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The Indian Enigma revisited

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Abstract

This paper re-enters the contested discussion surrounding the Indian Enigma, the high prevalence of chronic undernutrition in India relative to sub-Saharan Africa. Jayachandran & Pande argue that the key to the Indian enigma lies in the worse treatment of higher birth order children, particularly girls. Analyzing new data, we find: (1) Parameter estimates are sensitive to sampling design and model specification; (2) The gap between the heights of pre-school African and Indian children is closing; (3) The gap does not appear to be driven by differential associations by birth order and child sex; (4) The remaining gap is associated with differences in maternal heights. If Indian women had the heights of their African counterparts, pre-school Indian children would be taller than pre-school African children; and (5) Once we account for survey design, sibling size and maternal height, the coefficient associated with being an Indian girl is no longer statistically significant.

Keywords: Nutrition, India, sub-Saharan Africa, Height, India Enigma
JEL Classification codes: I12, I15, J13, O12, O15, O57, Z13

1. Introduction

Globally, 149.2 million children under 5 years of age are estimated to be chronically undernourished in 2020 (UNICEF et al., 2021). Eliminating chronic undernutrition is intrinsically valuable in that good nutritional status is a component of good health. It is also of instrumental value. Chronic undernutrition in early life is causally linked to lower schooling, lower test performance, lower household per capita expenditure, and a higher probability of living in poverty as an adult (e.g. Alderman et al. (2006), Hoddinott et al. (2013)). For these reasons, the elimination of chronic undernutrition has been included in the United Nations' Sustainable Development Goals (SDG) (United Nations, 2015), specifically SDG 2.2 – ending malnutrition like stunting in children under 5 years of age by 2030.

UNICEF, WHO, and World Bank (2021) estimate that 36 million children below 5 years of age in 2020, 24.2% of all chronically undernourished children, live in India. Given this large percentage, global progress on meeting SDG 2.2 requires substantial progress on reducing chronic undernutrition in India. Yet, chronic undernutrition in India has long been considered an enigma. Beginning in the late 1990s, a series of researchers noted that despite higher levels of gross domestic product (GDP), food supply, education, and health services, child malnutrition – as measured by height-for-age - was higher in India than in sub-Saharan Africa, (Klasen, 2008; Ramalingaswami et al., 1996; Smith, 2003). A scattering of studies (Smith et al. (2003); Spears (2018)) suggested that differences in women's status, sanitation, and urbanization accounted for at least part of this enigma. However, the most influential explanation comes from work by Jayachandran & Pande (2017), henceforth JP. They argue that much of the difference in height between African and Indian children is due to lower health investments made in higher birth order children, particularly girls. These differences by sex and birth order reflect parental preferences for eldest sons that arise from a mix of religious, cultural, and economic reasons. These preferences, that shape fertility behavior, family size, and investment decisions in child health, lie at the heart of what has been termed the Asian or Indian enigma.

The JP findings, however, have been subject to critique on three dimensions. The first is methodological. Spears, Coffey and Behrman (2022), henceforth SCB, argue that JP's results are confounded by omitted variable bias. Specifically, correlations between sibling size and birth order confound the relationship between birth order and nutritional status; once this is accounted for, the adverse effect of birth order on nutritional status is reversed. The second is based on environmental health considerations; Spears (2018) argues that the Indian enigma can be largely explained by differences in the prevalence of open defecation. The third critique comes from more explicit attention to physiological considerations -shorter mothers will, *ceteris paribus*, have smaller children. This reflects multiple biological considerations including physical constraints on offspring growth *in utero*, smaller protein and energy stores, smaller reproductive organ sizes, and limited room for fetal development that influence both fetal growth and through lower breast milk quantity and quality, growth during infancy. Beyond this age, child height is also affected by genetic considerations which also generate correlations between maternal and child heights. It is well known that, on average, Indian mothers are shorter than African mothers; Aiyar & Cummins (2021), henceforth AC, argue that as a result, differences in child height between African and Indian children are fully realized at birth.

Much of this work on the Indian enigma relies on data collected as part of the Indian Demographic and Health Survey (DHS) fielded in 2005/06. A newer round of DHS data from India collected in 2015/16 allows us to revisit the question of the Indian enigma and its causes. We address the following questions: (1) Has the Indian enigma persisted? (2) Do parental preferences for lower-birth order male children, as suggested by JP continue to account for differences between the nutritional status between African and Indian children? (3) How sensitive are these new estimates to methodological considerations such as omitted variable bias and – given that we now compare factors associated with undernutrition over both space *and* time – survey design? And (4) What role do differences in maternal heights (and their associations with children's nutritional status) play as factors associated with differences in undernutrition between Africa and India.

