Why Are Indian Children So Short? The Role of Birth Order and Son Preference*

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March 13, 2017

Abstract

Child stunting due to malnutrition in India exceeds that in poorer regions like Sub-Saharan Africa. Data on over 168,000 children show that, relative to Africa, India's height disadvantage increases sharply with birth order. We posit that India's steep birth order gradient is due to favoritism toward eldest sons, which affects parents' fertility decisions and resource allocation across children. We show that, within India, the gradient is steeper for high-son-preference regions and religions. The gradient also varies with sibling gender as predicted. A back-of-the-envelope calculation suggests that India's steeper birth order gradient can explain over half of the India-Africa gap in average child height.

*A previous version of this paper was titled, "Why Are Indian Children Shorter Than African Children?" We thank Patrick Agte, Alejandro Favela, Lydia Kim, Suanna Oh, and Alexander Persaud for excellent research assistance. We are grateful to Abhijit Banerjee, Jere Behrman, Diane Coffey, Angus Deaton, Rebecca Dizon-Ross, Jean Drèze, Esther Duflo, Erica Field, Dominic Leggett, Nachiket Mor, Debraj Ray, Dean Spears, Tomasz Strzalecki, Alessandro Tarozzi, several seminar and conference participants and the editor and three anonymous referees for helpful comments. We thank the International Growth Centre, National Science Foundation (Jayachandran) and Harvard's Women and Public Policy Program (Pande) for funding. Contact information: Jayachandran: seema@northwestern.edu; Pande: rohini_pande@harvard.edu.

1 Introduction

One in four children under age five worldwide is so short as to be classified as stunted (UNICEF, 2014). Child stunting – a key marker of child malnutrition – casts a long shadow over an individual's life: on average, people who are shorter as children are less healthy, have lower cognitive ability, and earn less as adults.[1]

India, where over 30% of the world's stunted children live, stands out in particular (UNICEF, 2013). Its child stunting rate is over 40 percent, an outlier even among poor countries (IIPS, 2010).[2] Figure 1 graphs average child height-for-age for Sub-Saharan African (hereafter, African) countries and Indian states against income. Both regions exhibit a positive correlation between income and child height, but the curve for India is lower; at a given level of income, Indian children are shorter. Given that India performs better than African countries on most health and development indicators, this contrast is striking and is the focus of this paper.[3]

Using survey data on over 168,000 children from India and 25 African countries, we demonstrate a steeper height drop-off for later-born children in India: India's relative height disadvantage materializes for second-born children and increases for third and higher order births, at which point mean height-for-age for Indian children is lower than that of African children by 0.3 standard deviations of the worldwide distribution. The steeper drop-off with birth order in India than Africa also holds for weight-for-age, child hemoglobin and, importantly, for an array of prenatal and postnatal health inputs.

We use several approaches to ensure that differential household selection into high fertility is not generating the observed steeper birth order gradient in India. First, the same

[1] Stunting is defined as having a height-for-age that is 2 standard deviations or more below the worldwide reference population median for one's gender and age in months. Child height is predictive of adult height (Tanner et al., 1956), and taller adults have greater cognitive skills (Glewwe and Miguel, 2007; Guven and Lee, 2015), fewer functional impairments (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).

[2] Unlike in western countries where economic growth was accompanied by rapid height increases (Floud et al., 2011), recent economic growth has only modestly increased average height in developing countries (Deaton, 2007). Between 1992 and 2005, India's annual economic growth exceeded 6 percent, yet stunting declined by just 0.6 percentage points (1.3 percent) per year (Tarozzi, 2012).

[3] India outperforms African countries on maternal mortality, life expectancy, food security, poverty incidence, and educational attainment (Gwatkin et al., 2007). Yet, India has the fifth highest stunting rate among 81 low-income and low middle-income countries with comparable child height data UNICEF (2013), despite being in the middle of the group (rank 43) for GDP per capita.

patterns hold when we control for maternal and neighborhood characteristics that are correlated with total fertility and child outcomes. Second, the results are robust to estimating the patterns using only between-sibling variation in child height (i.e., holding family size and other family characteristics fixed). Finally, we consider two different samples where mothers' have likely completed fertility, and in both cases the birth order patterns are robust to flexibly controlling for total fertility in parallel to birth order.

Turning to the underlying mechanism at work, we propose that eldest son preference in India – encompassing both a desire to have at least one son and for the son to be healthy – influences parents' fertility decisions and how they allocate resources across children, leading to the steep birth order gradient in height. Eldest son preference can be traced to the patrilocal and patrilineal Hindu kinship system: aging parents typically live with, and bequeath property to, their eldest son (Dyson and Moore, 1983; Gupta, 1987). Further, Hindu religious texts emphasize post-death rituals which can only be conducted by a male heir (Arnold et al., 1998). (Hereafter, 'son preference' is shorthand for eldest son preference.)[4]

The data support several specific predictions of this hypothesis. First, within India, the birth order gradient is shallower among children living in Indian states that practice matrilineality (Kerala and the Northeast states) and those with a less male-skewed sex ratio.[5] We also observe a shallower birth order gradient within India among Muslim children; relative to Hinduism, Islam places less emphasis on having a son. Finally, consistent with the Hindu-Muslim difference in eldest son preference, we show that the birth order gradient in India exceeds that in the neighboring countries of Bangladesh and Pakistan.[6]

Second, the son-preference mechanism predicts that the drop-off in height across successive children will depend on their older siblings' gender composition. Among boys, we posit that eldest sons receive more health and nutrition inputs than their brothers or sisters. Consistent with the fact that sons born at high birth order are less likely to be the family's first son, we observe a birth order gradient among boys. We also exploit variation in when

[4]India also exhibits a general preference toward all sons. In section 4, we discuss the role of eldest son preference versus general son preference in explaining the patterns we find.

[5]In Kerala and the eight Northeast states, some but not all population groups follow matrilineal practices.

[6]Using country comparison groups other than Africa also helps address the concern that it may be Africa that is special, not India. In addition to the within-South Asia comparison, we also compare Indian children to those in countries with similar GDP and those in countries with genetically similar population groups. In all cases, India exhibits the steepest birth order gradient.

the family's first son is born, and show that a son born at birth order 2 is taller in India than Africa if and only if his older sibling is a girl, i.e., he is the family's eldest son.

Among girls, older siblings' gender composition affects resources in two ways, both of which disfavor later-born daughters. First, there is the "sibling rivalry effect": a girl born at later birth order has (by definition) more older siblings. It follows that she is also more likely to have an elder brother, and likely to fare poorly when competing with him for family resources (Garg and Morduch, 1998; Pande, 2003).

The second mechanism is fertility-stopping behavior, which instead confers a disadvantage to a later-born daughter who lacks brothers. When a daughter is born into a family with only girls, her parents are likely to continue having children in their quest for a son, exceeding their originally desired family size. Thus, the birth of a late-parity girl is akin to a negative income per capita shock and fewer resources are expended on her. Both mechanisms generate a birth order gradient among girls, and the net effect of having an older brother on the resources allocated to a girl is ambiguous. Empirically, we find that the net effect is positive, pointing to the importance of the fertility-stopping mechanism.

These two mechanisms affecting girls provide a third testable prediction among daughters with no elder brother. While a lack of sibling rivalry will increase both prenatal and postnatal investments in these daughters relative to those with an elder brother, the fertility-stopping effect reduces the postnatal investment they receive because, after their birth, parents realize they need to try again for a son. We show that, relative to Africa and to prenatal inputs, girls in India receive fewer postnatal resources if their family does not yet have a son. Theories for the steep Indian birth order gradient other than son preference seem unlikely to explain the several patterns we find in the data.

The birth order differences in health inputs and height directly demonstrate stark inequality across Indian children. This inequality is also informative of the average Indian deficit in child height. At a most basic level, the decomposition by birth order and gender is informative about the genetic potential of Indian children: Unless genotypes vary systematically by birth order, all Indian children have the genetic potential to be at least as tall as the observed average height of firstborns. The absence of a height deficit for Indian firstborns, thus, suggests that genetics cannot explain most of India's height deficit compared to Africa.

More directly, we argue that parents' unequal allocation of resources across children affects average height in India. Mirroring the India-Africa patterns, our within-India analyses show that there is higher average child height *and* a shallower birth order gradient for Indian regions with less son preference. For these subgroups, we observe a more equal allocation of resources, but not more inputs to children on average. Consistent with height production functions in the literature, these patterns suggest that height exhibits diminishing returns to inputs (Steckel, 1995).[7] With diminishing returns to inputs, unequal investment across children will depress average child height.

To quantify the link between birth order gradient differences across India and Africa and the average child height deficit in India, we conduct two back-of-the-envelope calculations. The first asks how much of the gap is explained by the birth order gradient, and the second how much is explained specifically by eldest son preference generating a birth order gradient. As a starting point, we demonstrate a negative correlation between the birth order gradient and level of height across African countries. For the first exercise, we multiply this estimated correlation by the India-Africa gap in the birth order gradient. When we compare the resulting estimate to the observed India-Africa height gap (adjusted for GDP per capita), we find that the birth order gradient explains over half of the Indian height puzzle.

Next, we use the low eldest son preference states of Kerala and the Northeast as a proxy for India without eldest son preference and conduct a similar calculation. We find that the birth order gradient rooted in eldest son preference explains a third of the India-Africa height gap. While not rigorously establishing the link between the gradient and level, these two accounting exercises are suggestive that eldest son preference and, relatedly, the birth order gradient have quantitatively important implications for average height in India.

Our paper complements, and adds to, the literature on the environmental determinants of child height. Spears (2013), for instance, focuses on open defecation as a cause of the Indian height disadvantage.[8] We also contribute to the literature on how cultural gender preferences and gender gaps in perceived returns to investment cause unequal resource allocation across siblings (Rosenzweig and Schultz, 1982; Behrman, 1988; Garg and Morduch, 1998; Oster,

[7]We also use Indian Human Development Survey data to directly demonstrate that child height exhibits diminishing returns to household income and expenditures in India.

[8]Much of the recent evidence weighs against genetic explanations in explaining India's height deficit (Coffey et al., 2013). For instance, work examining the height of Indian children who's parents migrate to rich countries finds significant narrowing in the gap between Indian-born children and worldwide norms narrows but does not close (Tarozzi, 2008; Proos, 2009).

2009). Our contribution is to show how gender preferences, by accentuating birth order gradients, can explain a significant fraction of child stunting in India. To the best of our knowledge, ours is the first paper to examine how cultural norms of son preference influence birth order effects.[9] Finally, we contribute to the literature on the unintended consequences of son preference by demonstrating how dynamic fertility decisions cause inequality in health outcomes between genders, among brothers, and even among sisters (Sen, 1990; Clark, 2000; Jensen, 2003; Jayachandran and Kuziemko, 2011).

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 and also tests alternative explanations for the within-family patterns. Section 5 concludes.

2 Background and data description

The established link between child stunting and adverse long-term outcomes, as well as the relative ease of measuring child height (versus, say, keeping a comprehensive food diary for a child) has led to the widespread use of height as a marker of child malnutrition. However, and especially for cross-country comparisons, it is important to account for the other key factor determining height: genetic potential.

A common norm, and the one we follow, is to create the child's height-for-age (HFA) z-score based on the World Health Organization (WHO) universally applicable growth standard for children aged 0 to 5 years.[10] A z-score of zero represents the median of the gender- and age-specific reference population, and a z-score of -2 indicates that the child is two standard deviations below that reference-population median, which is the cutoff for being considered stunted. Our primary outcome of interest is the HFA z-score because it is the

[9] Birth order gradients exist for outcomes as varied as IQ, schooling, height, and personality (Behrman and Taubman, 1986; Sulloway, 1996; Black et al., 2005, 2011; Belmont et al., 1975; Horton, 1988).

[10] The WHO standard describes how children should grow if they receive proper nutrition and health care. It is premised on the fact that the height distribution among children under age five who receive adequate nutrition and health care has been shown to be similar in most ethnic groups (de Onis et al., 2006; WHO, 2006). The WHO constructs the height distribution using a sample of children from six affluent populations across five continents (Brazil, Ghana, India, Norway, Oman and the United States) with no known health or environmental constraints to growth and who received recommended nutrition and health inputs (WHO Multicentre Growth Reference Study Group, 2006b).

child health measure that has been most often linked to later-life outcomes and is viewed as the best cumulative measure of child malnutrition. As a robustness check we also consider weight for age (WFA) z-scores (which are similarly defined) as an outcome variable.

The 2005-06 National Family Health Survey (NFHS-3) is our data source for Indian children; it employs the same sampling methodology and survey instrument as the internationally-used Demographic and Health Surveys (DHS). Following the previous literature on the puzzle of Indian malnutrition, we use Sub-Saharan African children as the comparison group for Indian children (Ramalingaswami et al., 1996). Sub-Saharan Africa's level of development is similar to (but, on average, lower than) India. The comparison group comprises the 25 Sub-Saharan African countries (from now on, African countries) where DHS Surveys collected child anthropometric data and occurred between 2004 and 2010 (to ensure a comparable time period to NFHS-3). Two African countries (Tanzania and Lesotho) were surveyed twice in this time period, and we include both survey rounds. The "DHS sample" in our main analysis refers to the 27 Demographic and Health Surveys for African countries plus India's NFHS-3 survey. Our robustness checks also use DHS surveys from other regions.

The DHS interviews women aged 15 to 49 years, and measures height for their children aged five and under. Our sample comprises the 168,108 children with anthropometric data.[11] Table 1 provides summary statistics, and the Data Appendix provides other survey details. The average Indian child is slightly older than African counterpart (30.2 months versus 28.3 months); however, a comparison of average HFA z-scores shows that Indian children are significantly shorter than African chidlren (-1.51 and -1.35, respectively). We define child birth order based on all children, currently alive or deceased, ever born to a mother. As African women have more children (3.9) than their Indian counterparts (2.7), the mean birth order in Africa (3.7) exceeds that in India (2.6). Lower total fertility in India implies that despite similar mothers' age at first birth, average maternal age at birth for children in our sample is lower in India (25 years) than Africa (27 years). The average spacing between births is reasonably high and similar in India (36 months) and Africa (39 months). We also define a subsample with likely completed fertility comprising the 49,880 mothers who state that they do not want more children or are sterilized or infertile.

[11] Following WHO guideline on handling outlier values, we exclude observations with a HFA z-score > 6 or < -6 (> 5 or $<$ -6 for WFA) as these are likely to be erroneous.

We also use data on prenatal and postnatal health-related behaviors. Prenatal behavior includes the number of prenatal care visits, whether the pregnant woman received tetanus shots and iron supplementation, and delivery at a facility; India typically outperforms Africa on these measures. (For example, 69 percent of the time, pregnant women in India took iron supplements, compared to 62 percent in Africa.) Data on health inputs for young children include: whether had a medical checkup within the first two months of life, whether received iron supplementation, and the total number of vaccinations. India has higher vaccination rates, while postnatal checkups and child iron supplementation are more common in Africa. Table 1 also summarizes our control variables. Reflecting differences in the number of countries covered and total sample size, Africa has close to three times as many Primary Sampling Units as India (10,366 and 3,822 respectively), while maternal literacy is higher in India. The Data Appendix provides further details on variables entering the analysis.

Our within-India analysis uses two data sets. First, we pool all three waves of NFHS (conducted in 1992-93, 1998-9 and 2005-06), which gives us a sample of over 90,000 Indian children. Second, we use the Indian Human Development Survey (IHDS), a two-wave survey conducted in 2005 and 2012. The IHDS panel structure and seven-year gap between waves allows us to focus on families that had no children between the two waves and therefore (almost surely) completed fertility. While the sample size among families with completed fertility is relatively small (3,615 children under age five with height data in wave 1), the IHDS analysis allows us to show that our results are robust to controlling for family size. Appendix Table 4 provides summary statistics for these two data-sets.

