explanation we consider is that Africa is more land abundant than India, leading parents to invest more evenly in their children; we do not find empirical support for this explanation.

[5] One approach has been to ask whether the rate is really as high as Indians' short stature would suggest, testing for the potential role of genetics by examining 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).

explanation for India's high rate of stunting.[6] Our focus on parental choices regarding resource allocation across children is related to Mishra, Roy, and Retherford (2004) who also examine intra-household patterns, using earlier rounds of the Indian DHS to show that stunting in India varies with the gender composition of siblings. 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 the mother facing greater discrimination.

Second, we add to the growing literature on the ramifications, including unintended ones, of the demand for sons in India (Sen, 1990; Clark, 2000; Jensen, 2003; Jayachandran and Kuziemko, 2011). In this case, son preference causes inequality in health inputs and outcomes even among sisters. Third, we contribute to a much broader literature on inequality in parental allocations among children (Rosenzweig and Schultz, 1982; Behrman, 1988; Garg and Morduch, 1998). Finally, we add to a literature on the effects of birth order, 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). Our contribution to this literature is to show how birth order effects are amplified by son preference and how they account for the entire height gap between Indian and African children.

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 patterns. Section 6 concludes.

2 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

[6]Spears (2013) shows that the high rate of open defecation in India helps explain the high rate of child stunting. There are reasons to think this channel could contribute to the birth order gradient, for example if older siblings expose younger siblings to disease or if the childcare of higher birth order children is less vigilant. However, empirically, open defecation has smaller effects or no differential effects on height for higher birth order children.

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). The data appendix provides details.

The surveys sample and interview mothers who are 15 to 49 years old at the time of survey. Child height and weight are collected for respondents' children who were under five years of age at the time of the interview.[7] 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 anthropometric 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.[8] A z-score of -1 indicates that the child is 1 standard deviation below the reference-population median for his or her gender and 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.[9]

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

[7] The DHS nominally collects anthropometric data for children less than 60 months old, but many children who are in their 60th month of life are missing anthropometric data. Hence we limit the sample to children who are 59 months old or younger, or have not completed 59 months of life.

[8] 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).

[9] The DHS also collects data on mother height and hemoglobin levels. On average, Indian women are 7 cm shorter than African women and have lower hemoglobin levels (11.6 versus 12.0).

inputs and outcomes for young children including whether he or she received a postnatal checkup within the first two months, whether he or she was given iron supplementation, and the total number of vaccinations.[10] India has higher vaccination rates while child iron supplementation is more common in Africa. Finally, we use data from the NFHS and DHS for ten African countries on mother's food consumption, namely how often she ate particular kinds of foods such as fruits, milk products, leafy vegetables and meat or eggs, to construct a maternal nutrition index.

We also examine infant mortality and children's schooling as outcomes. For infant mortality, the sample includes all alive or deceased children, excluding those whose date of birth is less than one year before the survey date; the outcome of whether the child died before age one is not fully determined until he or she reaches (or could have reached) age one year.[11] For children's years of education, we use a sample of children age 7 to 14.[12] Average years of schooling is 3.6 years in India and 2.0 years in Africa.

3 India's differential birth order gradient

3.1 Child height

Figure 2 presents our key finding graphically by comparing the raw mean of child height-for-age (HFA) z-scores in India and Africa, separately by birth order. Among firstborn children, HFA is higher in India than Africa. An Indian deficit emerges at birth order 2 and widens for birth order 3 and higher.

In Table 1 we turn to the regression analysis. In column (1) we show the average difference in height between India and Africa for children under age 5: the Indian height advantage for firstborns combined with the Indian height disadvantage for later-born children imply that Indian children are, on average, 0.11 standard deviation shorter than African children.

In column (2) we disaggregate this height disadvantage by birth order. We estimate the

[10] 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.

[11] The infant mortality sample consists of children age 13 to 59 months and includes 199,696 children. The rate is 5 percent in India and 7 percent in Africa.

[12] 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.

following equation where the outcome variable is height-for-age for child i born to mother m in country c.

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

The variable I_c is an indicator for Indian children. α_1 is the India gap for firstborn children (omitted birth order category) and α_2 and α_3 capture how the gap differs for second-born children and third-and-higher birth order children. The regression includes a vector Y_c which consists of linear, quadratic and cubic terms for a continuous survey month-year variable, to control for the different timing of surveys. We also include dummy variables for the child's age in months C_{imc}, to adjust for any sampling differences between India and Africa. In all cases, 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-family comparisons could be proxying for high-fertility families. In column (3) we include three household covariates and their interactions with the India dummy – an index of the household's wealth, whether the mother is literate, and whether the household is in a rural area. The coefficients on $I_c \times 2ndChild$ and $I_c \times 3rd{+}Child$ diminish in magnitude but remain strongly significant, suggesting that total fertility and household socioeconomic status have a differential correlation with malnutrition in India compared to Africa.

Another concern relates to mother's age. Higher birth order children are born when their mothers are older, so the birth order gradient might actually reflect an India-Africa gap in the effect of maternal age on child height. Another concern is that birth order and child age are correlated; among siblings in the sample, the higher birth order child will, by definition, be younger. We thus test the robustness to controlling for $I_c \times MotherAge$ dummies, where mother's age is measured in five-year bins, and $I_c \times ChildAge$ dummies, where child age is measured in months. As seen in column (4), the coefficients on $I_c \times 2^{nd}Child$ and $I_c \times 3^{rd+}Child$ are essentially unchanged when adding these controls.