We find the following. As emphasized by AC and SBC, careful attention to sampling design (especially as it relates to maternal height and incomplete fertility) and model specification is crucial; many of our findings are sensitive to how these concerns are addressed. Second, the gap between the heights of pre-school African and Indian children is closing. Third, the gap that remains does not appear to be driven by differential associations by birth order and child sex. Fourth, the remaining gap is associated with differences in maternal heights. Indeed, if Indian women had the heights of their African counterparts, pre-school Indian children would be taller than pre-school African children. Fifth, once we account for survey design, sibling size and maternal height, the coefficient associated with being an Indian girl is no longer statistically significant.

2. Data and methods

Our initial approach closely follows the approach taken by JP when selecting the sample and analyzing the data, modified by the concerns raised by AC and SBC.

2.1 Sample description

To ensure that our comparison of the 2005/06 and 2015/16 data are not confounded by changes in sample composition, we use two sets of data. The first are the data sets used by JP in their 2017 analysis. The second data set includes the more recent Indian DHS conducted in 2015/16 (ICF, 2017). Unlike the previous three waves of Indian DHS data which sampled so as to be representative at the state level, sampling for the 2015/16 round was designed to collect data representative at the district level. A benefit of this approach is that we have a larger sample size to work with. It also includes union territories and different shares of observations per state.[1] However, it also means that there are differences in sample composition across the 2005/06 and 2015/16 survey rounds. To address this, when we compare descriptive statistics and when we undertake regression analysis taking survey design into account, we apply the sampling weights provided in these data sets that make them nationally representative.

Our selection of African countries to match the Indian 2015/16 data is a subsample of the selection by JP. We included the 25 DHS harmonized data sets on IPUMS DHS collected four years previous to and up to two years after the Indian survey in 2015/16, i.e. from 2011 to 2017 available in July 2018. We refer to this time period as around 2015. These data sets include 13 African countries found in both the original JP sample that we will refer to as the period around 2005 and in our 2015 sample (Heger Boyle and Sobek, 2019).[2] However, seven countries used by JP do not appear in the data available around 2015. Given these changes in the country composition of the African sample, we conduct Monte Carlo simulations to assess

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[1] The additional union territories included are like Andaman and Nicobar Islands, Chandigarh, Dadra and Nagar Haveli, Daman and Diu, Lakshadweep, and Puducherry. If we compare the shares of each Indian state of the collected data in 2005/06 to the one in 2015/16 like in Table B.1.1 in the appendix, states like Bihar, Jharkhand, Madhya Pradesh, Rajasthan, Uttar Pradesh take up an at least one percent larger share of observations and states like Andhra Pradesh, Delhi, Goa, Kerala, Maharashtra, Manipur, Nagaland, or West Bengal bring in less observations (with at least a one percent difference). States like Madhya Pradesh, Rajasthan, Uttar Pradesh with a higher sex ratio gain additional weight whereas states with low sex ratios such as Andhra Pradesh, Goa, Kerala, Manipur, Nagaland, and West Bengal lose weight. The sex ratio is defined as low if the ratio of boys and girls under five years of age is smaller than the median ratio using Indian census data of 2011.

[2] The following 25 surveys are used for the new sample: Cameroon 2011, Congo Democratic Republic 2013-14, Ethiopia 2011, Ethiopia 2016, Ghana 2014, Guinea 2012, India 2015-16, Kenya 2014, Lesotho 2014, Malawi 2016, Mali 2012, Namibia 2013, Niger 2012, Nigeria 2013, Rwanda 2014, Senegal 2010-11, Senegal 2012-13, Senegal 2012-13, Senegal 2015, Senegal 2016, Senegal 2017, Tanzania 2015, Uganda 2011, Uganda 2016, Zambia 2013, and Zimbabwe 2015.

the sensitivity of our results to the inclusion of different sets of African countries as alternative specifications.

Further, the samples differ in the number of surveys included for five countries. We provide an overview of the different Africa samples used in the 2005 sample and the 2015 sample in the appendix Table B.1.2. To ensure comparability the African surveys are weighted by the suggested sample weights of the DHS for the specifications adjusting for survey design. Doing this we maintained the within-survey national representativeness. Similar to the approach taken by AC, we also re-scaled the data so that each country's weights sum up to one. The weights of the countries that have conducted n surveys, i.e. more than one survey, in one of the given time periods are adjusted to 1/n times.

2.2 Estimation strategy

To ensure as much comparability with the JP approach and results as possible, we used their published, well-documented and accessible do-files for data cleaning, variable construction, and analysis for the 2005 survey and we follow, as much as possible, their approach when analyzing the 2015 data. We stress that we could replicate their 2005 findings with only negligible differences that are likely due to the use of slightly different versions of the available DHS data (see Appendix A in the supplementary material).

Our outcome variable, *HFA*, is the standardized height-for-age score (HFA z-score). A child with an HFA z-score less than -2 is considered to be stunted (WHO, 2006). The outcome variable has index *i*, *m*, and *c* standing for the *i*-th child born to mother *m* in country *c*.