3 Birth order and child outcomes

We start by documenting the key fact that underlies our analysis: the steeper birth order gradient in child height in India relative to Africa. We then discuss endogeneity concerns, and provide relevant robustness checks. We conclude this section by documenting similar gradients in parental inputs that likely influence height and other child health outcomes.

3.1 Child height

A. Basic finding

Figure 2 plots the average child height-for-age (HFA) z-scores for India and Africa, separately by birth order. An Indian deficit emerges at birth order 2 and widens for birth order 3 and higher.

Table 2 examines this pattern via regression analysis. In column (1) we show the average India-Africa height gap, pooling all children. Indian children are, on average, 0.08 standard deviations shorter than African children. As shown in column (1) Appendix Table 1, this average deficit increases to -0.16 if one controls for PPP-adjusted GDP per capita in the child's birth year; India is richer than the African comparison group, on average.

We next disaggregate the height disadvantage by birth order. The outcome variable remains HFA for child i born to mother m in country c. We estimate

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

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. X_{imc} is a vector of controls that always includes child age dummy variables (in months) to account for non-linear patterns of z-scores and age. We also expand the set of controls to check the robustness of our results, as described below. Throughout, standard errors are clustered at the mother level.

Column (2) shows that the Indian height disadvantage opens up at birth order 2: The interaction of India and being second-born is -0.14 and highly significant. The Indian disadvantage then increases, with third and higher births having a height z-score gap of -0.28 compared to African children (sum of main effect and interaction term).[12]

B. Endogeneity concerns

The ideal data for examining differences in the birth order gradient across India and Africa would use households that had completed fertility, and have height data for all children

[12]In Section 4.6, we conduct an accounting exercise that quantifies how much this gradient contributes to the average height deficit in India compared to Africa.

in the family. This would allow us to control for total family size in parallel to birth order and ensure that the estimates are not confounding the effects of birth order and family size (Black et al., 2005). In this case, birth order would be orthogonal to family characteristics (and so mother fixed effects might improve precision but would not change birth order coefficients).

However, the nature of DHS sampling implies that a large fraction of households in our sample have not completed childbearing. The best proxy for intended family size is a survey question on the mother's desired fertility, but it is not asked prior to childbearing, rendering it potentially endogenous to a woman's fertility decisions. Moreover, actual and desired fertility often differ in countries where access to contraception is limited. Hence, our regressions cannot control for total family size in general, raising an omitted variable bias concern: the birth order variable in between-household comparisons could be proxying for high-fertility families. Higher birth order children are more likely to come from larger families, and family size could be correlated with child height; family size could affect child height via its effect on the available resources per child, plus larger families tend to be poorer.

One response is to include family fixed effects; eventual total family size is held fixed when making comparisons across siblings, despite our not directly observing it. The one caveat is that DHS surveys only provide height data for children age five and younger raising the possibility of endogenous selection into the relevant sample; for example, the sample in regressions with family fixed effects will typically have shorter birth spacing than the full sample and birth spacing could differ across India and Africa.

Given this, we address endogeneity concerns in multiple ways: First, and as we describe immediately below, we conduct a set of robustness checks using the DHS data. Second, in Section 4 we conduct a parallel within-India analysis for children of women who have completed fertility using the IHDS data. Finally, we consider comparison groups of countries other than Africa; if the nature of differential selection is specific to the India-Africa comparison then we should not observe a steeper birth order gradient when we use alternative comparison groups.

Our first approach to address endogeneity is to include a rich set of covariates in parallel to birth order: primary sampling unit (PSU) fixed effects, maternal literacy, maternal age, and child age. In rural areas a PSU is a village, and in urban areas it is a neighborhood. PSU fixed effects control for many dimensions of economic and health status, as well as unobserved environmental conditions. For instance, fertility outcomes are highly correlated within PSUs. We also control for maternal literacy, which again is highly correlated with observed fertility.[13] Our other two controls relate to maternal and child age: Within families, birth order is correlated with maternal age. The public health literature identifies a non-linear relationship between maternal age and child health (specifically early and late pregnancies are associated with worse outcomes (Fall et al., 2015)). To ensure that birth order effects do not proxy for maternal age, we include a quadratic in maternal age in the controls.[14] Finally, child age is correlated with birth order within families; among siblings, the higher birth order child will, by definition, be younger. We therefore use child age dummies as covariates. Importantly, for each of these covariates, we include the interaction with the India dummy. Column (3) of Table 2 shows that the addition of these control variables reduces the magnitude but not significance of the $I_c \times 3rd{+}Child$ coefficient, and does not appreciably change the $I_c \times 2ndChild$ coefficient. This specification will be our main specification in later analyses.

Next, we classify women who stated they do not want any more children or who have been sterilized as likely to have completed fertility. We then reproduce column (3) for children belonging to this subsample of households where the mother has likely completed fertility (our sample size is roughly 40% of the original sample). We use the observed number of children for these households as their total family size, and in our regression include controls for family size dummies interacted with India. Column (4) shows that our results on the birth order gradient hold, although they are less precisely estimated. Finally, similar in spirit to controlling for actual family size is to control for desired family size. Keeping in mind the caveats mentioned earlier, Appendix Table 2, column (1) shows that our results are robust to controlling for desired fertility.

In column (5) we report regressions that include mother fixed effects. By only using within-family comparisons for identification we fully control for family size differences. Birth order and child's age are strongly correlated within a family, so we continue to control for

[13]For the completed fertility sample, in India (Africa) the average standard deviation of fertility within a PSU is 1.27 (2.01) while the standard deviation across all of India (Africa) is 1.88 (2.76). Pooling regions, literate women with completed fertility have 1.7 fewer children than illiterate women. In India (Africa), literate women with completed fertility have 1.6 (1.9) fewer children than illiterate women

[14]We also *de facto* control for mother's current age, as it is the sum of child age and mother's age at birth.

$I_c \times ChildAge$. Requiring there to be at least two children from a family in the sample reduces the sample size to 83,228 children. The effective sample size is even smaller: the birth order coefficients are identified off of the 42,524 children (13,550 for India and 28,974 for Africa) with one or more siblings in the sample with a different birth order than them (i.e., not simply multiple births) and where at least one sibling is birth order 1 or 2 (so that not all siblings fall in our $3^{rd+}Child$ category). The Indian birth order gradient remains statistically significant, and the results are similar though somewhat larger in magnitude to those in columns (2) and (3). Consistent with findings in many settings that low-parity children have better outcomes, we observe a negative birth order gradient in Africa (the coefficients on $2^{nd}Child$ and $3^{rd+}Child$ are negative and significant). The key finding is that the birth order gradient in child height is twice as large in India as in Africa.

The mother fixed effects specification is an important robustness check that *de facto* includes fixed effects for eventual total family size, which does not vary within family. The drawback is that the birth order gradient is identified off less than half the sample. A specific concern is that siblings with shorter than average birth spacing identify the mother fixed effects estimates and, therefore, selection based on birth spacing might differ between India and Africa. Reassuringly, average birth spacing in this subsample is reasonably high and similar across India and Africa (26 months versus 29 months). Moreover, because the mother fixed effects specification includes child age (in months) dummies we are *de facto* controlling for birth spacing between the siblings in the sample. As a further robustness check, we also control directly for a child's birth spacing from his or her older sibling interacted with India. In the specification with household controls (Appendix Table 2 column 2), the birth order gradient is similar to our main results. With mother fixed effects (column 3), India's birth order gradient remains statistically significantly steeper for children of birth order 3 and higher; the coefficient for the birth order 2 interaction becomes smaller but remains marginally significant.[15]

[15] Appendix Table 2 reports further robustness checks. In columns (4) and (5) we find similar estimates when we restrict the sample to children who are birth order 4 or lower. Our estimates are also robust to considering a more endogenous definition of birth order, namely birth order among currently living children (columns 6 and 7). In Jayachandran and Pande (2015) we show that the results are robust to excluding African countries with fertility that is above the median of our full African sample. Further, to check that polygamy (which is more common in Africa than India) is not biasing estimates, we show that the results are similar when the sample is restricted to mothers who have only had children with one partner.

Next, we use alternative geographic comparison groups to check whether what we interpret as an abnormally steep birth order gradient in India is actually an abnormally shallow gradient in Africa. In Appendix Table 3 columns (1)-(3) we define the comparison group for India economically: The comparison group comprises 25 country surveys (between 2004 and 2010) for which country GDP per capita in the survey year was within 50 percent (either higher or lower) of India's 2005-06 GDP per capita. India exhibits a stronger birth order gradient than this alternative comparison group.

In columns (4)-(6) we define the comparison group in terms of (relative) genetic similarity. Recent genome studies that use modern-day genetic distance between ethnic groups to reconstruct prehistoric migration patterns find evidence of Indo-European migration and genetic similarity between India, Europe, Central Asia, and West Asia (Cavalli-Sforza et al., 1994). We use 16 European and Central and West Asian countries with DHS surveys as the comparison group, and again find a stronger birth order gradient in India than in the comparison group.[16]

Finally, we compare India to its two South Asian neighbors. The puzzle of stunting is often framed as the "South Asian enigma", but our hypothesis that son preference is the root cause predicts that the birth order gradient should be steeper in India than Bangladesh and Pakistan (which are majority Muslim countries; Islam has less eldest son preference than Hinduism). Columns (7)-(9) show that the birth order gradient is indeed steeper in India. (In section 4, we will show that a steeper birth order gradient among Hindus than Muslims also holds within India.)[17]

3.2 Other health outcomes

We focus on the continuous HFA z-score but of specific policy relevance is the stunting rate (a measure of overall child malnutrition): the incidence of children with a HFA z-score

[16] One difference is the absence of a firstborn advantage in India, which is unsurprising given that these comparison groups are significantly richer than the African comparison group.

[17] Jayachandran and Pande (2015) reported a placebo test for whether India's birth order gradient is an outlier among countries. We compared each country in our sample to the rest of the sample and found that India is the only country with a significantly steeper birth order gradient than the rest of the sample. This is the case even when, to account for India's larger sample size, we aggregate African countries to regions. A second placebo test used the 25 African countries and 29 Indian states in the sample, randomly selected 29 countries or states to comprise a placebo "India," and estimated the differential "Indian" birth order gradient, repeating the exercise 500 times. The actual $India \times 2^{nd} Child$ and $India \times 3^{rd+} Child$ coefficients are in the bottom 1% of the distribution of estimates, i.e., have a p-value < 0.01.

≤ -2. Table 2, column (6) shows that the steep Indian birth order gradient holds for stunting: Relative to their African counterparts, the disadvantage for Indian second borns is 5 percentage points, and for third borns, 6 percentage points. Thus, the high birth order penalty for stunting is two to three times as large in India as in Africa. A similar pattern holds when height in centimeters is the outcome (Appendix Table 2, columns 8 and 9).

If the birth order gradient in height reflects unequal resource allocation across children then we would also predict a birth order gradient in other health outcomes. To examine this possible mechanism, we start by considering other health outcomes that are likely also affected by parents' resource allocation. Table 2, columns (7) and (8) show a differentially steep birth order gradient in weight-for-age and hemoglobin in India. Finally, column (9) examines infant mortality. This is a negative health outcome, so we would predict positive India-birth order interaction terms. The point estimates are indeed positive, though statistically insignificant. Examining infant mortality also serves a different purpose: It addresses the concern that mortality selection might underlie India's strong birth order gradient. For mortality selection to explain the height patterns, we would need India to have a negative differential birth order gradient in infant mortality; weak later-born children survive at a high rate, generating a negative birth order gradient in survivors' height. However, we observe the opposite pattern.

3.3 Health inputs

Next, in Table 3 we examine birth order gradients in multiple prenatal and postnatal child investments. The prenatal input information is based on retrospective information about inputs *in utero* and at childbirth; the prenatal outcomes (and some of the postnatal outcomes) are only available for the youngest child in the family. We estimate equations of the form of equation (1), and the set of covariates include PSU fixed effects and controls for maternal literacy, mother's and child's age, and their interactions with the India dummy.

In columns (1) to (4) we examine whether the steeper gradient holds for each prenatal input. On average, Indian women are more likely to obtain prenatal care, take iron supplements, and receive tetanus shots during pregnancy but are less likely to deliver at a health facility. However, for all outcomes other than tetanus shots, we observe a sharper decline with birth order in India than in Africa. The gradient magnitudes are 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 receive fewer inputs than their African counterparts.[18]

Columns (5) to (7) analyze three postnatal investments. The prevalence of postnatal checkups is much lower in India than Africa (reflecting an Indian social norm of maternal home confinement for forty days after birth) and child iron pill consumption is also lower. However, Indian children are more likely to get vaccinated. There is no differential birth order gradient across India and Africa for postnatal checkups and iron pill consumption. In contrast, vaccinations show a strong negative India birth order gradient.[19] In column (8) we summarize our findings and show that the steeper birth order gradient holds for a composite input measure: the average pooled inputs received by a child. This measure is the average value of seven indicator variables. For the three input variables that are originally multi-valued (total prenatal visits, total tetanus shots and total vaccines), we construct dummy variables that equal 1 if the original measure exceeds the sample median. Thus, to the extent that child health inputs affect child height, this birth order gradient in inputs is consistent with a behavioral basis for the height birth order gradient.

4 Culture and height deficits

The Indian birth order gradient in child height is steeper than that in Africa and several alternative comparison groups including India's neighboring countries of Bangladesh and Pakistan. An important difference between India and comparator countries lies in the religious make-up of the population: Roughly four fifths of India's population is Hindu.

In this section, we provide two types of evidence that eldest son preference – which follows from the tenets of Hinduism – is an important mechanism underlying the steep child height gradient in India. First, we use regional and religious variation within India to show that the birth gradient in height is shallower when son preference is lower. Second, we show that the Indian birth order gradient varies with the gender composition of siblings in a manner consistent with eldest son preference.

[18]As the main effect for India is absorbed by PSU fixed effects, the tables do not report the gap among firstborns. The comparison of absolute levels is based on a specification without PSU fixed effects.

[19]We do not examine breastfeeding as an outcome because the choice of how long to breastfeed is determined both by its health benefits and subsequent fertility (Jayachandran and Kuziemko, 2011).

4.1 Within-India evidence

We identify multiple subgroups within India that are marked by lower than average son preference and examine whether, relative to the rest of India, these subgroups have a less negative birth order gradient.

To do so, we use two different datasets. First, we use the pooled sample of all three NFHS waves, conducted in 1992-3, 1998-99 and 2005-06; by pooling the three waves, we gain statistical power. Second, we use a completed-fertility sample from the Indian Human Development Survey (IHDS), a panel with two waves collected seven years apart. To construct our IHDS sample, we use the second wave to identify mothers who had completed fertility by the first wave: non-pregnant women who did not give birth after the first wave.[20] Among children born to these mothers, we examine height-for-age of children who were under age five in wave one.

To examine whether the birth order gradient is muted in regions and among social groups that exhibit lower son preference, we estimate a model analogous to equation (1) with one difference: The indicator for India is replaced by an indicator for the low-son-preference subgroup. In regressions using the IHDS sample, we also control for family size dummies in parallel to birth order, i.e., include fixed effects for family size interacted with the son-preference proxy.