Finally, we consider a specification where we only use within-family variation for identification. Column (5) includes mother fixed effects along with child age dummies interacted with India. The Indian birth order gradient remains statistically significant and, in fact, increases in magnitude relative to columns (3) and (4). This suggests that the unobserved differential selection of Indian households into higher fertility, conditional on the household covariates, is positive. The mother fixed effects results in column (5) are quite similar to the unadjusted results in column (2). Note that column (6) also shows that there is a 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. What column (5) reveals that was not previously known is that 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 also care specifically about stunting, which is a marker of malnutrition. Column (6) presents the mother fixed-effects results using stunting (HFA z-score ≤ -2) as the outcome. Relative to their African counterparts, the disadvantage for Indian secondborns 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 shows that we find similar patterns using height in centimeters as the outcome.

Appendix Table 2 also presents a series of robustness checks. Fertility is higher in Africa than India, so one might worry that this difference is driving the results. First, we drop very high birth-order children and re-run the mother fixed effect specification restricting the sample to children who are birth order 4 and below (column (2)). Second, we restrict 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 (column (3)). In both cases, the coefficients are less precisely estimated with the smaller samples, but the point estimates remain very similar to the specification in Table 2, column (5). 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 sampling units where in fewer than 5 percent of cases, mothers reported having an ultrasound during pregnancy. (There are no ultrasound data in the African DHS data.). Again, the standard errors become larger but the point estimates remain similar.[13]

3.2 Child investments

The fact that firstborn children in India are no shorter than firstborn children in Africa—and in fact are *taller*—casts doubt on the genetic-based explanation for Indian stunting, since no obvious genetic theory suggests that genes express themselves differently on first births; any purely genetic (as opposed to epigenetic) difference would likely materialize in children of all birth orders. Moreover, take-up of services not access *per se* seems to underlie the patterns: We find strongly declining investment in subsequent children in India.

Columns (1) to (4) of Table 2 examine retrospective information about health inputs in utero and childbirth conditions. Note that the sample for these outcomes is typically smaller than for our height analysis since most questions are asked only for the youngest child in the family, which also precludes mother fixed effects specifications. To address selection concerns, all regressions include our set of three household covariates (wealth index, female literacy, and rural residence) and their interactions with the India dummy. Also, note that we are not claiming that intrahousehold variation in these health inputs is causing intrahousehold variation in height; rather, the purpose of analyzing health inputs is to show more directly that the resources parents allocate to their children falls sharply with birth order in India.

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 each of these outcomes 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 the other outcomes examined in columns (2) to (4). The magnitude of these gradients is large enough that for two of the three inputs where the India

[13]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, when we restrict the sample to mothers who have only had children with one partner, we find similar results (Appendix Table 2, column (5)). Another robustness check we perform relates to the definition of birth order. We define birth order as among ever-born children because mortality is endogenous. Child mortality is higher in Africa, though, so a child's position among surviving children, given birth order, might differ between the regions. Column (6) shows that our results hold when we define birth order instead among all currently living children.

average exceeds the Africa average (prenatal visits and iron supplementation), later-born Indian children actually get fewer inputs than their African counterparts.[14]

We next consider postnatal investments in Columns (5) to (7) of Table 2.[15] On average, Indian mothers are less likely to seek postnatal health care within two months of childbirth and while their children are less likely to take iron pills, they are more likely to get vaccinated. For both postnatal checkups and vaccinations, we see a significant decline with birth order in India relative to Africa (the effect is similar but statistically insignificant for iron supplementation). In column (8), we pool the two postnatal outcomes for which we have observations for multiple children, whether the child is taking iron pills and vaccinations, and in column (9) show that the patterns using the pooled inputs are robust to including mother-by-input fixed effects.[16]

We also 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 different sample, comprised of children of school-going age who are 7 to 14 years old at the time of the survey. The regression specification controls for child age in years rather than months but is otherwise the same. The education patterns (column (10)) also show a stronger birth order gradient, although only beginning with thirdborns.

4 Patterns by gender: The role of eldest son preference

4.1 Results by child gender

In this section, we present evidence that the patterns of investments and child outcomes seem to stem from cultural norms of gender discrimination, specifically son preference in India.

Table 3, column (1) examines whether the strong Indian birth order gradient is concentrated among boys or girls. Two patterns can be seen. First, the Indian birth order gradient is similar for boys and girls; the triple interactions of India, higher birth order, and

[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).

[16] For comparability when stacking the outcomes, we use a dummy for having above the sample median number of vaccinations, which is 7.

a dummy for being a girl, are negative but small and statistically insignificant. Second, the India-Africa gap is concentrated among girls. The main effect for India is 0.15; firstborn Indian boys are on average 0.15 z-score points taller than their African counterparts. Meanwhile the coefficient on $India * Girl$ is -0.15. Firstborn Indian girls have no advantage over their African counterparts.[17] In column (2) we see that these patterns are similar but less precise with household covariates added.

The large negative coefficient $India{*}Girl$ is consistent with India's well-documented son preference. Moreover, the fact that sons born at birth order 1 do especially well is consistent with the specific preference for eldest sons in India. A birth order 1 son is necessarily the family's eldest son, but of course not all eldest sons are born at birth order 1. Thus, the next columns explicitly decompose the effects by eldest sons, other sons, girls born before the eldest son and girls born after the eldest son. As seen in Table 3, columns (3) and (4), eldest sons in India do better than their counterparts in Africa, but non-eldest sons and all daughters do worse.

4.2 Results by composition of elder siblings

The fact that Indian parents place very high value on their eldest son will clearly generate a birth order gradient among boys born to them (relative to African counterparts). The mechanism through which eldest son preference leads to a birth order gradient among girls is different: Indian parents revise their fertility decisions based on child gender. When parents only have daughters, they will change their total fertility plans to try again for a son. Given limited resources, this means that they will have fewer resources to spend on these later-born children and will, in particular, hold back on spending on later-born girls to save for the prospective eldest son.

Table 4 tests this hypothesis by examining how, conditional on birth order, the composition of one's older siblings affects outcomes. Specifically, we include interactions with a dummy for all of a child's elder siblings being girls. For a boy, this variable equaling 1 indicates he is the family's eldest son. For a girl, it indicates that the family has not yet had an eldest son. Columns (1) and (2) first show how gender composition affects fertility plans. The outcome is the mother's response about whether she wants more children. A family

[17] Pooling children of all birth orders, Indian and African boys are the same height but the India-African height gap is -0.18 among girls.

that has just had their eldest son reports a reduced desire for more children. Meanwhile, for girls (triple interaction of *India*, *Girl*, and *All elder sibs are girls*) is large, positive, and statistically significant. The birth of a girl is associated with wanting to have more children.[18] Note that these specifications control for birth order and its interaction with India, so these results are not simply recasting the birth order patterns. Conditional on birth order, the sex composition of existing children has strong effects on fertility continuation in India and, as we will see, on height.

Columns (3) and (4) show that child height matches these patterns. For a boy, having only older sisters leads to a height advantage, whereas for girls, the opposite holds. Interestingly, this pattern is the opposite of the "sibling rivalry" hypothesis that having sisters (relative to brothers) increases the resources enjoyed by a girl (Garg and Morduch, 1998). Our results suggest that the basic problem with that hypothesis is that it fails to account for the fact that family size is endogenous to the gender composition of siblings. Columns (5) and (6) consider the pooled postnatal inputs of taking iron pills and child vaccinations. We observe a similar pattern, though the estimated gender differential effects are sensitive to the inclusion of household covariates in column (6). In columns (7) and (8) we examine years of schooling as the outcome. While girls and boys younger than the eldest son get similar levels of schooling, a gender gap is present when the first few children in the family are girls. Specifically, a son who only has sisters as older siblings receives 0.13 to 0.17 more years of schooling.

Another prediction of this fertility stopping mechanism is that when the low birth order children are all are girls and thus the parents have to have a larger family size than expected in order to obtain a son, there are fewer resources to spend on even an eldest son who is later birth order than one who is earlier birth order. The assumption here is that families still do provide some resources to daughters. Such a pattern is evident in the earlier results presented in Table 3. In column (1), the main effect of 0.15 is for eldest sons who are born at birth order 1; in column (3) the main effect is for all eldest sons, and the coefficient of 0.09 is smaller. It is important to note that eldest son preference does not explain the all of the patterns we observe, though. Table 3, columns (3) and (4) showed that girls born after the eldest son are shorter than girls born before him, suggesting that birth order per

[18] Appendix Table 5 shows the well-known fact that having only daughters is a positive predictor of continued fertility in India.

se matters too. Nonetheless, eldest son preference, which affects resource allocation and fertility stopping behaviors, seems to be a key factor behind the strong birth order gradient in height in India.

4.3 Comparison of subgroups in India that vary in son preference

India has stronger son preference than Africa, but eldest son preference also varies within India. In Table 5, we ask whether the birth order gradient in height is stronger for subpopulations with stronger son preference. First, we compare Hindus to Muslims. Several papers find that son preference is stronger among Hindus; for example the sex ratio is less skewed among Muslims than Hindus. Column (1) shows that the birth order gradient is more muted for Muslims than Hindus, consistent with the hypothesis that son preference is at the root of the strong birth order gradient in India. In column 2, we compare the Indian states where matrilineal population groups reside —Kerala and states in the Northeast— to the rest of India. The positive point estimates on matrilineality interacted with higher birth order are as predicted, but the coefficient is only significant for the third and higher coefficient. Finally, we examine heterogeneity by the child sex ratio, calculated for each state-by-urban cell (which is the granularity with 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 negative interaction effects, or a stronger birth order gradient when the sex ratio is higher. Here we find mixed results; the secondborn interaction term is negative and marginally significant but the thirdborn interaction is positive though insignificant.[19]

5 Alternative explanations

This section tests other potential explanations for the within-family patterns we have shown.