We begin by comparing matrilineal Indian states – Kerala and the eight Northeastern states – with the rest of India. Matrilineality – which is associated with kinship practices that favor boys less and do not prioritize eldest sons – is more common in these states (Oommen, 1999; Chakrabarti and Chaudhuri, 2007; Gneezy et al., 2009). Column (1) of Table 4 shows that the birth order gradient in height is more muted in matrilineal states. A comparison of subsample means provides suggestive evidence that differences in the gradient influence average child height: average child height in matrilineal states exceeds that in the rest of India. Column (2) shows that the same pattern holds for weight-for-age. In column

[20]The approach of using a long gap of no childbearing to identify completed fertility complements is arguably superior to using mothers' stated desire to not have more children to measure completed fertility in DHS surveys, which we employed in Table 2, column (4). Mothers who completed their fertility have, on average, 3.11 children in IHDS as compared to 3.22 children in the NFHS-3 sample that we identified as likely having completed fertility. With our IHDS analysis, we can enlarge the sample slightly by also including women who gave birth after wave 1, but just not in the five years preceding wave 2; we find similar and somewhat more precisely estimated effects.

(3) we estimate this relationship using the IHDS sample. We observe the same pattern – a shallower birth order gradient for child height in matrilineal states.[21]

Next we examine heterogeneity by the child sex ratio, calculated for each state-by-urban cell (which is the finest administrative level at which we can match census sex ratio data to NFHS). The sex ratio, as defined, is increasing in the proportion male. In columns (4) to (6) we find that, as predicted, low-sex-ratio regions have a shallower birth order gradient. We continue to see a negative correlation between the steepness of birth order gradient and average child height: the subsample means show that average child height is higher in low-sex-ratio regions.

Finally, we examine differences by religion: compared to Hinduism, Islam places less emphasis on needing a son for religious ceremonies, and Islamic inheritance rules disfavor women less. 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 et al., 2010). Using our NFHS data we find that, relative to Hindus, Muslims Indian have a much more muted birth order gradient in HFA and WFA for birth order three and higher (columns 7 and 8). However, we do not observe a differential Hindu-Muslim height gradient using IHDS data (column 9). It could be that our covariates are unable to fully control for unobserved socio-economic characteristics by religion; this may also be the reason why subsample averages show that Muslim children have relatively lower HFA and WFA z-scores. Consistent with the idea that Muslim families are, on average, poorer, Appendix Table 5 shows that child inputs are lower among Muslim families. Importantly, we do see that these resources are more equally distributed across birth order among Muslims.

4.2 Favoritism toward eldest sons and birth order gradients

We now use the DHS sample to test a series of predictions that follow if the child height gradient stems from parents' eldest son preference.

Prediction 1. *Relative to African counterparts, both boys and girls in India will exhibit a steeper birth order gradient.*

[21] Appendix Table 5 reports similar specifications examining weight-for-age using IHDS data and prenatal and postnatal inputs using NFHS data.

Among boys this is straightforward: the eldest son, by definition, has the lowest birth order among sons in the family and will be favored over his siblings. Importantly, this gradient should be absent if, instead, parents exhibit general son preference i.e., they favor sons over daughters but not the eldest son particularly.

Among girls, eldest son preference disfavors later-born girls in two ways. First, by virtue of having more older siblings, a later-born girl is more likely to have an elder brother and be in competition with him for resources.

Second, parents' desire for a son affects their fertility decisions. Consider a family with a desired fertility of two children that wants at least one son. *Ex ante* the preferences are compatible because the likelihood of any child being male is (very close to) 50 percent. If the firstborn is a daughter, then parents realize that they may need to exceed desired fertility to ensure a son. They will decide expenditures on this daughter given their available resources and an expected family size of three. If their second child is also a girl, then parents certainly need to exceed their desired fertility of two in order to have a son. Consequently, and assuming fixed family resources, the second daughter will receive fewer early-life resources than her older sister because the expected family size has increased from three to four.[22]

Eldest son preference - that directly drives unequal allocation of resources across brothers – may have a particularly strong effect on allocation and outcomes across boys. In contrast, the birth order gradient for girls is *not* generated by parents having discriminatory preferences across daughters. It is, therefore, theoretically ambiguous whether the male or female gradient in India should be steeper. We, therefore, turn to the data and estimate:

$$\begin{aligned}
Y_{icm} \quad = \quad & \alpha_1 I_c + \delta_1 I_c \times Girl + \delta_2 I_c \times Girl \times 2^{nd}Child_{imc} + \delta_3 I_c \times Girl \times 3^{rd+}Child_{imc} \\
& + \beta_1 2^{nd}Child_{imc} + \beta_2 3^{rd+}Child_{imc} + \beta_3 Girl \times 2^{nd}Child_{imc} + \beta_4 Girl \times 3^{rd+}Child_{imc} \\
& + \beta_5 Girl_{imc} + \alpha_2 I_c \times 2^{nd}Child_{imc} + \alpha_3 I_c \times 3^{rd+}Child_{imc} + \gamma X_{imc} + \epsilon_{imc} \qquad (2)
\end{aligned}$$

This is an expanded form of equation (1), where the key additional regressors are the triple interaction between India, birth order and being a girl. We are interested in δ_2 and δ_3 which

[22] In our data, the majority of Indian mothers report an ideal family size of two children. Families strongly want at least one son and thereafter prefer having a roughly balanced gender composition (Jayachandran, 2017). Myopia among parents such that they only update their fertility plans when it is certain that they need to exceed their desired fertility will amplify the extent to which the birth of a second or later daughter is a positive shock to expected family size and thus to future expenses.

test whether the India's steep birth order gradient is stronger among girls or boys.

Column (1) of Table 5 shows a similarly steep birth order gradient for Indian boys and girls; the triple interactions of India, higher birth order, and the girl dummy, while negative, are statistically insignificant. However, unlike with boys, the firstborn height advantage is absent for Indian girls (relative to their African counterparts). Specifically, the main effect for India implies that, on average, firstborn Indian sons are 0.15 z-score points taller than their African counterparts.

The coefficients remain fairly similar when we include additional covariates (column 2) and mother fixed effects (column 3). Finally, in column (4) we show that the same pattern holds when we consider weight-for-age as the outcome variable.

While the birth order gradient does not differ by gender, there are two reasons to expect a level difference by gender in India. First, if eldest sons receive more resources than all other children, then sons on average will fare better than daughters. Second, the gender composition of children influences fertility behavior: In India, relative to Africa, the birth of a girl in a family with only daughters increases mothers' desire for additional children (Jayachandran and Pande, 2015). Thus, relative to sons, daughters in India are more likely to belong to larger than planned families that lack adequate resources for their children (Clark, 2000; Jensen, 2003). These two effects, together, yield a second prediction:

Prediction 2. *The India-Africa height gap will be more pronounced among girls.*

Table 5, column (5) summarizes the average gender bias in the Indian height deficit. The India dummy is small and insignificant and the coefficient on $India \times Girl$ is -0.14. Thus, overall, only Indian girls show a child height disadvantage relative to Africa and this gender deficit remains significant when we include additional covariates (column 6), and also when we estimate a regression with mother fixed effects (column 7). Column (8) shows that Indian girls are relatively disadvantaged in terms of weight-for-age as well.

Eldest versus general son preference

An overall gender gap in child height would also be observed if parents favor all sons and not just their eldest sons. This raises the question of whether India's birth order gradient and height gap are driven by eldest son preference or general son preference. As we elaborate on below, while both types of son preference are present – Indian parents favor all sons over daughters and also favor the eldest son over other sons – eldest son preference appears to be what causes the birth order gradient.

As evidence that India exhibits general son preference, when we compare boys and girls with an older brother, the boys enjoy a relative height advantage over the girls in India. In other words, even non-eldest sons are favored over girls. However, general son preference cannot by itself explain two patterns we see in the data. First, general son preference does not predict a birth order gradient among boys (Prediction 1). Second, the within-India evidence using matrilineal states indicates that the birth order gradient is linked to eldest son preference. We showed earlier that matrilineal states have a shallower gradient and a higher level of height than the rest of India. If what differentiates these states from the rest of India is weaker eldest son preference, then both girls and non-eldest sons should do better in these states. If, instead, matrilineal states differ in their general son preference, then we should see a smaller girl disadvantage in these states but no obvious gains among non-eldest boys in these states. Figure 3 plots average child height in all-India and the matrilineal states in comparison to the Africa sample and shows that both girls and non-eldest sons fare much better in matrilineal states than the rest of India, while eldest sons enjoy a much smaller gain.[23] In other words, what distinguishes the matrilineal states, where we see a shallow gradient, from the rest of India is how not just girls but also non-eldest sons are treated.

4.3 Implications of son-biased fertility-stopping behavior

We now further drill down on the implications of son-biased fertility-stopping behavior for resource allocation across siblings. The birth of a daughter with no older brothers causes her parents to exceed their intended fertility to try again for a son, reducing resources spent on her. Our first test seeks to provide evidence on the "try again" mechanism, separate from the sibling rivalry mechanism that posits that having a brother worsens outcomes for a girl because she has to compete with him for resources (Garg and Morduch, 1998).

At the prenatal stage, both mechanisms benefit daughters without an older brother: there is no sibling rivalry and parents will invest in her while she is *in utero* anticipating

[23]Less eldest son preference might also imply that eldest sons do worse in matrilineal states than the rest of India given a household budget constraint. The fact that they do slightly better likely derives from higher overall spending on children in matrilineal societies (Lowes, 2016). Also, while girls' and non-eldest boys' disadvantage relative to Africa is smaller in matrilineal states than in the rest of India, it still exists (Appendix Table 11. We return to this fact while doing the accounting exercises in section 4.6.

that – with 50 percent chance – they are investing in their eldest son.[24] Post-birth, the negative effects of son-biased fertility-stopping behavior materialize as parents re-optimize fertility and expenditure decisions. Thus, at the postnatal stage, not having an older brother disadvantages girls through the fertility continuation mechanism.

Prediction 3. *Relative to African counterparts, later parity girls with no older brothers in India face larger disadvantages in postnatal than prenatal investments.*

Table 6 reports results from regressions estimated at the input-level for the sample of girls. We consider the set of inputs reported in Table 3 and distinguish between prenatal and postnatal inputs. In columns (1) and (2) we see a positive and significant coefficient on $I_c \times PrenatalInputs \times NoElderBro$. This tells us that parents allocate more prenatal inputs during a pregnancy when they do not have any sons. Strikingly, this pattern is exactly reversed for postnatal inputs, and we observe a negative and significant coefficient on $I_c \times NoElderBro$.

Given this evidence, we examine how height deficits vary with the gender of elder siblings. If the fertility-stopping mechanism dominates the sibling rivalry mechanism, then Indian daughters with only sisters as elder siblings should do relatively worse than their African counterparts, and vice versa.

Among boys, eldest sons in India should do well, but those born at late parity may suffer as their parents expended resources on a more-than-planned number of daughters. A family with desired fertility of two children and an eldest son born at birth order 1 or 2 need not exceed desired fertility. By contrast, while an eldest son born at birth order 3 might fare better than his sisters and better than any subsequent sons, across families, he might be disadvantaged relative to eldest sons born at earlier birth order because his family expended resources on his older sisters and exceeded their desired fertility. To summarize,

Prediction 4. *Relative to African counterparts, outcomes for Indian children will vary with sibling composition and birth order as follows:*

a. If fertility stopping effects dominate sibling rivalry effects, then later parity girls with no older brothers will show larger height deficits.

[24] Specifically, relative to postnatal investments, prenatal investments for a daughter will be better (in a family that has no son) as it will be based on expected, not realized, gender. Later in this section, we discuss robustness to prenatal sex determination.

b. High birth order eldest sons fare worse than eldest sons born at lower birth order.

To test (a), we estimate the model described in equation (2), with height as the outcome. The coefficient on $I_c \times NoElderBro$ captures the differential outcome for a family's eldest son in India, and the coefficient on $I_c \times Girl \times NoElderBro$ captures the differential outcome for a girl in India who either only has sisters as older siblings or is the firstborn. In Table 6, column (3) we observe a positive coefficient on $I_c \times NoElderBro$. Adding in the main effect, relative to his African counterpart, an Indian eldest son enjoys a 0.15 z-score height advantage. The coefficient on $I_c \times Girl \times NoElderBro$ shows that the opposite is true for girls: having no older brother is worse than having an older brother. The net effect for girls of lacking an elder brother is negative in India than Africa ($I_c \times NoElderBro + I_c \times Girl \times NoElderBro$), but insignificant. In column (4), this finding of lower height for girls in India who only have sisters as elder siblings is marginally significant (p-value of 0.07). Thus, the son-biased fertility mechanism appears to slightly dominate, such that not having an older brother on net disadvantages girls.

Column (3) also allows us to examine whether eldest sons born at later parity are advantaged as long as they are born within their family's desired family size. $I_c + I_c \times 2^{nd}Child + I_c \times NoElderBro$, which gives the relative Indian advantage for an eldest son at birth order 2, is positive and significant (p-value of 0.037). Meanwhile, an eldest son born at birth order 3 does worse in India than Africa which is consistent with Prediction 4(b), assuming that families want two children (the modal preference in India). Columns (5) and (6) show similar patterns using weight-for-age as the outcome.

In unreported results, we observe a birth order gradient between a family's second and third sons suggesting that our model cannot explain all birth order patterns across siblings. Nonetheless, taken together the observed patterns in the data point to eldest son preference being an important determinant of resource allocation across siblings and fertility stopping behaviors – and consequently child height – in India. In Section 4.6 we provide an accounting exercise that quantifies the fraction of the India-Africa height gap that can be explained by the eldest son preference mechanism.

4.4 Sex selection as a potential confound

The incidence of sex-selective abortions is higher in India than Africa, raising concerns about selection into high fertility in India. Wealthier households in India are more likely to use sex-selection techniques; both as measured by use of ultrasound and incidence of skewed sex ratios. If poor families who do not have a son within their desired family size try again for a son, while wealthy families use sex-selection, then, first, this could cause poor families to be overrepresented at high birth order in India (relative to Africa). Second, if wealthy households who have girls at low birth order are particularly likely to engage in sex-selection then girls at birth order 2 or 3 may belong to relatively poor households in India, so treating gender as an exogenous variable is problematic. This could create selection bias when we include interactions with the child's or siblings' gender.

On the first concern, Table 2 already showed that our results are not driven by differential household selection into high fertility: the India-Africa gap in the birth order gradient is robust to allowing for differential effects of socioeconomic variables in India, and importantly to the inclusion of family fixed effects interacted with India.

To address the concern that endogenous child gender in India may bias our estimates, we replicate our main results with the first NFHS survey. This survey was conducted in 1992-3, which was prior to significant sex-selection by Indian families (Jha et al., 2011). To create the comparison sample of African countries, we consider the 18 African countries with DHS surveys between 1991 and 1997. First, Appendix Table 6 shows that the differential birth order gradient in height and weight between India and Africa holds up for this sample, and the magnitudes are comparable to our main results. Next, Appendix Table 7 replicates the results that use the child's or his or her siblings' gender. Columns (1) and (4) show an overall height and weight deficit for girls. We also continue to find a steeper birth order gradient in India than Africa for both boys and girls (columns 2 and 5). Column (3) and (6) find some evidence that eldest sons are the most advantaged in India and having an older brother is a net positive for girls; the point estimate is similar to the result in NFHS-3 but is statistically insignificant. (It is worth noting that theoretically the net effect of having an older brother on a girl's height is ambiguous).[25]

[25] Very limited data on postnatal health inputs in NHFS-1 makes it infeasible to estimate regressions that use pooled inputs.

A different worry is whether the fertility-continuation behavior that we posit contributes to the birth order gradient was made obsolete by sex-selective abortion by the time of NFHS-3. To allay this concern, we show that the "try again" approach was still prevalent at the time of NFHS-3. Even when sex-selective abortion is available, it is financially, physically, and psychologically costly, and many families continue to use son-biased fertility-stopping rules. Appendix Table 8 shows this by examining, first, whether families have gone beyond their desired fertility and, second, whether they want more children even if they are already at or beyond their desired fertility. In India, families are more likely to go beyond their desired fertility or want to go beyond their desired fertility if they do not yet have a son. The prevalence of fertility continuation is, as expected, somewhat diminished in NFHS-3 compared to NFHS-1, but importantly it is still very pronounced in NFHS-3: For example, not having a son yet is associated with an 19 percentage point increase in the desire to go beyond one's desired family size to have another child in India.

4.5 Alternative explanations

We conclude this section by examining a set of alternative explanations for India's steep birth order gradient in height. Appendix Table 9 reports the results.

Health conditions

Maternal health. Indian mothers are, on average, six centimeters shorter than African mothers. To examine whether maternal health endowment has differential effects on child height by birth order, column (1) presents our basic birth order regression adding in interactions between mother's height and birth order.[26] The test is whether including mother's height "knock outs" the stronger birth order gradient in India, and it does not: The coefficients on $Mother'sHeight \times BirthOrder$ dummies are small and insignificant, and the steep Indian birth order gradient remains.[27]

[26] This possibility is related to Deaton and Drèze's (2009) gradual catch-up hypothesis which posits that if a mother's poor nutrition and health as a child, in turn, affect her children's size then India's height gap could take generations to close.

[27] In Jayachandran and Pande (2015), we examined India-Africa differences in how, holding constant number of children born, maternal nutritional inputs and outcomes vary with a woman's pregnancy status: Relative to African mothers, Indian women show a greater drop-off in food consumption and hemoglobin levels across successive pregnancies. These India-Africa differences are absent among non-pregnant mothers. This suggest that differences in preferences, not a steeper decline in Indian household resources over the lifecycle relative to African counterparts, underlies observed birth order patterns.

Disease environment. Spears (2013) highlights India's high rate of open defecation as a contributor to child stunting. Even absent changes in a household's sanitation infrastructure, later-born children may have a worse disease environment because older siblings expose them to pathogens or because they receive lower-quality care. Column (2) shows that there is no appreciable birth order gradient for diarrhea in India. Column (3) directly shows that controlling for the rate of open defecation does not diminish the magnitude of the India-Africa birth order gradient in child height.

Other cultural norms

Communal child-rearing. The presence of older siblings will typically reduce the time parents can devote to later-born infants. This constraint may be less strict in Africa which has a strong norm of relatives and neighbors helping raise children (Goody, 1982), allowing greater investments in later born children. To test this hypothesis, we consider two PSU-level "communal child-rearing" proxies: The proportion of women's children under ten years in age who are non-resident in their household and the number of adult females in the household. While both proxies are higher in Africa, the India-Africa birth order gradient is robust to inclusion of either proxy (columns 4 and 5).

Land scarcity. In Africa, where land is more abundant, parents might value a larger number of children as farm help, and this could imply that early and later-born children are more equally valued. This, in turn, could have engendered an African norm of valuing higher birth order children more. In column (6) we include the 1961 ratio of population to land area as a proxy for historical land scarcity. By this metric, while land is indeed more scarce in India than Africa it cannot explain why height drops off so steeply with birth order in India.

In sum, we find limited evidence that these alternative explanations can cause a large differential birth order gradient in height in India compared to Africa. Moreover, they do not predict several other patterns observed: how height varies with older siblings' gender, how health inputs vary with birth order and gender, and how having an older brother differentially impacts girls' prenatal versus postnatal inputs. In this sense, eldest son preference is likely unique in offering a parsimonious explanation for not just the birth order gradient but also a suite of other facts.

4.6 Impact on average height

The inequality across children in health inputs and outcomes that we document is important *per se* if we value equity. But does it also affect the average height gap across India and Africa, which is an important motivation for our paper?

Our within-India comparisons provide suggestive evidence. There is higher average height and a shallower birth order gradient for Indian subgroups with less son preference such as Kerala and the Northeast. A second piece of supportive evidence comes from the literature documenting diminishing returns to inputs for adult height (Steckel, 1995). While our data do not allow for a rigorous estimation of a similar height production function for child height, using the IHDS data we find that child height exhibits diminishing returns to household income and expenditures in India (Appendix Table 10). We use the IHDS because, unlike NFHS, it provides measures of family resources that have a cardinal interpretation (income, expenditures). The ideal data, which we lack, is child-level expenditures.

The above facts suggest a link, but leave open the question of how much of the level deficit is explained by the gradient. To this end, we conduct two back-of-the-envelope calculations to estimate: (a) how much of the India-Africa height gap is explained by the birth order gradient, and (b) how much is explained specifically by eldest son preference generating a birth order gradient.

The first step is to estimate the correlation between the birth order gradient and level of height across countries in our African subsample. Up until now, our regressions have quantified the birth order gradient via the coefficients on birth order 2 and on birth order 3 and higher (relative to birth order 1). For our accounting exercise we need to collapse this information into a single country-specific summary measure, and we do this in two ways. Our first gradient proxy is defined as the average height gap between first and second-borns and between first and third-borns and higher, weighted by the observed distribution of birth order in that country. To obtain our second proxy we estimate, separately for each country, a regression of height on a linear birth order variable, top-coded at birth order 3, and then use the regression coefficient as the gradient proxy. The first approach has the advantage that it does not impose linearity (i.e. that the dropoff in height from birth order 1 to 2 is the same as the drop-off from birth order 2 to 3+), while the second approach uses a measure derived from regression analysis, paralleling the analyses presented earlier in the paper.

Appendix Table 1 shows the correlation between the HFA z-score and each gradient proxy. We use only the African sample so that this calculation is not "assuming the answer" by comparing India (with its steeper gradient and lower average height) to Africa. The regression includes controls for child age dummies and real GDP per capita in the child's birth year. Column (2) uses the first gradient proxy, and we observe a strong negative correlation between the level of height and the gradient proxy.[28] For (a) – quantifying the role of the birth order gradient – we multiply the coefficient of -0.400 from column (2) by the India-Africa gap in the birth order gradient. Assuming that Indian children showed the same relationship between average child height and the birth order gradient as African children, this product provides an estimate of how much India's steeper-than-usual birth order gradient depresses its average height compared to Africa. We can then compare this explained amount (-0.106 z-score points) to the overall India-Africa height gap (adjusted for GDP per capita) in column (1) of -0.162 z-score points. This exercise suggests that the birth order gradient accounts for 65% of the Indian height puzzle. When we repeat the exercise using the second gradient proxy, we again find a significant correlation between the HFA z-score and the gradient proxy (column 3), and we find that the birth order gradient accounts for 84% of the Indian height deficit.

For (b), we use the matrilineal states of Kerala and the Northeast as a proxy for India without eldest son preference and conduct a similar calculation. Using the first gradient proxy, Kerala and the Northeast have an average gradient that is 0.129 z-score points smaller in magnitude than the rest of India. This gradient difference multiplied by the gradient-level correlation accounts for a -0.052 z-score level deficit. Thus, the birth order gradient rooted in eldest son preference explains 32% of the India-Africa height gap (or 43% using the second gradient proxy). The fact that half (32%/65% with the first gradient proxy and 43%/84% with the second) rather than all of the birth order gradient effect is explained by eldest son preference in this exercise could be due to Kerala and the Northeast having some son preference compared to Africa even though they have low eldest son preference compared to

[28]Appendix Figure 1 shows the scatter plot of average height and the gradient proxy. Panel A and Panel B correspond to the gradient proxies in Columns 2 and 3, respectively. India is roughly on the regression line, but slightly below, consistent with the birth order gradient explaining much but not all of India's height deficit in our accounting exercise.

the rest of India,[29] or to other mechanisms such as those discussed in the previous subsection also contributing to India's steep gradient.

These accounting exercises by no means establish a causal link between the gradient and level, but they are suggestive that eldest son preference and the birth order gradient have quantitatively important implications for average height in India.

5 Conclusion

This paper compares child height-for-age in India and Africa in order to shed light on India's puzzlingly high rate of stunting. Several facts point to intra-family allocation decisions as a key factor. First, India's height disadvantage emerges with second-born children and increases with birth order. Second, investments in successive pregnancies and higher birth order children decline faster in India than Africa.

We examine a specific mechanism that could drive the India-Africa birth order gradient in child height: eldest son preference. We compare subgroups within India and show that subgroups with lower son preference exhibit a shallower birth order gradient. We then derive a set of predictions linking the extent of unequal resource allocation within a family to the gender composition of siblings and find that these predictions are supported in the data. We take this as evidence that son-biased fertility stopping rules are an important factor linking eldest son preference and the observed birth order gradient in child height. Finally, an accounting exercise suggests that roughly two thirds of India's child height deficit (relative to Africa) can be explained by India's steeper birth order gradient. Half of this can be attributed to eldest son preference in India.

One might expect that unequal allocation in the household will matter less as India develops. With greater financial resources, families could provide all children with enough food and health care to achieve their height potential. The time trend in India can shed some light on this: Between the earlier and recent NFHS waves of data, the stunting rate in India indeed fell, but it remains very high. Malnutrition could eventually be an obsolete problem, but India still appears decades away from this achievement. Moreover, the inequality across birth order has persisted over time. Parents' son preference and unequal investment in

[29] Appendix Table 11 shows that in India's matrilineal states, girls have a height deficit relative to Africa and there is a steeper birth order gradient than Africa.

children do not seem to be diminishing. Even cross-sectionally, richer families in India show a steeper birth order gradient than poorer ones.[30]

Thus, even once the problem of chronic malnutrition is solved, other important human capital investments might remain unequally allocated within families. This matters, first, because if the investments have diminishing returns, unequal investment will depress India's total human capital and economic growth. Second, intra-family inequality might widen societal inequality which, in turn, could limit the economic opportunities available to many, exacerbate societal discord, or have other attendant ills.[31] Third, and perhaps most importantly, most societies value equality per se (Sen, 1992). For all these reasons, policies to counteract the intra-family allocation decisions that parents are making, such as poverty-alleviation programs targeted toward specific children, could be very valuable. The need for such policies might be especially strong in India, given the level and persistence of its intra-family inequality.

[30]The analysis behind this finding is reported in Jayachandran and Pande (2015) where we examine cross-sectional heterogeneity by wealth within India to infer the likely effect of economic development (given the caveat that the wealthy may also differ on unobserved characteristics that predict son preference such as caste). We also find that at each birth order, children in wealthier households (defined as those in the top two quintiles of the wealth index) are taller than those in less wealthy families, and that even among the wealthy, stunting is prevalent (the rate is 21%).

[31]The effects of intra-family inequality may be distinct from those of general inequality. For instance, it might translate into differences in bargaining power enjoyed by siblings once they form independent households. See Chiappori and Meghir (forthcoming).

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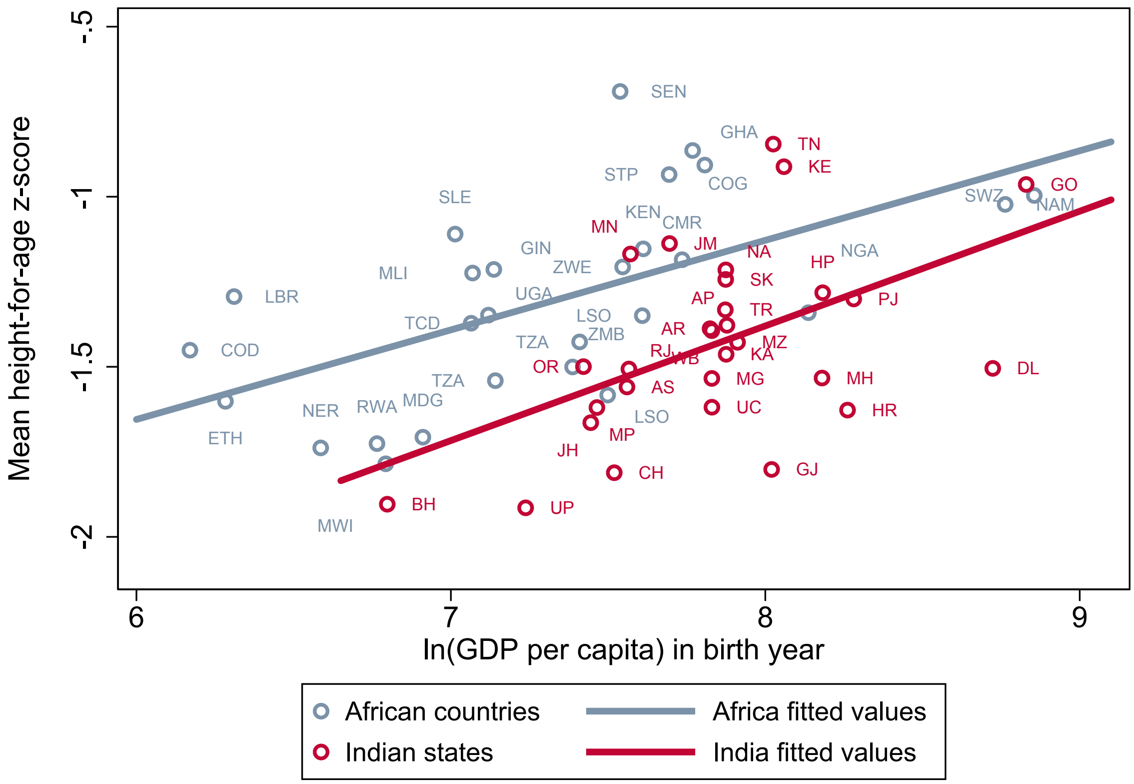
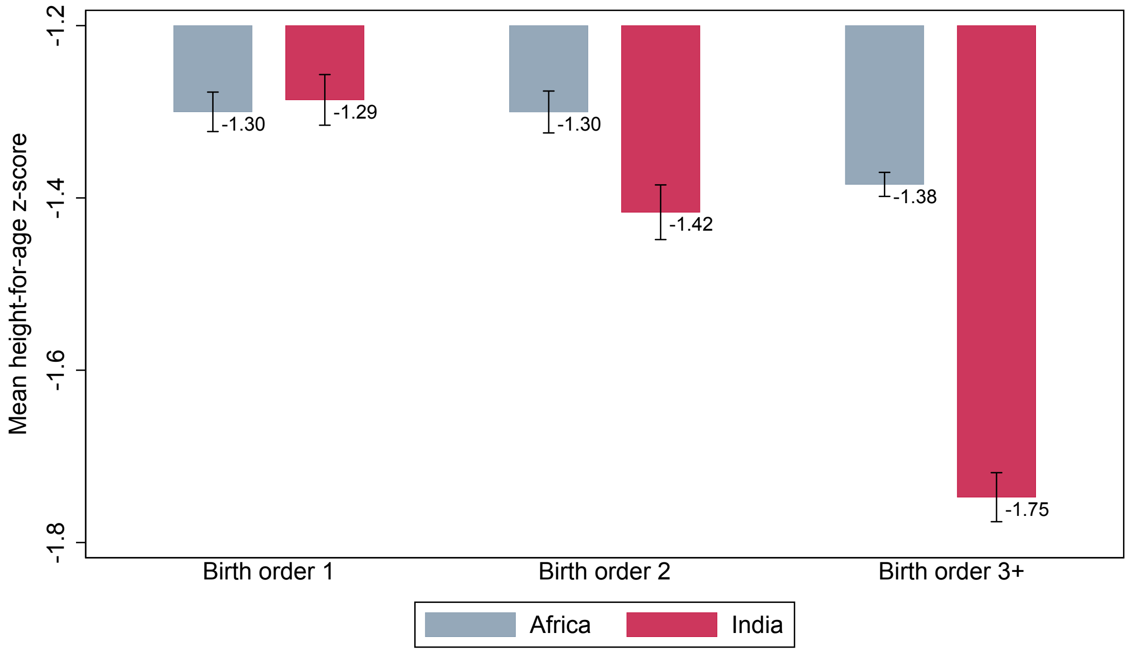
Figure 1: Child height versus national GDP