Mortality selection

Mortality selection could explain the India height deficit if relatively weak (and short) children have a higher survival rate in India compared to Africa, causing the surviving children to be shorter in India. For mortality selection to explain the birth order patterns

[19] Jayachandran (2014) discusses the limitations of using the sex ratio as a proxy for son preference given that, because of eldest son preference, the sex ratio decreases sharply with desired total fertility.

we find, India's infant survival would need to be especially high for later-born children since this is where the Indian height disadvantage is largest. In column (1) of Appendix Table 3 we show that there is no differential birth order gradient in infant mortality between India and Africa. Thus, mortality selection cannot account for the height gradient.

Deteriorating maternal health

A different explanation is that women's predetermined health is worse in India than in Africa and with successive childbirths, women's health deteriorates more rapidly to the detriment of infant health. This mechanism is related to the gradual catch-up hypothesis of Deaton and Drèze (2009), who propose 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. We test whether mothers' childhood malnutrition and poor health, as proxied by their height, has differential effects by birth order.

Column (1) of Appendix Table 4 presents interactions between the mother's height and birth order. The prediction is not that there is a differential effect of height by birth order in India, but rather that there is an effect of height by birth order, which can explain or "knock out" the stronger birth order gradient in India since women are on average (seven centimeters) shorter in India than in Africa. The key coefficients are the interactions of mother's height and the birth order dummies. The signs of the coefficients are positive but small and statistically insignificant and the coefficients on India interacted with higher birth order dummies remain relatively unchanged by the addition of the maternal height variables.

Time-varying budget constraints

Higher birth order children are born later in their parents' lives, on average, and the resources available to spend on them could differ depending on the time profile of income for the household. If families could save and borrow freely, then the timing of income should not affect the available resources for each child, but families in both India and Africa likely have limited ability to smooth consumption intertemporally. Thus, if Indian families have relatively less income than African parents at the time later born children are born, then this could lead to fewer resources to spend on these children and worse outcomes for them. Note that the relevant dimension for the "time" profile is age, or more specifically marriage duration, rather than calendar time. A related idea, which seems less plausible but is technically possible, is that the time profile of prices differ between regions, with relative prices in India rising with time, which allows African parents to invest relatively more in later born children.

This is perhaps the most challenging alternative to test with our data; while we can compare child height across siblings, we do not have time-varying measures of household income or wealth that capture the family's resources when those siblings were born. Instead, to test this budget constraint hypothesis, we examine mothers' nutritional inputs and outcomes, comparing periods when they are pregnant versus not pregnant. 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.

To implement this test, we use recall data on mothers' food consumption, which was collected for mothers who have given birth in the last three years. We create a consumption index which average 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. Our sample is African and Indian mothers, and we allow effects to vary depending on whether the woman is currently pregnant. As consumption questions were only asked of women who had given birth, our sample excludes women who have no children or are pregnant with their first child.

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). The declines in consumption are concentrated among Indian women pregnant with their third or higher birth order child. The point estimates suggest a much smaller relative decline in consumption among non-pregnant Indian mothers. (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). This 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 but the gradient is reversed among non-pregnant women. The evidence in Table 6 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.[20] The patterns in columns (3) and (4) mirror those in columns (1) and (2). We observe that the consumption declines in India as family size increases are concentrated among women and do not extend to their husbands. Again, the gap between women's and men's 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.

Communal child-rearing

Another constrained resource is time. Parents might have less time to take care of later-born infants because they also have older children to 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 4, 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.

[20] 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.

Disease environment

Another potential explanation is that later born Indian children face a worse disease environment. In particular, recent work points to the high rate of open defecation in India as a contributor to the prevalence of child stunting (Spears, 2013). Perhaps, even if the family's sanitation infrastructure does not change over time, later-born children have more exposure to disease because older siblings expose them to pathogens or they receive care from inferior caregivers. Appendix Table 3, column (2) examines whether there is a stronger birth order gradient in diarrhea in India. The results suggest that later born children in India are less likely to have had diarrhea in last two weeks, according to their mother. Column (3) looks directly at whether open defecation (statistically) explains 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. Note that this does not mean that open defecation is not part of the explanation for low child height in India; absent open defecation, the intercept term for India could be higher.