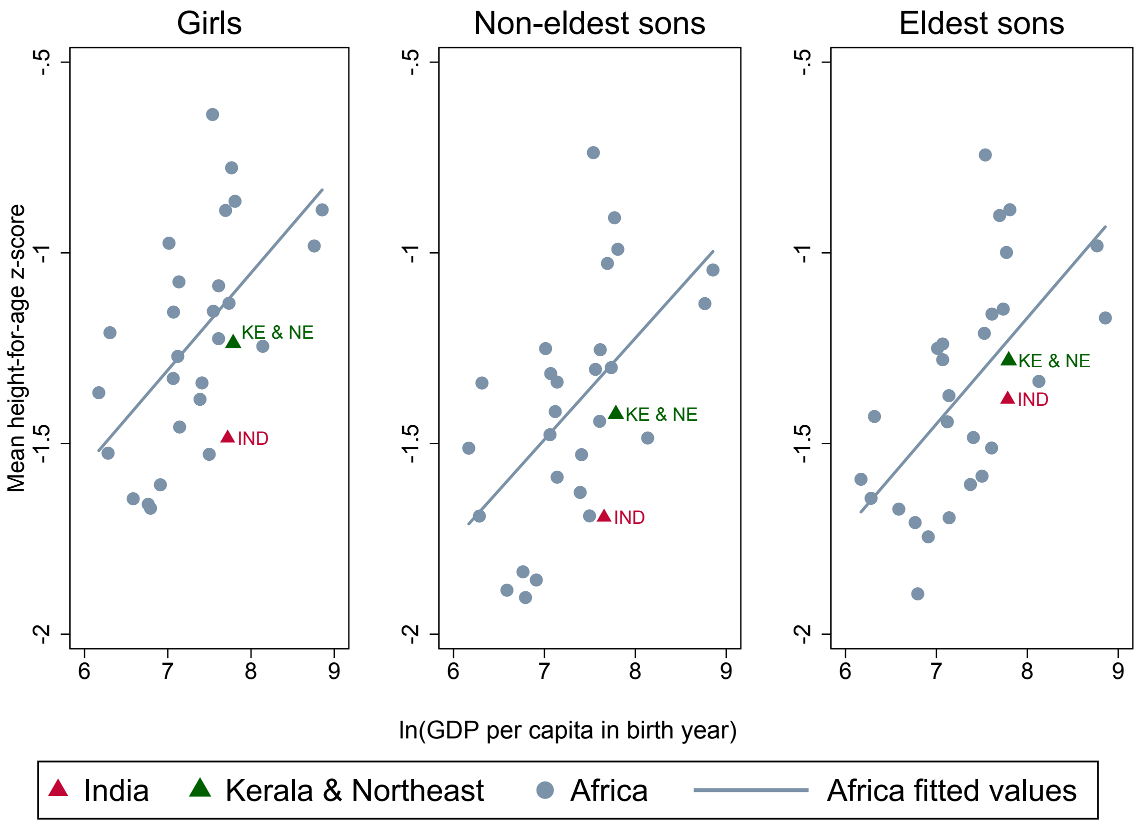
Notes: The light blue and dark red circles represent Sub-Saharan Africa countries and Indian states, respectively. The averages are calculated over all children less than 60 months old. The lines represent the best linear fit for each sample. National GDP data are based on the Penn World Table 9.0 (Feenstra et al., 2015).

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



Notes: 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.

Figure 3: Height of Indian children relative to Africa



Notes: The difference between the gap between the Africa fitted line and *Kerala & Northeast* and the gap between the Africa fitted line and *India* is 0.231 for girls, 0.235 for non-eldest sons, and 0.098 for eldest sons. GDP data are based on the Penn World Table 9.0 (Feenstra et al., 2015).

Table 1: Summary statistics

	India subsample	Africa subsample		India subsample	Africa subsample
Mother's age at birth (years)	24.75	26.96	Child's age (months)	30.20	28.27
	[5.23]	[6.86]		[16.90]	[17.06]
Mother's total children born	2.74	3.88	Child is a girl	0.48	0.50
	[1.82]	[2.54]		[0.50]	[0.50]
Mother's desired fertility	2.47	4.62	Child's birth order	2.62	3.74
	[0.96]	[1.47]		[1.80]	[2.48]
Mother wants more children	0.34	0.67	Child's HFA z-score	-1.51	-1.35
	[0.47]	[0.46]		[1.81]	[1.94]
Mother completed her fertility	0.67	0.33	Child is stunted	0.40	0.38
	[0.47]	[0.47]		[0.49]	[0.48]
Mother is literate	0.58	0.50	Child's WFA z-score	-1.53	-0.88
	[0.49]	[0.50]		[1.33]	[1.42]
Mother's height (meters)	1.52	1.58	Child's hemoglobin level (g/dl)	10.28	10.15
	[0.06]	[0.07]		[1.57]	[1.68]
Mother took iron supplements	0.69	0.62	Child is deceased	0.05	0.07
	[0.46]	[0.48]		[0.22]	[0.26]
Mother's total tetanus shots	1.87	1.41	Child taking iron pills	0.06	0.11
	[0.94]	[1.20]		[0.23]	[0.32]
Total prenatal visits	4.04	3.85	Child's total vaccinations	6.61	6.24
	[3.48]	[3.07]		[2.80]	[3.12]
Delivery at health facility	0.45	0.47	Birth spacing (months)	36.16	38.69
	[0.50]	[0.50]		[20.32]	[20.63]
Postnatal check within 2 months	0.09	0.30	Diarrhea in last 2 weeks	0.09	0.16
	[0.29]	[0.46]		[0.29]	[0.36]
Average pooled inputs	0.33	0.38	Open defecation	0.46	0.32
	[0.28]	[0.30]		[0.50]	[0.47]
% non-resident among children	0.02	0.10	Land scarcity	5.03	2.56
	[0.04]	[0.08]		–	[1.17]
Number of adult females in household	1.85	1.60	Number of PSUs	3,822	10,366
	[1.09]	[1.06]			
Log GDP per capita (in child's birth year)	7.78	7.36	Main sample of children <60 months (N)	42,069	126,039
	[0.10]	[0.65]			

Notes: The means of the specified variables are calculated separately for the India and Africa subsamples. Standard deviations appear in brackets. The following variables are summarized at the mother level: total children born, mother's desired fertility, wants more children, mother completed her fertility, mother is literate, and mother's. Total prenatal visits, mother took iron supplements, total tetanus shots, postnatal check within 2 months are also, in effect, summarized at the mother level because they are only available for the most recent birth. Variables summarized at the child level include: mother's age at birth, birth spacing (the birth interval between a child and his or her older sibling), delivery at health facility, average pooled inputs, all child variables (first 10 variables in the second column), diarrhea in last 2 weeks, open defecation, % non-resident among children, number of adult females in the household, and log GDP per capita in child's birth year. Land scarcity is summarized at the country level.

Table 2: Birth order gradient gap in child height and related outcomes: India vs. Africa

	HFA z-score (1)	HFA z-score (2)	HFA z-score (3)	HFA z-score (4)	HFA z-score (5)	Stunted (6)	WFA z-score (7)	Hb level (8)	Deceased (9)
India	-0.082***	0.092***							
	[0.011]	[0.018]							
India × 2nd child		-0.144***	-0.161***	-0.110*	-0.243***	0.051***	-0.146***	-0.091***	0.003
		[0.025]	[0.027]	[0.063]	[0.048]	[0.007]	[0.020]	[0.031]	[0.004]
India × 3rd+ child		-0.377***	-0.227***	-0.193**	-0.436***	0.064***	-0.198***	-0.158***	0.002
		[0.024]	[0.032]	[0.092]	[0.085]	[0.009]	[0.024]	[0.036]	[0.004]
2nd child		0.023	-0.011	-0.097*	-0.167***	0.009**	0.009	-0.013	-0.014***
		[0.015]	[0.017]	[0.053]	[0.027]	[0.004]	[0.012]	[0.022]	[0.002]
3rd+ child		-0.066***	-0.118***	-0.169**	-0.334***	0.036***	-0.063***	-0.038	-0.011***
		[0.013]	[0.019]	[0.074]	[0.044]	[0.005]	[0.014]	[0.026]	[0.003]
Africa mean of outcome	-1.351	-1.351	-1.351	-1.351	-1.351	0.375	-0.877	10.145	0.071
Child's age dummies × India	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Mother's literacy × India	No	No	Yes	Yes	No	Yes	Yes	Yes	Yes
Mother's age at birth × India	No	No	Yes	Yes	No	Yes	Yes	Yes	Yes
PSU FEs	No	No	Yes	Yes	No	Yes	Yes	Yes	Yes
Mother FEs	No	No	No	No	Yes	No	No	No	No
Completed fertility sample	No	No	No	Yes	No	No	No	No	No
Observations	168,108	168,108	167,737	66,566	83,228	167,737	167,737	87,124	199,514

Notes: Standard errors are clustered by mother and appear in brackets. Asterisks denote significance: * $p < .10$, ** $p < .05$, *** $p < .01$. *HFA z-score* is the child's height-for-age z-score, *Stunted* is defined as having an HFA z-score ≤ -2, *WFA z-score* is the child's weight-for-age z-score, and Hb level is the child's hemoglobin level. *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. Child age dummies are included in all columns. In columns (3)-(4) and (6)-(9), the main effect *India* is absorbed by PSU fixed effects. In column (5), the main effect *India* is absorbed by mother fixed effects. Columns (3)-(4) and (6)-(9) include PSU fixed effects, a linear and a quadratic variable for mother's age at birth, mother's literacy, and mother's literacy, maternal age, and child age dummies interacted with *India*. In columns (3) and (5)-(9), the sample is restricted to PSUs with at least two children aged 1-59 months. In column (4), the sample is restricted to children whose mothers report that they do not want to have more children, are sterilized, or are infecund. Column (4) includes total fertility dummies, top-coded at 6 children, and total fertility dummies interacted with *India*. In column (8), *Hb level* is defined for children 6 months or older and is not available for six surveys. In column (9), the sample consists of ever-born children aged 13-59 months. See Data Appendix for further details.

Table 3: 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 vac- cinations	Average pooled inputs
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
India × 2nd child	-0.525***	-0.031***	-0.019	-0.040***	-0.009	-0.008	-0.203***	-0.011***
	[0.052]	[0.008]	[0.018]	[0.006]	[0.013]	[0.005]	[0.039]	[0.003]
India × 3rd+ child	-1.012***	-0.071***	-0.036*	-0.092***	0.014	-0.010	-0.462***	-0.033***
	[0.060]	[0.009]	[0.021]	[0.008]	[0.014]	[0.006]	[0.051]	[0.004]
2nd child	-0.181***	-0.014***	-0.112***	-0.088***	0.005	-0.004	-0.098***	-0.044***
	[0.029]	[0.005]	[0.013]	[0.004]	[0.010]	[0.004]	[0.025]	[0.002]
3rd+ child	-0.431***	-0.031***	-0.206***	-0.133***	-0.022**	-0.013**	-0.207***	-0.071***
	[0.033]	[0.005]	[0.014]	[0.004]	[0.011]	[0.005]	[0.030]	[0.003]
Africa mean of outcome	3.846	0.622	1.415	0.472	0.302	0.113	6.245	0.380
India mean of outcome	4.041	0.689	1.872	0.450	0.090	0.055	6.607	0.334
Age & other controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	115,343	117,686	117,199	167,377	35,888	91,936	122,898	167,724

Notes: Standard errors are clustered by mother and appear in brackets. Asterisks denote significance: * $p < .10$, ** $p < .05$, *** $p < .01$. Control variables included are child age dummies, mother's literacy, maternal age, PSU fixed effects, and child age dummies, mother's literacy, and maternal age interacted with *India*. The main effect *India* is absorbed by PSU fixed effects. 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 uses children ages 13-59 months, as the recommended age for some is up to 1 year. In column (8), the average across 4 prenatal and 3 postnatal inputs is used to create the outcome. The dummies are: 1) total prenatal visits >3; 2) mother took iron supplements; 3) mother's total tetanus shots >2; 4) child was delivered at a health facility; 5) child is taking iron pills; 6) total vaccinations >8; 7) child had postnatal check within 2 months of birth. See Data Appendix for further details.

Table 4: Cultural norms and child height: Within-India evidence

Low son preference proxy:	*Kerala & Northeast*			*Below-median child sex ratio*			*Muslims*		
	HFA z-score (1)	WFA z-score (2)	HFA z-score (3)	HFA z-score (4)	WFA z-score (5)	HFA z-score (6)	HFA z-score (7)	WFA z-score (8)	HFA z-score (9)
Low son pref proxy × 2nd child	0.078**	0.008	1.040**	0.078***	0.039*	0.374	-0.027	0.034	0.212
	[0.039]	[0.029]	[0.515]	[0.030]	[0.023]	[0.236]	[0.047]	[0.035]	[0.360]
Low son pref proxy × 3rd+ child	0.108**	0.069**	1.793*	0.081**	0.044	1.065***	0.184***	0.156***	-0.279
	[0.045]	[0.033]	[1.043]	[0.036]	[0.027]	[0.372]	[0.055]	[0.041]	[0.568]
2nd child	-0.185***	-0.154***	-0.578***	-0.207***	-0.173***	-0.650***	-0.159***	-0.153***	-0.573***
	[0.017]	[0.013]	[0.116]	[0.020]	[0.015]	[0.140]	[0.017]	[0.013]	[0.123]
3rd+ child	-0.422***	-0.350***	-0.472**	-0.437***	-0.363***	-0.738***	-0.412***	-0.354***	-0.413**
	[0.020]	[0.015]	[0.183]	[0.024]	[0.019]	[0.218]	[0.021]	[0.016]	[0.193]
Low son pref group mean of outcome	-1.388	-1.198	-1.407	-1.561	-1.491	-1.485	-1.732	-1.602	-1.227
High son pref group mean of outcome	-1.710	-1.648	-1.557	-1.721	-1.622	-1.584	-1.691	-1.628	-1.575
Sample	NFHS 1-3	NFHS 1-3	IHDS 1	NFHS 1-3	NFHS 1-3	IHDS 1	NFHS 1-3	NFHS 1-3	IHDS 1
Age & other controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	95,125	95,125	3,615	95,125	95,125	3,615	82,084	82,084	3,405

Notes: Standard errors are clustered by mother and appear in brackets. Asterisks denote significance: * $p < .10$, ** $p < .05$, *** $p < .01$. In columns (1)-(2), (4)-(5) and (7)-(8), the sample uses NFHS 1-3. NFHS-1 only has data for children aged 4 years and younger, and NFHS-2 only has data for children aged 3 years and younger. In columns (3), (6) and (9), the sample uses IHDS 1 and consists of children aged 1-59 months in IHDS 1 whose mothers (likely) had completed their fertility, i.e. their mothers did not give birth between Wave 1 and Wave 2. All columns include child age dummies, maternal age, mother's literacy, and child age dummies, maternal age, and mother's literacy interacted with *Low son pref proxy*. Columns (1)-(2), (4)-(5) and (7)-(8) include survey and PSU fixed effects, and survey and PSU fixed effects interacted with *Low son pref proxy*. Columns (3), (6) and (9) include total fertility dummies, top-coded at 6 children, and total fertility dummies interacted with *Low son pref proxy*. In columns (1)-(2) and (4)-(5), the main effect *Low son pref proxy* is absorbed by PSU fixed effects. In columns (3) and (6)-(9), the main effect *Low son pref proxy* is included but not shown. *Kerala & Northeast* include Arunachal Pradesh, Assam, Kerala, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim and Tripura. *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 respondents state-by-rural cell. In columns (7)-(9), the sample is restricted to Muslims and Hindus. See Data Appendix for further details.

Table 5: Child gender and the birth order gradient in height

	HFA z-score (1)	HFA z-score (2)	HFA z-score (3)	WFA z-score (4)	HFA z-score (5)	HFA z-score (6)	HFA z-score (7)	WFA z-score (8)
India	0.148***				-0.011			
	[0.026]				[0.014]			
India × Girl	-0.111***				-0.143***	-0.147***	-0.098***	-0.116***
	[0.036]				[0.020]	[0.019]	[0.032]	[0.014]
India × 2nd child	-0.107***	-0.152***	-0.228***	-0.122***				
	[0.036]	[0.040]	[0.069]	[0.030]				
India × 3rd+ child	-0.352***	-0.221***	-0.414***	-0.175***				
	[0.033]	[0.047]	[0.097]	[0.035]				
India × 2nd child × Girl	-0.076	-0.045	-0.024	-0.047				
	[0.053]	[0.057]	[0.101]	[0.043]				
India × 3rd+ child × Girl	-0.051	-0.048	-0.030	-0.064				
	[0.047]	[0.067]	[0.092]	[0.049]				
Africa mean of outcome	-1.575	-1.575	-1.575	-1.575	-1.351	-1.351	-1.351	-1.351
Age & other controls	No	Yes	No	Yes	No	Yes	No	Yes
Mother FEs	No	No	Yes	No	No	No	Yes	No
Observations	168,108	165,596	83,228	165,596	168,108	167,737	83,228	167,737

Notes: Standard errors are clustered by mother and appear in brackets. Asterisks denote significance: * $p < .10$, ** $p < .05$, *** $p < .01$. Child age dummies are included in all regressions. Columns (2), (4), (6) and (8) additionally include mother's literacy, maternal age and PSU fixed effects. In columns (2) and (4), child age dummies, maternal age, and mother's literacy are interacted with *Girl*, *India*, and *India* × *Girl* and PSU fixed effects are interacted with *Girl*. In columns (3) and (7), the main effect *India* is absorbed by mother fixed effects. In columns (2) and (4), the main effects *India* and *India* × *Girl* are absorbed by PSU fixed effects and their interactions with *Girl*. In columns (6) and (8), the main effect *India* is absorbed by PSU fixed effects. The main effect *Girl* is included in all regressions but not shown. In columns (1)-(3), coefficients for *2nd child* and *3rd+ child*, *2nd child* × *Girl* and *3rd+ child* × *Girl* are included in the regression but not shown. See Data Appendix for further details.

Table 6: Heterogeneity by the gender of older siblings

	Pooled inputs (1)	Pooled inputs (2)	HFA z-score (3)	HFA z-score (4)	WFA z-score (5)	WFA z-score (6)
India × Prenatal input	0.047***					
	[0.004]					
India × Prenatal input × No elder brother	0.057***	0.034***				
	[0.006]	[0.007]				
India × Girl			-0.021		0.008	
			[0.066]		[0.050]	
India × Girl × No elder brother			-0.091*	-0.103*	-0.088**	-0.110***
			[0.055]	[0.058]	[0.041]	[0.042]
India × No elder brother	-0.036***	-0.025***	0.060	0.024	0.059**	0.081***
	[0.007]	[0.006]	[0.038]	[0.040]	[0.029]	[0.029]
India	-0.022***		0.088*		-0.488***	
	[0.007]		[0.047]		[0.036]	
India × 2nd child	-0.028***	-0.034***	-0.080**	-0.142***	-0.098***	-0.084**
	[0.007]	[0.005]	[0.041]	[0.044]	[0.031]	[0.033]
India × 3rd+ child	-0.120***	-0.060***	-0.311***	-0.208***	-0.239***	-0.119***
	[0.007]	[0.007]	[0.046]	[0.056]	[0.035]	[0.042]
India × Girl × 2nd child			-0.118**	-0.093	-0.086*	-0.099**
			[0.059]	[0.064]	[0.045]	[0.047]
India × Girl × 3rd+ child			-0.122*	-0.122	-0.139***	-0.143**
			[0.065]	[0.080]	[0.049]	[0.058]
Africa mean of outcome	0.385	0.385	-1.351	-1.351	-0.877	-0.877
p-value: India + India × No elder brother=0			0.000		0.000	
p-value: India × No elder brother + India × Girl × No elder brother=0			0.448	0.070	0.343	0.355
p-value: India + India × 2nd child + India × No elder brother=0			0.037		0.000	
p-value: India + India × 3rd+ child + India × No elder brother=0			0.000		0.000	
Sample	Girls	Girls	Children	Children	Children	Children
Age & other controls	No	Yes	No	Yes	No	Yes
Observations	379,055	377,922	168,108	165,596	168,108	165,596

Notes: Standard errors are clustered by mother and appear in brackets. Asterisks denote significance: * $p < .10$, ** $p < .05$, *** $p < .01$. Control variables include child age dummies. Even columns control for maternal age, mother's literacy, PSU fixed effects, and child age dummies, maternal age, and mother's literacy interacted with *India*. Column (2) additionally includes child age dummies, maternal age, and mother's literacy interacted with *Prenatal input* and *India* × *Prenatal input* and PSU fixed effects interacted with *Prenatal input*. Columns (4) and (6) includes child age dummies, maternal age, and mother's literacy interacted with *Girl* and *India* × *Girl*, and PSU fixed effects interacted with *Girl*. In column (2), the main effects *India* and *India* × *Prenatal Input* are absorbed by PSU fixed effects and their interactions with *Prenatal input*. In columns (4) and (6), the main effects *India* and *India* × *Girl* are absorbed by PSU fixed effects and their interactions with *Girl*. In columns (1)-(2), all other main effects (*2nd child*, *3rd+ child*, *No elder brother*, *Prenatal Input*, *Prenatal Input* × *No elder brother*) are included but not shown. In columns (3)-(6), all other main effects (*2nd child*, *3rd+ child*, *Girl*, *2nd child* × *Girl*, *3rd+ child* × *Girl*, *No elder brother*, *Girl* × *No elder brother*) are included but not shown. The sample in columns (1)-(2) is girls aged 1-59 months, and the sample in columns (3)-(6) is the main sample of children aged 1-59 months. See Data Appendix for further details.

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Appendix Table 1: Accounting exercise

		Accounting Exercise 1	Accounting Exercise 2
	HFA z-score	HFA z-score	HFA z-score
	(1)	(2)	(3)
India	-0.162***		
	[0.017]		
Gradient proxy		0.400***	0.688***
		[0.070]	[0.132]
Mean of gradient proxy			
India		-0.331	-0.234
Africa		-0.066	-0.037
Kerala & Northeast		-0.229	-0.155
Rest of India		-0.358	-0.257
Log GDP per capita	Yes	Yes	Yes
Sample	Full	Africa	Africa
Observations	168,108	126,039	126,039

Notes: Standard errors are clustered by PSU and appear in brackets. Asterisks denote significance: * $p < .10$, ** $p < .05$, *** $p < .01$. In column (1), the sample consists of children aged 5 or less in NFHS-3 and 27 African countries. In columns (2)-(3), the sample is restricted to African countries. In column (2), *Gradient proxy* is defined as the weighted average of the height gap between second borns and first borns and the height gap between third- and higher-borns and first borns. In column (3), *Gradient proxy* is defined as the regression coefficient that is obtained by regressing, separately by country-wave, HFA z-scores on a linear birth order variable that is top-coded at 3+. All columns include child age dummies and log GDP per capita in the birth year. See Data Appendix for further details.

	Accounting Exercise 1	Accounting Exercise 2
Calculation 1: Share explained by birth order gradient		
– India-Africa gap in birth order gradient	-0.265	-0.197
– India-Africa gap in birth order gradient × Gradient coeff	-0.106	-0.136
– Explained share of India-Africa level gap in height (shown in column 1)	65 %	84 %
Calculation 2: Share explained by birth order gradient rooted in eldest son preference		
– Rest of India - Kerala & NE gap in birth order gradient	-0.129	-0.102
– Rest of India - Kerala & NE gap in birth order gradient × Gradient coeff	-0.052	-0.070
– Explained share of India-Africa level gap in height (shown in column 1)	32 %	43 %

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

	HFA z-score (1)	HFA z-score (2)	HFA z-score (3)	HFA z-score (4)	HFA z-score (5)	HFA z-score (6)	HFA z-score (7)	Height in cm (8)	Height in cm (9)
India × 2nd child	-0.151***	-0.144***	-0.088*	-0.154***	-0.294***	-0.140***	-0.260***	-0.521***	-1.189***
	[0.027]	[0.027]	[0.054]	[0.027]	[0.059]	[0.026]	[0.049]	[0.087]	[0.156]
India × 3rd+ child	-0.201***	-0.219***	-0.223**	-0.215***	-0.541***	-0.218***	-0.429***	-0.670***	-1.823***
	[0.033]	[0.033]	[0.092]	[0.034]	[0.109]	[0.032]	[0.087]	[0.106]	[0.275]
2nd child	-0.014	-0.003	-0.039	-0.033*	-0.311***	-0.041**	-0.199***	-0.105**	-0.752***
	[0.017]	[0.017]	[0.028]	[0.017]	[0.034]	[0.016]	[0.027]	[0.053]	[0.088]
3rd+ child	-0.123***	-0.081***	-0.120***	-0.118***	-0.629***	-0.124***	-0.391***	-0.502***	-1.491***
	[0.020]	[0.020]	[0.045]	[0.020]	[0.061]	[0.019]	[0.044]	[0.063]	[0.141]
Africa mean of outcome	-1.351	-1.351	-1.351	-1.316	-1.316	-1.351	-1.351	81.476	81.476
Age & other controls	Yes	Yes	No	Yes	No	Yes	No	Yes	No
Mother FEs	No	No	Yes	No	Yes	No	Yes	No	Yes
Sample	All	All	All	Birth order ≤4	Birth order ≤4	All	All	All	All
Additional controls	Desired fertility	Birth spacing	Birth spacing	No	No	Birth order among living siblings	Birth order among living siblings	No	No
Observations	167,737	167,737	83,228	121,221	53,133	167,737	83,228	167,737	83,228

Notes: Standard errors are clustered by mother and appear in brackets. Asterisks denote significance: * $p < .10$, ** $p < .05$, *** $p < .01$. All regressions include child age dummies, and child age dummies interacted with *India*. Columns (1), (2), (4), (6), and (8) additionally include maternal age, mother's literacy, PSU fixed effects, and maternal age and mother's literacy interacted with *India*. Column (1) includes dummies for mother's desired fertility, top-coded at 6 children, and dummies for mother's desired fertility interacted with *India*. This regression does not have a parallel mother fixed effects specification, since desired fertility is absorbed by mother fixed effects. Columns (2)-(3) include birth spacing in months and birth spacing interacted with *India*. Birth spacing for firstborns is imputed with the sample average for the rest of the sample. In columns (4)-(5), the sample is restricted to children of birth order 4 or less. In columns (6)-(7), birth order is redefined as the birth order among currently living siblings. See Data Appendix for further details.

Appendix Table 3: Birth order gradients compared to other regions

Comparison sample:	*Countries with similar GDP to India*			*Europe, Central & West Asia*			*Bangladesh & Pakistan*		
	HFA z-score (1)	HFA z-score (2)	HFA z-score (3)	HFA z-score (4)	HFA z-score (5)	HFA z-score (6)	HFA z-score (7)	HFA z-score (8)	HFA z-score (9)
India	-0.034*			-0.785***			0.221***		
	[0.018]			[0.020]			[0.020]		
India × 2nd child	-0.095***	-0.121***	-0.259***	-0.064**	-0.085***	-0.200***	-0.111***	-0.057*	-0.182***
	[0.025]	[0.026]	[0.048]	[0.028]	[0.030]	[0.052]	[0.028]	[0.030]	[0.062]
India × 3rd+ child	-0.284***	-0.191***	-0.514***	-0.298***	-0.153***	-0.459***	-0.192***	-0.059	-0.297***
	[0.024]	[0.032]	[0.085]	[0.028]	[0.037]	[0.097]	[0.028]	[0.038]	[0.114]
2nd child	-0.025*	-0.052***	-0.152***	-0.058***	-0.088***	-0.211***	-0.010	-0.116***	-0.229***
	[0.015]	[0.016]	[0.027]	[0.020]	[0.021]	[0.034]	[0.019]	[0.021]	[0.048]
3rd+ child	-0.159***	-0.155***	-0.251***	-0.147***	-0.193***	-0.306***	-0.251***	-0.287***	-0.468***
	[0.013]	[0.019]	[0.044]	[0.019]	[0.026]	[0.064]	[0.019]	[0.027]	[0.088]
Comparison group mean of outcome	-1.303	-1.303	-1.303	-0.560	-0.560	-0.560	-1.610	-1.610	-1.610
Age & other controls	No	Yes	No	No	Yes	No	No	Yes	No
Mother FEs	No	No	Yes	No	No	Yes	No	No	Yes
Observations	166,709	166,281	81,742	83,998	83,461	39,463	75,535	75,435	30,357

Notes: Standard errors are clustered by mother and appear in brackets. Asterisks denote significance: * $p < .10$, ** $p < .05$, *** $p < .01$. Child age dummies are included in all regressions. Columns (2), (5) and (8) include mother's literacy, maternal age, PSU fixed effects, and child age dummies, mother's literacy, and maternal age interacted with *India*. In columns (2), (5) and (8), the main effect *India* is absorbed by PSU fixed effects. In column (3), (6) and (9), the main effect *India* is absorbed by mother fixed effects. In columns (1)-(3), the omitted category includes 23 DHS's (2004-2010) of countries with height data that had a log GDP per capita within in a 50% upper and lower bound of India's 2005-6 log GDP per capita in its survey year. In columns (4)-(6), the omitted category includes 16 DHS's (1995-2012) of European, Central and West Asian countries with height data available. In columns (7)-(9), the omitted category includes Bangladesh 2004, Bangladesh 2007, Bangladesh 2011 and Pakistan 2012-13. See Data Appendix for further details.

Appendix Table 4: Summary statistics for within-India analysis

	India	Kerala & Northeast	Below-median child sex ratio	Muslims
NFHS 1-3				
Child's age (months)	24.74	25.42	25.02	25.07
	[15.33]	[15.35]	[15.37]	[15.50]
Child's birth order	2.74	2.76	2.69	3.24
	[1.87]	[1.93]	[1.84]	[2.19]
Child's HFA z-score	-1.65	-1.39	-1.56	-1.73
	[1.91]	[1.93]	[1.90]	[1.94]
Child's WFA z-score	-1.56	-1.20	-1.49	-1.60
	[1.41]	[1.41]	[1.41]	[1.39]
Mother's age at birth (years)	24.70	25.72	24.77	24.97
	[5.32]	[5.72]	[5.52]	[5.68]
Mother's total children born	2.97	2.99	2.90	3.50
	[1.89]	[1.96]	[1.87]	[2.20]
Mother is literate	0.51	0.68	0.54	0.43
	[0.50]	[0.46]	[0.49]	[0.49]
Average pooled inputs	0.40	0.39	0.41	0.37
	[0.33]	[0.33]	[0.33]	[0.33]
Child sex ratio (boys/girls)	1.08	1.04	1.04	1.08
	[0.05]	[0.01]	[0.01]	[0.04]
Main sample of children <60 months (N)	95,220	17,899	42,424	14,053
IHDS				
Child's age (months)	33.43	34.52	33.31	33.59
	[16.00]	[15.22]	[16.10]	[16.43]
Child's birth order	2.77	2.13	2.44	3.81
	[1.71]	[1.03]	[1.37]	[2.41]
Child's HFA z-score	-1.55	-1.41	-1.49	-1.23
	[2.30]	[2.51]	[2.37]	[2.44]
Child's WFA z-score	-1.16	-0.69	-1.10	-0.93
	[1.58]	[1.89]	[1.66]	[1.64]
Mother's age at birth (years)	25.93	27.17	25.77	27.23
	[5.31]	[4.77]	[5.44]	[6.74]
Mother's total children born	3.11	2.42	2.74	4.21
	[1.71]	[0.99]	[1.37]	[2.36]
Mother is literate	0.64	0.91	0.68	0.57
	[0.48]	[0.29]	[0.47]	[0.50]
Child sex ratio (boys/girls)	1.09	1.04	1.05	1.08
	[0.05]	[0.01]	[0.01]	[0.04]
Main sample of children <60 months (N)	3,615	189	1,266	351

Notes: The means of the specified variables are calculated separately for each subsample. Standard deviations appear in brackets. The following variables are summarized at the mother level: total children born, mother is literate, and mother completed her fertility. Variables summarized at the child level include: all child variables, mother's age at birth, average pooled inputs, and child sex ratio. Except for the first variable, all IHDS variables are summarized for the completed fertility sample.