Land scarcity

The last alternative we test 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 4, 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. The fact that the decline is concentrated among pregnant women and children, and non-pregnant women and men are less affected, suggests that a preference over children rather than a gradient in financial resources or increasing mistreatment of women drives the height patterns. 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 three 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 7 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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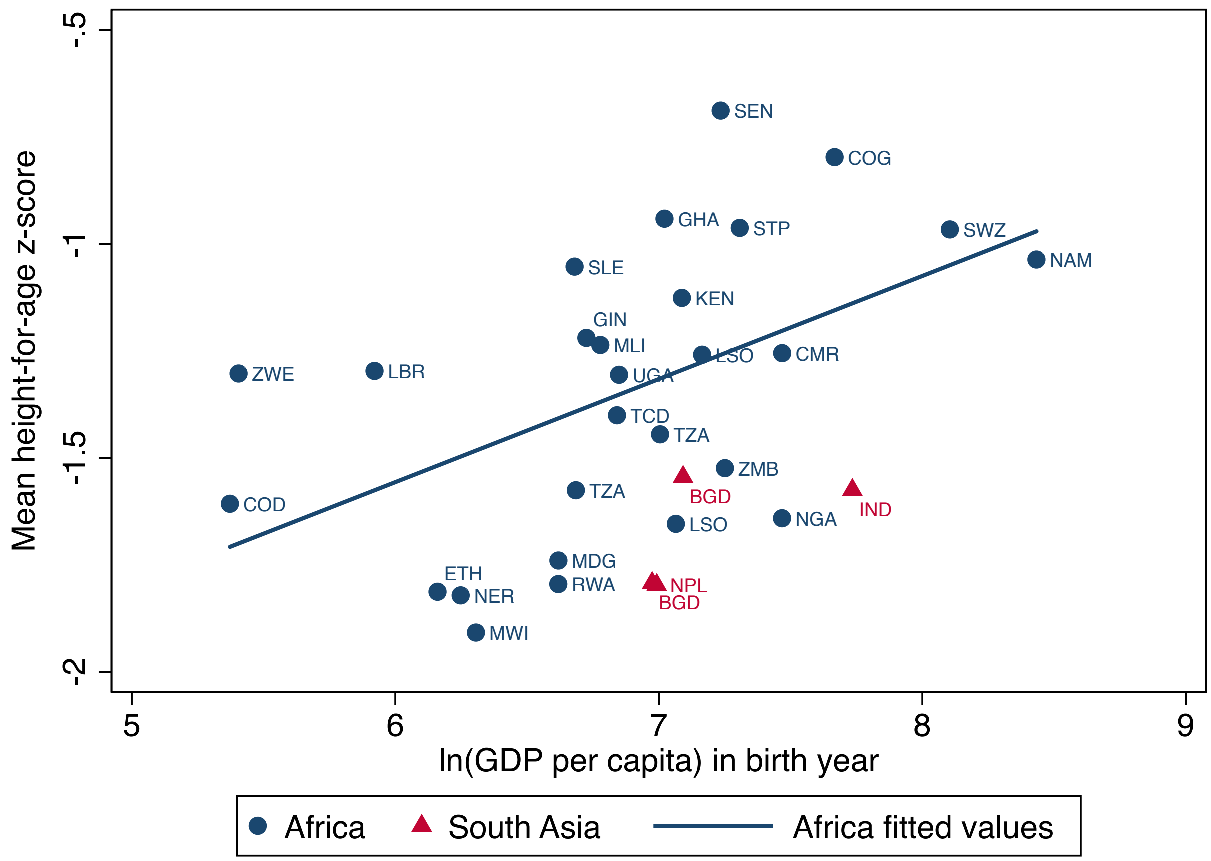
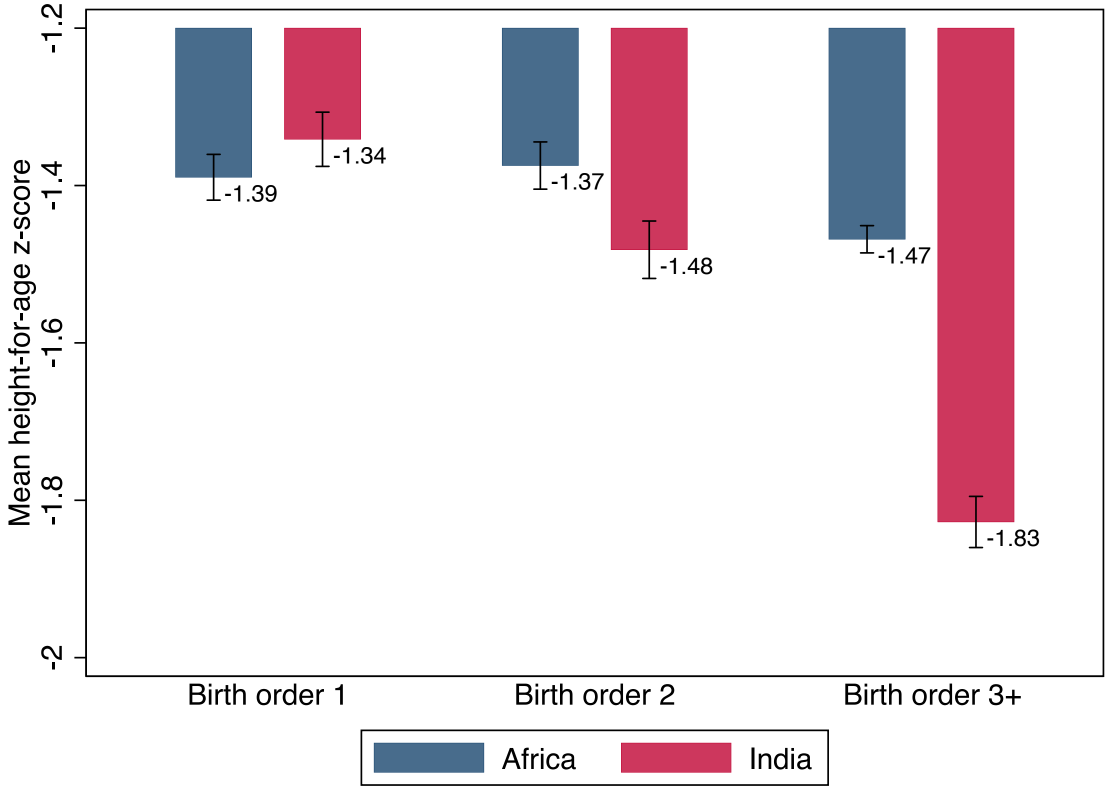
Figure 1: Child height versus national GDP