Appendix Table 5: Cultural norms and child outcomes: Additional within-India evidence

Low son preference proxy:	*Kerala & Northeast*		*Below-median child sex ratio*		*Muslims*	
	Average pooled inputs (1)	WFA z-score (2)	Average pooled inputs (3)	WFA z-score (4)	Average pooled inputs (5)	WFA z-score (6)
Low son pref proxy × 2nd child	0.012**	0.544	0.010**	0.145	0.019***	0.346
	[0.006]	[0.384]	[0.005]	[0.151]	[0.007]	[0.268]
Low son pref proxy × 3rd+ child	-0.016**	0.663	-0.011*	0.233	0.061***	0.055
	[0.007]	[0.688]	[0.006]	[0.255]	[0.009]	[0.361]
2nd child	-0.089***	-0.381***	-0.092***	-0.421***	-0.089***	-0.385***
	[0.003]	[0.074]	[0.003]	[0.093]	[0.003]	[0.080]
3rd+ child	-0.170***	-0.404***	-0.168***	-0.457***	-0.177***	-0.364***
	[0.003]	[0.120]	[0.004]	[0.142]	[0.003]	[0.131]
Low son pref group mean of outcome	0.392	-0.690	0.411	-1.098	0.371	-0.932
High son pref group mean of outcome	0.399	-1.185	0.386	-1.192	0.402	-1.211
Sample	NFHS 1-3	IHDS 1	NFHS 1-3	IHDS 1	NFHS 1-3	IHDS 1
Age & other controls	Yes	Yes	Yes	Yes	Yes	Yes
Observations	95,089	3,615	95,089	3,615	82,054	3,405

Notes: Standard errors are clustered by mother and appear in brackets. Asterisks denote significance: * $p < .10$, ** $p < .05$, *** $p < .01$. In columns (1), (3), and (5), the sample uses NFHS 1-3. NFHS-1 only has data for children aged 4 years and younger, and NFHS-2 only has data for children aged 3 years and younger. In columns (2), (4), and (6), the sample uses IHDS 1 and consists of children aged 1-59 months in IHDS 1 whose mothers (likely) had completed their fertility, i.e. their mothers did not give birth between wave 1 and wave 2. NFHS-1 and NFHS-2 do not have data on whether the child is taking iron pills, whether the child had a postnatal check within 2 months of birth, and whether the child received one of the four doses of the polio vaccine. *Average pooled inputs* is thus restricted to 4 prenatal and 1 postnatal inputs. All columns include child age dummies, maternal age, mother's literacy, and child age dummies, maternal age, and mother's literacy interacted with *Low son pref proxy*. Columns (1), (3), and (5), include survey and PSU fixed effects, and survey and PSU fixed effects interacted with *Low son pref proxy*. Columns (2), (4), and (6) include total fertility dummies, top-coded at 6 children, and total fertility dummies interacted with *Low son pref proxy.*. In columns (1), (3), and (5), the main effect *Low son pref proxy* is absorbed by PSU fixed effects. In columns (2), (4), and (6), the main effect *Low son pref proxy* is included but not shown. Matrilineal states include Arunachal Pradesh, Assam, Kerala, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim and Tripura. *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 respondents state-by-rural cell. In columns (5)-(6), the sample is restricted to Muslims and Hindus. See Data Appendix for further details.

Appendix Table 6: Birth order gradient in the India height gap using NFHS-1

	HFA z-score (1)	HFA z-score (2)	HFA z-score (3)	HFA z-score (4)	WFA z-score (5)
India	-0.306***	-0.098***			
	[0.013]	[0.025]			
India × 2nd child		-0.162***	-0.167***	-0.251***	-0.184***
		[0.035]	[0.037]	[0.074]	[0.029]
India × 3rd+ child		-0.357***	-0.280***	-0.427***	-0.258***
		[0.031]	[0.042]	[0.130]	[0.033]
2nd child		0.085***	0.013	-0.088**	0.021
		[0.020]	[0.021]	[0.040]	[0.018]
3rd+ child		0.030*	-0.135***	-0.193***	-0.093***
		[0.016]	[0.023]	[0.066]	[0.020]
Africa mean of outcome	-1.476	-1.476	-1.476	-1.476	-1.033
Sample	Children $\leq$ 48 mths	Children $\leq$ 48 mths	Children $\leq$ 48 mths	Children $\leq$ 48 mths	Children $\leq$ 48 mths
Age & other controls	No	No	Yes	No	Yes
Mother FEs	No	No	No	Yes	No
Observations	92,726	92,726	92,644	32,797	92,644

Notes: Standard errors are clustered by mother and appear in brackets. Asterisks denote significance: * $p < .10$, ** $p < .05$, *** $p < .01$. Sample for India uses NFHS-1 rather than NFHS-3; NFHS-1 only has data for children age 4 years and younger. The comparison sample includes African DHS's between 1991 and 1997. Four of these surveys (Ghana 1993, Madagascar 1997, Mali 1995-96 and Zimbabwe 1994) only have data for children age 3 years and younger. The other surveys have data for children aged 4 years and younger. Child age dummies are included in all regressions. Columns (3) and (5) include mother's literacy, maternal age, PSU fixed effects, and child age dummies, mother's literacy, and maternal age interacted with *India*. In columns (3) and (5), the main effect *India* is absorbed by PSU fixed effects. In column (4), the main effect *India* is absorbed by mother fixed effects. See Data Appendix for further details.

Appendix Table 7: The role of gender using NFHS-1

	HFA z-score (1)	HFA z-score (2)	HFA z-score (3)	WFA z-score (4)	WFA z-score (5)	WFA z-score (6)
India × Girl	-0.140***			-0.047**		
	[0.025]			[0.020]		
India × 2nd child		-0.132**	-0.106*		-0.133***	-0.119**
		[0.055]	[0.061]		[0.043]	[0.048]
India × 3rd+ child		-0.257***	-0.222***		-0.228***	-0.208***
		[0.061]	[0.074]		[0.048]	[0.059]
India × 2nd child × Girl		-0.071	-0.103		-0.111*	-0.149**
		[0.078]	[0.086]		[0.062]	[0.068]
India × 3rd+ child × Girl		-0.053	-0.100		-0.069	-0.127
		[0.084]	[0.102]		[0.067]	[0.082]
India × No elder brother			0.046			0.026
			[0.053]			[0.042]
India × Girl × No elder brother			-0.061			-0.073
			[0.074]			[0.059]
Africa mean of outcome	-1.476	-1.476	-1.476	-1.033	-1.033	-1.033
Age & other controls	Yes	Yes	Yes	Yes	Yes	Yes
Observations	92,644	91,984	91,984	92,644	91,984	91,984

Notes: Standard errors are clustered by mother and appear in brackets. Asterisks denote significance: * $p < .10$, ** $p < .05$, *** $p < .01$. All columns include child age dummies, mother's literacy, mother's age, and PSU fixed effects. In columns (2)-(3) and (5)-(6), child age dummies, maternal age, and mother's literacy are interacted with *Girl*, *India*, and *India* × *Girl* and PSU fixed effects are interacted with *Girl*. The main effect *Girl* is included in all regressions but not shown. In columns (2) and (5), the main effects *2nd child*, *3rd+ child*, *Girl*, *2nd child* × *Girl* and *3rd+ child* × *Girl* are included but not shown. In columns (3) and (6), all other main effects (*2nd child*, *3rd+ child*, *Girl*, *2nd child* × *Girl*, *3rd+ child* × *Girl*, *No elder brother*, *Girl* × *No elder brother*) are included but not shown. In all columns, the main effect *India* absorbed by PSU fixed effects. In columns (2)-(3) and (5)-(6), the main effect *India* × *Girl* absorbed by PSU fixed effects and their interactions with *Girl*. See Data Appendix for further details.

Appendix Table 8: Fertility continuation in NFHS-1 and NFHS-3

	NFHS-1		*NFHS-3*	
	Beyond desired fertility	Wants more children	Beyond desired fertility	Wants more children
	(1)	(2)	(3)	(4)
India × No son within desired fertility	0.068***		0.067***	
	[0.008]		[0.007]	
No son within desired fertility	-0.114***		-0.047***	
	[0.004]		[0.003]	
India × At or beyond desired fertility × No son yet		0.300***		0.189***
		[0.027]		[0.017]
India × At or beyond desired fertility		-0.133***		-0.130***
		[0.008]		[0.007]
India × No son yet		0.002		0.022**
		[0.008]		[0.009]
At or beyond desired fertility × No son yet		0.049**		0.025**
		[0.021]		[0.011]
Africa mean of outcome	0.179	0.703	0.172	0.667
India mean of outcome	0.284	0.484	0.326	0.339
PSU FEs & literacy controls	Yes	Yes	Yes	Yes
Observations	70,160	65,131	115,768	114,362

Notes: Standard errors are clustered by mother and appear in brackets. Asterisks denote significance: * $p < .10$, ** $p < .05$, *** $p < .01$. All columns include mother's literacy, PSU fixed effects, and mother's literacy interacted with *India*. The main effect *India* is absorbed by PSU fixed effects. In columns (2) and (4), the main effects *At or beyond desired fertility* and *No son yet* are included but not shown. See Data Appendix for further details.

Appendix Table 9: Alternative explanations for the Indian birth order gradient

	HFA z-score	Diarrhea in last 2 weeks	HFA z-score	HFA z-score	HFA z-score	HFA z-score
	(1)	(2)	(3)	(4)	(5)	(6)
India × 2nd child	-0.158***	-0.001	-0.165***	-0.142***	-0.154***	-0.153***
	[0.031]	[0.005]	[0.028]	[0.030]	[0.029]	[0.046]
India × 3rd+ child	-0.193***	0.012**	-0.217***	-0.215***	-0.212***	-0.211***
	[0.038]	[0.006]	[0.035]	[0.036]	[0.035]	[0.054]
2nd child	0.300	-0.001	-0.024	-0.036	-0.061**	-0.003
	[0.347]	[0.003]	[0.019]	[0.025]	[0.027]	[0.041]
3rd+ child	-0.235	0.001	-0.138***	-0.133***	-0.199***	-0.100**
	[0.419]	[0.004]	[0.023]	[0.028]	[0.033]	[0.047]
2nd child × Mother's height	-0.020					
	[0.022]					
3rd+ child × Mother's height	0.008					
	[0.026]					
2nd child × Open defecation			0.035			
			[0.030]			
3rd+ child × Open defecation			0.055			
			[0.035]			
2nd child × % non-resident among children				0.251		
				[0.178]		
3rd+ child × % non-resident among children				0.176		
				[0.204]		
2nd child × Nr. of adult females in hh					0.022*	
					[0.012]	
3rd+ child × Nr. of adult females in hh					0.044***	
					[0.015]	
2nd child × Land scarcity						-0.003
						[0.015]
3rd+ child × Land scarcity						-0.007
						[0.017]
Africa mean of outcome	-1.351	0.157	-1.351	-1.351	-1.351	-1.351
Age & other controls	Yes	Yes	Yes	Yes	Yes	Yes
Observations	166,550	167,186	162,503	167,737	167,737	167,737

Notes: Standard errors are clustered by mother and appear in brackets. Asterisks denote significance: * $p < .10$, ** $p < .05$, *** $p < .01$. Control variables included are child age dummies, mother's literacy, maternal age, PSU fixed effects, and child age dummies, mother's literacy, and maternal age interacted with *India*. The main effect *India* is absorbed by PSU fixed effects. Column (1) additionally controls for child's age, maternal age, mother's literacy, and PSU fixed effects interacted with *Mother's height*. Column (3) additionally controls for child's age, maternal age, mother's literacy, and PSU fixed effects interacted with *Open defecation*. *Open defecation* is a dummy variable that equals 1 if the mother reports that the household has no toilet facility. Column (4) also controls for child's age, maternal age, and mother's literacy interacted with *% non-resident among children*. Column (5) controls for child's age, maternal age, mother's literacy, and PSU fixed effects interacted with *Nr. of adult females in hh*. *Nr. of adult females in hh* is defined as the total number of interviewed females aged 18 or above in the household. Column (6) controls for child's age, maternal age, and mother's literacy interacted with *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. See Data Appendix for further details.