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***	-0.148***	-0.270**	0.106***
		[0.030]	[0.030]	[0.031]	[0.111]	[0.027]
India*3rd+ child		-0.401***	-0.211***	-0.204***	-0.426**	0.142***
		[0.029]	[0.029]	[0.037]	[0.193]	[0.046]
2nd child		0.038**	0.067***	-0.009	-0.205***	0.045***
		[0.019]	[0.019]	[0.021]	[0.066]	[0.014]
3rd+ child		-0.063***	0.057***	-0.145***	-0.461***	0.093***
		[0.017]	[0.017]	[0.023]	[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 FEs	No	No	No	Yes	Yes	Yes
Mother's age at birth*India FEs	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*$\times$*India* or *Child's age*$\times$*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$\times$India. 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	Total vac-cinations	Pooled inputs	Pooled inputs	Years of schooling
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
India*2nd child	-0.455***	-0.016**	0.007	-0.027***	-0.022*	-0.004	-0.168***	-0.014***	-0.073***	0.009
	[0.056]	[0.008]	[0.017]	[0.006]	[0.013]	[0.005]	[0.040]	[0.005]	[0.011]	[0.017]
India*3rd+ child	-1.206***	-0.109***	-0.034**	-0.089***	-0.027**	-0.004	-0.675***	-0.044***	-0.150***	-0.137***
	[0.049]	[0.008]	[0.016]	[0.006]	[0.011]	[0.005]	[0.045]	[0.005]	[0.017]	[0.019]
2nd child	-0.032	-0.004	-0.109***	-0.068***	0.027***	-0.000	0.024	-0.001	0.031***	0.012
	[0.031]	[0.005]	[0.012]	[0.004]	[0.010]	[0.004]	[0.027]	[0.003]	[0.009]	[0.010]
3rd+ child	-0.215***	-0.010**	-0.256***	-0.112***	0.004	-0.008**	-0.069***	-0.016***	0.061***	-0.029***
	[0.025]	[0.004]	[0.010]	[0.003]	[0.008]	[0.004]	[0.025]	[0.003]	[0.013]	[0.009]
Africa mean of outcome	3.828	0.617	1.406	0.469	0.293	0.112	6.187	0.389	0.389	1.999
India mean of outcome	4.031	0.687	1.867	0.449	0.090	0.055	6.593	0.284	0.284	3.613
Mother*input fixed effects	No	No	No	No	No	No	No	No	Yes	No
Observations	120,570	122,977	122,530	173,772	39,248	95,986	127,544	223,530	223,530	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, household covariates, and households covariates × India. 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. See Data Appendix for further details. In Columns 8 and 9, the two postnatal inputs available for multiple births in the past 5 years (child taking iron pills, and total vaccinations) are pooled in one regression.

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

	HFA z-score	HFA z-score	HFA z-score	HFA z-score
	(1)	(2)	(3)	(4)
India	0.151***		0.090***	
	[0.032]		[0.025]	
India*Girl*2nd child	-0.077	-0.060		
	[0.063]	[0.061]		
India*Girl*3rd+ child	-0.057	-0.052		
	[0.056]	[0.057]		
India*Girl	-0.146***	-0.107		
	[0.044]	[0.066]		
India*2nd child	-0.131***	-0.114***		
	[0.044]	[0.043]		
India*3rd+ child	-0.373***	-0.183***		
	[0.040]	[0.041]		
India*Boy younger than eldest son			-0.268***	-0.137***
			[0.033]	[0.033]
India*Girl older than eldest son			-0.209***	-0.168***
			[0.033]	[0.059]
India*Girl younger than eldest son			-0.419***	-0.271***
			[0.033]	[0.057]
Africa mean of outcome	-1.435	-1.435	-1.435	-1.435
Household covariates	No	Yes	No	Yes
Sample	All	All	All	All
Observations	174,157	174,157	174,157	174,157

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. Even columns additionally control for household covariates and household covariates interacted with *Girl*, *India*, and *Girl* × *India*. The main effect of *India* is included in these regressions but is not shown. In Columns 1-2, 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 3-4, the main effects of *Boy younger than eldest son*, *Girl older than eldest son*, and *Girl younger than eldest son* are included in the regression but are not shown.