Appendix Table 10: Diminishing returns to inputs

Input proxy:	*Income per capita*		*Consumption per capita*	
	HFA z-score	WFA z-score	HFA z-score	WFA z-score
	(1)	(2)	(3)	(4)
Input proxy	0.415***	0.492***	0.638***	0.810***
	[0.101]	[0.069]	[0.147]	[0.095]
Input proxy (quadratic)	-0.046*	-0.063***	-0.104**	-0.163***
	[0.027]	[0.018]	[0.048]	[0.028]
Indian mean of outcome	-1.607	-1.190	-1.607	-1.190
Observations	6,351	6,351	6,424	6,424

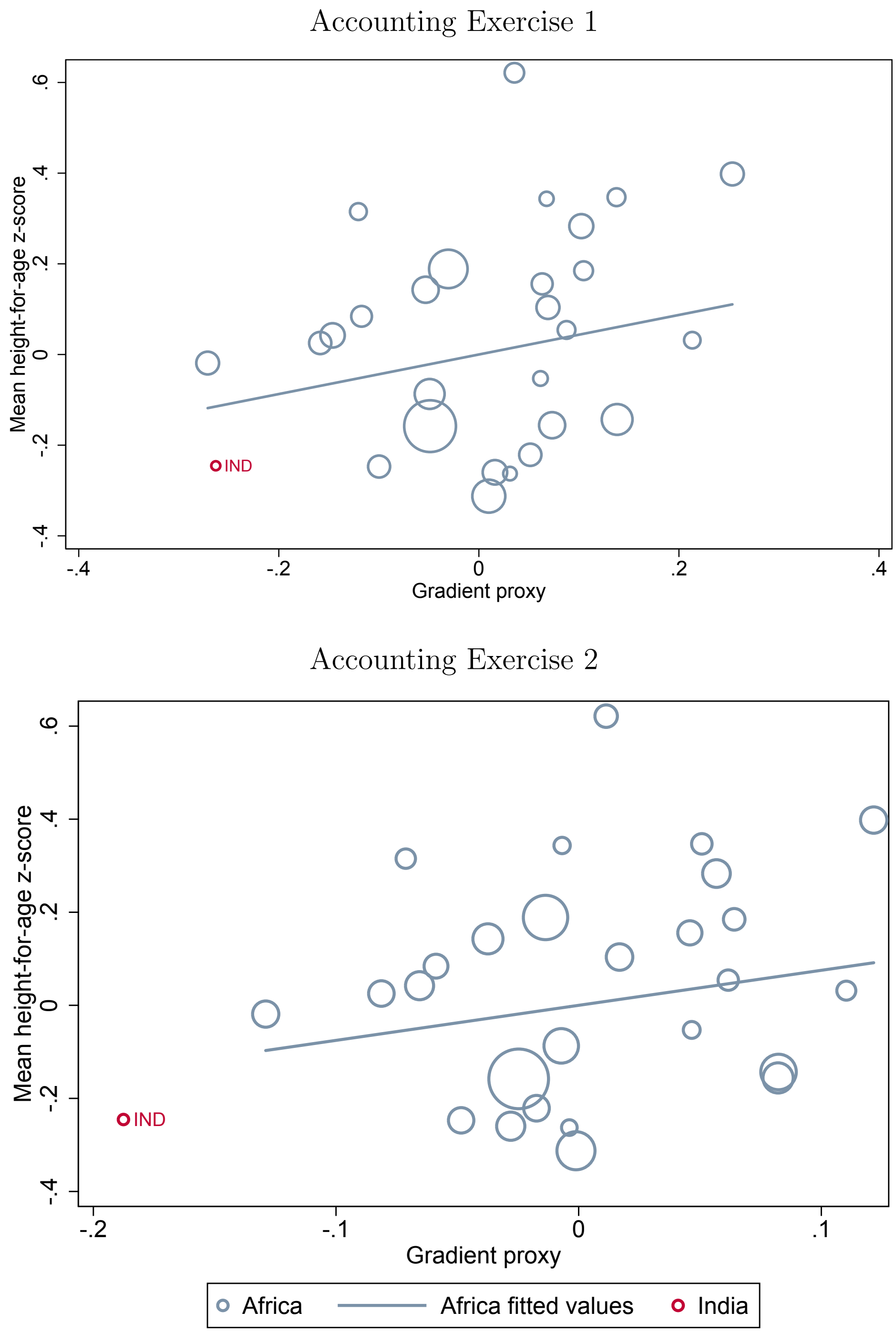
Notes: Standard errors are clustered by mother and appear in brackets. Asterisks denote significance: * $p < .10$, ** $p < .05$, *** $p < .01$. Sample uses children aged 1-59 months in IHDS 1. Control variables included in all columns are child age dummies and *Girl*. In columns (1)-(2), the *Input proxy* is monthly household income per capita, trimmed at 1%. In columns (3)-(4), the *Input proxy* is monthly household consumption per capita, trimmed at 1%. One unit of the input proxy is equal to 1'000 rupees. The negative coefficient for the quadratic term is suggestive for diminishing marginal returns. See Data Appendix for further details.

Appendix Table 11: Birth order gradient and gender gap in Kerala & NE compared to Africa

	HFA z-score (1)	WFA z-score (2)	HFA z-score (3)	WFA z-score (4)
Kerala & Northeast × 2nd child	-0.139***	-0.155***		
	[0.051]	[0.037]		
Kerala & Northeast × 3rd+ child	-0.201***	-0.204***		
	[0.059]	[0.043]		
Kerala & Northeast × Girl			-0.079**	-0.098***
			[0.038]	[0.027]
Africa mean of outcome	-1.351	-0.877	-1.351	-0.877
Age & other controls	Yes	Yes	No	No
Mother FEs				
Observations	134,584	134,584	134,584	134,584

Notes: Standard errors are clustered by mother and appear in brackets. Asterisks denote significance: * $p < .10$, ** $p < .05$, *** $p < .01$. All columns include child age dummies, mother's literacy, maternal age, PSU fixed effects, and child age dummies, mother's literacy, and maternal age interacted with *Kerala & NE*. The main effect *Kerala & NE* is absorbed by PSU fixed effects. In columns (1)-(2), the main effects *2nd child* and *3rd child+* are included but not shown. In columns (3)-(4), the main effect *Girl* is included but not shown. See Data Appendix for further details.

Appendix Figure 1: Child height versus gradient proxy (conditional on GDP)



Notes: The graphs plot the residuals obtained by regressing the mean HFA z-score in each country on log GDP per capita in birth year against the residuals obtained by regressing the gradient proxy (used in the accounting exercises in section 4.6) on log GDP per capita in birth year. In the upper graph, *Gradient proxy* is defined as the weighted average of the height gap between second borns and first borns and the height gap between third- and higher-borns and first borns. In the lower graph, *Gradient proxy* is defined as the regression coefficient that is obtained by regressing, separately by country-wave, HFA z-scores on a linear birth order variable that is top-coded at 3+. GDP data are based on the Penn World Table 9.0 (Feenstra et al., 2015).

Data Appendix

DHS surveys used in main analysis

The data sets from Sub-Saharan Africa in our main analysis 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), Lesotho 2004 (IV), Lesotho 2009 (VI), Liberia 2007 (V), Madagascar 2003-4 (IV), Malawi 2004 (IV), Mali 2006 (V), Namibia 2006-7 (V), Niger 2006 (V), Nigeria 2008 (V), Rwanda 2005 (V), Sao Tome and Principe 2008-9 (V), Senegal 2005 (IV), Sierra Leone 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 for India is India 2005-6 (NFHS-3).

Indian Human Development Survey

The Indian Human Development Survey (IHDS) is a nationally representative two-wave panel conducted in 2005 and 2012. It contains anthropometric measures as well as data on household income and consumption. We use child anthropometric measurements from wave 1. Because birth date data are often missing in wave 1, we restrict our sample to children who were surveyed in both waves and use birth date data from wave 2. All other variables (e.g., control variables such as mother's literacy) are from wave 1. The other way we make use of the second wave is to infer whether fertility was complete by wave 1; we construct our completed-fertility sample as women who are not pregnant in wave 2 and who did not give birth to a child between wave 1 and wave 2.

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, 2006b). 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. Because child height has 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. We follow the WHO's guidelines and exclude observations with a HFA z-score $>$ 6 or $<$ -6 ($>$ 5 or $<$ -6 for WFA) as these are likely to be erroneous data.

Birth order

Birth order is defined as birth order among children ever born to one's mother. Multiple births, such as twins, 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, e.g., the next child born after firstborn twins is birth order 3.

Child's 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.

Prenatal inputs

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 NFHS-3. 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. We top-code the maximum number of visits 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 NFHS-3. 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 for consistency. It is available in all 27 African DHS's and NFHS-3. 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 NFHS-3. 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. Any delivery that did not occur at a home is considered a delivery at health facility.

Postnatal inputs

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, Lesotho 2009, Liberia 2007, Namibia 2006-7, Nigeria 2008, Sao Tome and Principe 2008-9, Sierra Leone 2008, Swaziland 2006-7, Tanzania 2010, Uganda 2006, Zambia 2007, and Zimbabwe 2005-6) as well as NFHS-3. 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, Namibia 2006-7, Nigeria 2008, Sao Tome and Principe 2008-9, Sierra Leone 2008, Swaziland 2006-7, Tanzania 2010, and Uganda 2006) as well as NFHS-3. 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 NFHS-3. It is the mother's self-report of the total number of vaccinations the child has received to date from among those that the DHS collects data on: BCG, 3 doses of DPT, 4 doses of polio, and measles. Thus the value of child's total vaccinations is 9 if the child received all vaccines. The sample is restricted to children who should have completed their course of vaccinations, specifically those age 13-59 months, as the recommended age for the vaccinations is up to age 12 months.

Other child outcomes

Pooled inputs. The pooled input regressions (both input-level regressions in Table 6 and average pooled input regressions in Table 3) are based on binary versions of the seven input variables. Two of the four prenatal inputs (Mother took iron supplements and delivery at health facility) are dummy variables as are two of the three postnatal inputs (Postnatal check within 2 months and Child taking iron pills). For the pooled input regressions, we convert the remaining four input variables into dummy variables that equal 1 if the original variable for a respondent is greater than the sample median. Specifically, the dummy variables we create are 1) total prenatal visits >3; 2) mother's total tetanus shots >2; 3) total vaccinations >8. The average pooled inputs is then the average value across the seven health-input dummy variables.

Child's Hb level is the child's hemoglobin level in g/dl adjusted by altitude. It is defined for children 6 months or older and is not available for 6 surveys: Chad 2004, Kenya 2008-9, Liberia 2007, Namibia 2006-7, Nigeria 2008, and Zambia 2007.

Infant mortality is an indicator for whether the child is deceased. It is available in all 27 African DHS's and NFHS-3. It is the mother's self-report of whether the child is deceased. The sample is restricted to children age 13-59 months because whether they died in infancy is censored for children under age 1 year.

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 NFHS-3. It is the mother's self-report of whether the child had diarrhea in the 2 weeks before the survey.

Maternal outcomes

Wants more children is created based on the question, "Would you like to have another child, or would you prefer not to have more children?" It is coded as 0.5 if the mother said she is undecided whether she wants to have more children and 0 if she wants no more children or has been sterilized. This variable is missing if the woman is infecund, not currently married, or indicated that she has never had sex.

Variables used in heterogeneity analyses

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 2001 Indian census. Higher values indicate greater gender imbalance favoring boys.

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 NFHS-3. Mother's height is converted to meters and is coded as missing if the height is less than 1.25 meters.

Open defecation is available for all births in the past 5 years in the full sample of 27 African DHS's and NFHS-3. It is the mother's self-report of whether the household has no toilet facility.

% 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 PSU-level. Children's age and whether they are living in the household are available in the full sample of 27 African DHS's and NFHS-3. 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.

Number of adult females in household is calculated as the number of females aged 18 or above who live in the same household.

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).

Other variables

Mother is literate is available for the full sample of 27 African DHS's and NFHS-3. It is based on a literacy test that requires her to read at least part of a sentence in her language. If literacy data are missing, we impute it using the country-specific literacy rate at the number of school years she completed. If we lack information on number of school years, we include dummies for missing values of literacy in the regressions.

Primary sampling units (PSUs) are the smallest geographic unit used in DHS's multi-stage sampling procedure. A PSU is typically an enumeration area or part of an enumeration area used for the national population census.

Birth spacing is the number of months of spacing between a child and his or her older sibling. It is calculated using the children's age and is top-coded at 120 months. Because a firstborn child does not have an older sibling, in regressions where we control for birth spacing, for firstborns, we set the variable equal to the sample mean. The regressions also *de facto* include a flag for the observations with the imputed value because we have birth order dummies.

Desired fertility is available for the full sample of 27 African DHS's and NFHS-3 and is based on the mother's answer to a hypothetical question: if she could go back to the start of her childbearing, what is the ideal number of children she would want. We top-code the variable at 6 children.

Alternative samples used

The main sample includes children age 1-59 months who have anthropometric data. (Note that we are using the convention where a child in the first month of life is 1 (rather than 0) months old.) There is a high rate of missing data for children in their 60th month of life, and hence we limit the sample to children who are 59 months old or younger. In Table 2, column (4), *Completed fertility* is the sample restricted to children whose mothers do not want to have more children, are sterilized, or are infecund. In column (9), the sample consists of ever-born children aged 13-59 months. We exclude younger children, as infant mortality is censored for children less than 1 year old.

Kerala & Northeast include the Indian states Arunachal Pradesh, Assam, Kerala, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim, and Tripura.

Countries with similar GDP to India include 25 DHS's administered between 2004-2010 from countries that have height data available and that had a log GDP per capita within a 50% upper and lower bound of India's 2005-6 log GDP per capita. These countries are: Benin 2006 (V), Bolivia 2008 (V), Burkina Faso 2010 (VI), Cambodia 2005 (V), Cambodia 2010 (VI), Cameroon 2004 (IV), Chad 2004 (IV), Egypt 2005 (V), Ghana 2008 (V), Haiti 2005-6 (V), Honduras 2005-6 (V), Kenya 2008-9 (V), Lesotho 2004 (IV), Lesotho 2009 (VI), Mali 2006 (V), Moldova 2005 (V), Nigeria 2008 (V), Sao Tome and Principe 2008-9 (V), Senegal 2005 (IV), Senegal 2010-11 (VI), Tanzania 2010 (VI), Timor-Leste 2009-10 (VI), Zambia 2007 (V), Zimbabwe 2005-6 (V), and Zimbabwe 2010-11 (VI).

Europe, Central & West Asia includes 16 DHS's spanning 1995-2012 for European, Central and West Asian countries with height data available: Albania 2008-2009 (V), Armenia 2005 (V), Armenia 2010 (VI), Azerbaijan 2006 (V), Jordan 2002 (IV), Jordan 2007 (V), Jordan 2012 (VI), Kazakhstan 1995 (III), Kazakhstan 1999 (IV), Kyrgyz Republic 1997 (III), Kyrgyz Republic 2012 (VI), Moldova 2005 (V), Tajikistan 2012 (VI), Turkey 1998 (IV), Turkey 2003 (IV), and Uzbekistan 1996 (III). Because of the relative paucity of surveys in this region, we expand the time period to cover 1995 to 2012 rather than just 2004 to 2010.

Bangladesh & Pakistan includes 4 DHS's: Bangladesh 2004 (IV), Bangladesh 2007 (V), Bangladesh 2011 (VI), and Pakistan 2012-13 (VI). We expand the time period beyond the 2004 to 2010 time period used in our main analysis because earlier DHS's in Pakistan do not have data on child's height.

NFHS-1 and NFHS-2 are the first two rounds of the National Family Health Survey; our main sample for India is the most recent round, NFHS-3. NFHS-1 (1992-3) collects height data for children up to age 4, while NFHS-2 (1998-9) does so for children up to age 3. Due to data availability, pooled inputs used in Appendix Table 5 include 5 of the 7 inputs used in NFHS-3, and total vaccinations is based on 8 of the 9 vaccines used in NFHS-3. Specifically, NFHS-1 and NFHS-2 do not have data on whether the child is taking iron pills, whether the child had a postnatal check within 2 months of birth, and whether the child received one of the four doses of the polio vaccine. In Appendix Tables 6-8, the comparison sample for NFHS-1 includes African DHS's between 1991 and 1997. These are Cameroon 1991 (II), Ghana 1993 (II), Kenya 1993 (II), Namibia 1992 (II), Madagascar 1992 (II), Madagascar 1997 (III), Mali 1995-96 (III), Malawi 1992 (II), Niger 1992 (II), Rwanda 1992 (II), Senegal 1992-93 (II), Chad 1996-97 (III), Tanzania 1991-92 (II), Tanzania 1996 (III), Uganda 1995 (III), Zambia 1992 (II), Zambia 1996 (III) and Zimbabwe 1994 (III). Ghana 1993, Madagascar 1997, Mali 1995-96 and Zimbabwe 1994 only have data for children aged 3 years and younger. The other DHS's have data for children aged 4 years and younger.

Accounting exercise

For the first accounting exercise in Appendix Table 1, the *Gradient proxy* is defined as the weighted average of the height gap between first borns and second borns and the height gap between first borns and third- and higher-borns in each country-wave. The weight for the height gap between first borns and second borns is equal to the total number of ever-born second borns divided by the total number of ever-born second- and higher-borns in the completed fertility sample in that country-wave. Analogously, the weight for the height gap between first borns and third- and higher-borns is equal to the total number of ever-born third- and higher-borns divided by the total number of ever-born second- and higher-borns in the completed fertility sample for that country-wave.

For the second accounting exercise in Appendix Table 1, the *Gradient proxy* is defined as the regression coefficient that is obtained by regressing, separately by country-wave, HFA z-scores on a linear birth order variable that is top-coded at 3+.