Table 4: Heterogeneity by the gender of older siblings

	Wants more children	Wants more children	HFA z-score	HFA z-score	Pooled inputs	Pooled inputs	Years of schooling	Years of schooling
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
India	-0.176***		0.151***		-0.114***		1.777***	
	[0.008]		[0.032]		[0.005]		[0.021]	
India*2nd child	-0.379***	-0.377***	-0.197***	-0.149***	-0.031***	-0.025***	-0.091***	-0.066**
	[0.011]	[0.011]	[0.049]	[0.048]	[0.008]	[0.007]	[0.030]	[0.028]
India*3rd+ child	-0.284***	-0.294***	-0.404***	-0.202***	-0.089***	-0.054***	-0.246***	-0.152***
	[0.009]	[0.009]	[0.041]	[0.042]	[0.006]	[0.006]	[0.026]	[0.025]
India*Girl	0.071***	0.069***	-0.146***	-0.111*	-0.022***	-0.022**	-0.024	0.004
	[0.010]	[0.015]	[0.044]	[0.066]	[0.007]	[0.010]	[0.029]	[0.040]
India*All elder sibs are girls	-0.031***	-0.025***	0.123***	0.065	0.021***	0.011	0.168***	0.133***
	[0.010]	[0.009]	[0.045]	[0.044]	[0.007]	[0.007]	[0.029]	[0.027]
India*Girl*All elder sibs are girls	0.235***	0.227***	-0.163**	-0.106*	-0.029***	-0.015	-0.031	-0.011
	[0.015]	[0.015]	[0.064]	[0.063]	[0.011]	[0.010]	[0.044]	[0.040]
Africa mean of outcome	0.670	0.670	-1.435	-1.435	0.389	0.389	1.999	1.999
Household covariates	No	Yes	No	Yes	No	Yes	No	Yes
Observations	124,537	124,537	174,157	174,157	223,530	223,530	265,352	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 and child age dummies. Even columns additionally control for household covariates and household covariates interacted with *Girl*, *India*, and *Girl* × *India*. The main effect of *India* is included in even columns but is not shown. The birth order dummies, *Girl*, *All elder sibs are girls* and *Girl* × *All elder sibs are girls* are included in all regressions but are 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 3-6 are all children aged 1-59 months. The sample in Columns 7-8 is children age 7 to 14.

Table 5: Heterogeneity within India by son preference

Gender preference proxy:	*Muslim*	*Matrilineal states*	*Child sex ratio (boys/girls)*
	HFA z-score (1)	HFA z-score (2)	HFA z-score (3)
Gender pref proxy*2nd child	0.125*	0.085	-0.851*
	[0.065]	[0.068]	[0.477]
Gender pref proxy*3rd+ child	0.139**	0.158**	0.339
	[0.066]	[0.070]	[0.529]
2nd child	-0.094***	-0.093***	0.850
	[0.026]	[0.024]	[0.521]
3rd+ child	-0.196***	-0.188***	-0.515
	[0.028]	[0.025]	[0.577]
Sample	Hindus & Muslims	India	India
Observations	36,657	43,043	43,043

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, household covariates, and household covariates × *Gender pref proxy*. The main effect of *Gender pref proxy* is included in all regressions but is not shown. *Matrilineal states* include Arunachal Pradesh, Nagaland, Kerala, Meghalaya, Mizoram, Tripura, Sikkim, and Assam. *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. See Data Appendix for further details.

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		-0.259***		
		[0.087]		
India*Has 2+ children	-0.193***	-0.489***		
	[0.072]	[0.079]		
India*Has 1 child*Not pregnant		0.178*		
		[0.092]		
India*Has 2+ children*Not pregnant	0.116	0.400***		
	[0.076]	[0.082]		
Mother*Has 1 child			0.018	-0.116
			[0.072]	[0.135]
Mother*Has 2+ children			-0.157**	-0.377***
			[0.073]	[0.140]
Mother*Has 1 child*Not pregnant			-0.064	0.000
			[0.081]	[0.150]
Mother*Has 2+ children*Not pregnant			0.088	0.210
			[0.080]	[0.151]
Africa mean of outcome	2.248	12.023		
p-value: India*Has 2+ children*Not preg	0.001	0.000		
p-value: India*Has 1 child*Not preg		0.008		
p-value: Mother*Has 1 child*Not preg			0.207	0.085
p-value: Mother*Has 2+ children*Not preg			0.025	0.004
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, household covariates 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, household covariates 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.

Table 7: Heterogeneity by wealth and female empowerment

Heterogeneity:	*Above-median 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
	(1)	(2)	(3)	(4)	(5)
India*Heterogeneity	0.256***	-0.266***	0.147	0.182**	0.049
	[0.080]	[0.065]	[0.097]	[0.091]	[0.076]
India*2nd child*Heterogeneity	-0.244***	-0.210***	-0.063	0.025	0.018
	[0.060]	[0.061]	[0.083]	[0.076]	[0.064]
India*3rd+ child*Heterogeneity	-0.180***	-0.110*	-0.018	0.146*	-0.041
	[0.059]	[0.062]	[0.082]	[0.075]	[0.062]
India*2nd child	-0.007	-0.060	-0.114**	-0.147***	-0.125***
	[0.046]	[0.037]	[0.056]	[0.035]	[0.043]
India*3rd+ child	-0.153***	-0.166***	-0.213***	-0.232***	-0.167***
	[0.042]	[0.036]	[0.055]	[0.035]	[0.042]
Africa mean of outcome	-1.435	-1.435	-1.435	-1.435	-1.435
Household covariates	Yes	Yes	Yes	Yes	Yes
Observations	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, household covariates, and household covariates × *Heterogeneity*. The main effect of *India*, *Heterogeneity*, the birth order dummies, and the birth order dummies × *Heterogeneity* 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. *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	-1.300***	-0.257*	-0.261*	-0.148	-0.270**	-0.322***
	[0.341]	[0.143]	[0.157]	[0.186]	[0.122]	[0.111]
India*3rd+ child	-1.868***	-0.400	-0.438	-0.401	-0.382*	-0.522***
	[0.595]	[0.264]	[0.267]	[0.310]	[0.219]	[0.200]
2nd child	-0.830***	-0.383***	-0.213*	-0.205***	-0.241***	-0.227***
	[0.202]	[0.089]	[0.126]	[0.065]	[0.078]	[0.065]
3rd+ child	-1.817***	-0.825***	-0.449**	-0.461***	-0.548***	-0.481***
	[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 fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Child age*India fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Sample	All	Birth order ≤ 4	Below median fertility	India PSU ultrasound mean $<5\%$	Children have the same father	Birth order among living siblings
Observations	174,157	125,991	82,441	141,736	112,784	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's 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 whose mothers (presumably) had children with only one partner; children in Indian PSUs where less than 5 percent of mothers reported using ultrasound during pregnancy, plus Africa. In Column 6, birth order is defined as the birth order among currently living siblings. See Data Appendix for further details.

Appendix Table 3: Alternative explanations: Mortality selection and open defecation

	Deceased	No diarrhea in last 2 weeks	HFA z-score
	(1)	(2)	(3)
India*2nd child	0.004	-0.004	-0.157***
	[0.003]	[0.005]	[0.031]
India*3rd+ child	0.003	-0.018***	-0.219***
	[0.003]	[0.004]	[0.030]
2nd child	-0.019***	0.006*	0.054**
	[0.002]	[0.003]	[0.021]
3rd+ child	-0.017***	0.007***	0.044**
	[0.002]	[0.003]	[0.019]
2nd child*Open defecation			0.044
			[0.033]
3rd+ child*Open defecation			0.033
			[0.030]
Africa mean of outcome	0.072	0.843	-1.435
Household covariates	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, household covariates, and household covariates interacted with *India*. Column 3 additionally controls for household covariates × *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 4: 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	-0.126***	-0.117***	-0.171***
	[0.033]	[0.034]	[0.054]
India*3rd+ child	-0.168***	-0.186***	-0.239***
	[0.032]	[0.032]	[0.049]
2nd child	-0.073	0.032	0.039
	[0.384]	[0.028]	[0.045]
3rd+ child	-0.028	0.021	0.034
	[0.347]	[0.025]	[0.039]
2nd child*Mother's height	0.081		
	[0.242]		
3rd+ child*Mother's height	0.029		
	[0.219]		
2nd child* % non-resident among children		0.353*	
		[0.204]	
3rd+ child* % non-resident among children		0.404**	
		[0.176]	
2nd child*Land scarcity			0.011
			[0.017]
3rd+ child*Land scarcity			0.010
			[0.015]
Africa mean of outcome	-1.435	-1.435	-1.435
Household covariates	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, household covariates, and household covariates interacted with *India*. Column 1 additionally controls for household covariates × *Mother's height*; Column 2 for household covariates × *% non-resident among children*; and Column 3 for household covariates × *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 5: Fertility stopping patterns

	Has 2+ children (1)	Has 3+ children (2)	Has 2+ children (3)	Has 3+ children (4)	Has 2+ children (5)	Has 3+ children (6)
Firstborn is a girl	-0.002		-0.003		0.000	
	[0.002]		[0.003]		[0.003]	
India*Firstborn is a girl	0.027***		0.035***		0.015***	
	[0.004]		[0.007]		[0.005]	
First and second borns are girls		0.002		0.003		0.001
		[0.004]		[0.006]		[0.005]
First and second borns include a boy and a girl		0.001		0.000		0.001
		[0.003]		[0.005]		[0.004]
India*First and second borns are girls		0.119***		0.168***		0.072***
		[0.008]		[0.012]		[0.010]
India*First and second borns include a boy and a girl		0.017**		0.023**		0.015*
		[0.007]		[0.011]		[0.009]
Africa mean of outcome	0.810	0.771	0.781	0.739	0.840	0.800
Wealth level	All	All	Above median	Above median	Below median	Below median
Observations	128,129	101,119	64,060	48,049	64,069	53,070

Notes: Robust standard errors 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 dummies, and mother's age dummies × *India*. The sample includes mothers who have given birth to at least 1 child in the last 5 years. *Has 2+ children* signifies that the mother has given birth twice or more. In even columns where the outcome is *Has 3+ children*, the sample is restricted to mothers who have given birth at least 2 times. *Above median* wealth level indicates that mothers are from African or Indian households that have higher DHS wealth index values than the African or Indian sample median, respectively. 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, weight-for-age, and weight-for-height z-scores

For comparing height and weight 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, weight and weight-for-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 and weight 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. *Wants* $\leq$*3 children* represents the sample of children from mothers who ideally want 3 or fewer children; in all DHS's and the NFHS, the respondent reported the ideal number of children that she would have liked to have in her whole life, irrespective of the number she already has. *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

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.

Total tetanus shots is collected for the most recent birth in the past 5 years. The exception is 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.

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

Matrilineal states is an indicator for whether or not the respondent lives in one of the following states: Arunachal Pradesh, Assam, Kerala, Meghalaya, Mizoram, Nagaland, Sikkim, Tripura.

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.

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.