We first assess the role of birth order discussed in Table 2 column 3 of JP:

$$HFA_{imc} = \alpha_1 I_c + \alpha_2 I_c \times 2^{nd}Child_{imc} + \alpha_3 I_c \times 3^{rd}Child_{imc} + \beta_1 2^{nd}Child_{imc} + \beta_2 3^{rd}Child_{imc} + \gamma_1 X_{imc} + \epsilon_{imc}$$

Where I_c represents the indicator for Indian children; the coefficient α_1 measures the India gap for first-born children, the omitted birth order category. α_2 and α_3 represent the gap for second-born children and third-and-higher birth order children in India. β_1 and β_2 for second-born children and third-and-higher birth order children show the gap relative to first-born children. *X* represents control variables measured at the child, mother, or primary sampling unit (PSU) level. In our basic specification, these include a linear and a quadratic variable for mother's age at birth, mother's literacy, children's age dummies in months (to allow for nonlinear patterns of z-scores) and their interactions with India. As JP and others have noted, the sampling approach used by the DHS surveys means that not all families have completed having children and anthropometric data are only collected for children below five years of age. As completed family size cannot be controlled for, the birth order variables could also be capturing the effects of high-fertility families (Jayachandran and Pande, 2017). JP argue that the inclusion of the covariates described above addresses, in part, this omitted variables problem. Models are estimated using least squares and, again following JP, standard errors are clustered at the mother level.

Initially, we apply this model to both our 2005 data (to replicate the JP findings) and to assess whether their results continue to hold in 2015. We then introduce several robustness checks that we apply to both sets of data. These include accounting for survey design by using weights and clustered standard errors at the PSU level. We also assess the sensitivity of the model to the selection of African countries by reporting an alternative specification without the two African countries with the largest number of observations, Nigeria and Mali, in 2005. We also report results from a Monte Carlo simulation over 10,000 random draws of African countries where at least one African country is included in each draw.

We do not include other strategies by JP to address endogeneity like the sample restriction to women with completed fertility or a model using mother fixed effects given the critique by SCB. They argue that that the results of these models are misleading due to the data structure of the DHS samples. Further SCB conclude that JP's findings of birth order effects depend on the coding of birth order and an omitted variable bias: the number of siblings in their regressions. Drawing on SCB's critique, we include a specification that includes sibling size dummies and their interaction with India and birth order. We check whether alternative coding of birth order matters by excluding children without siblings or the inclusion of dummies capturing mothers' first- and last-born child with children between first- and last-born children as reference category.

To explore whether eldest son preference is the root of the height-gap between African and Indian children, JP extend their estimation equation (in their paper Table 5 column 2) to:

$$\begin{aligned}HFA_{imc} = {} & \alpha_1 I_c + \delta_1 I_c \times Girl + \delta_2 I_c \times Girl \times 2^{nd}Child_{imc} + \delta_3 I_c \times Girl \times 3^{rd}Child_{imc} \\ & + \beta_1 2^{nd}Child_{imc} + \beta_2 3^{rd}Child_{imc} + \beta_3 Girl \times 2^{nd}Child_{imc} \\ & + \beta_4 Girl \times 3^{rd}Child_{imc} + \beta_5\, Girl_{imc} + \alpha_2 I_c \times 2^{nd}Child_{imc} \\ & + \alpha_3 I_c \times 3^{rd}Child_{imc} + \gamma_6 X_{imc} + \epsilon_{imc}\end{aligned}$$

In addition to previously defined vectors, this specification includes the child's gender, the interaction of *Girl* with India δ_1, with Indian second-born children δ_2, with Indian third-and-higher born children δ_3, with first-born children β_3, with second-born children β_4, with third-and-higher born children β_5. Control variables found in the vector X_{imc} now include mother's literacy, PSU fixed effects, and PSU fixed effects all interacted with the gender of the child. As robustness checks, we again consider variation in the inclusion of African countries (model III, IV, and VII), survey design (model II and VI), different coding of birth order (model VIII and IX), and inclusion of sibling size and its interaction with India, birth order, and gender (model X). These approaches allow us to re-examine two predictions made by JP:

> PREDICTION 1: *Relative to African counterparts, both boys and girls in India will exhibit a steeper birth order gradient.* (JP, p. 2616)
>
> PREDICTION 2: *The India-Africa height gap will be more pronounced among girls.* (JP, p. 2617)

JP consider the health investments channel in their study (in Table 3 in their paper), applying these models where the outcomes are health inputs. If the birth order effect were the key driver for the height-gap between African and Indian children, the birth order effect should also be reflected in the inputs necessary for child growth. Accordingly, as do JP, we also estimate the equation above with health inputs as the dependent variable, adding in addition to the inputs assessed by JP, two additional inputs related to the consumption of animal sourced foods: two dummy variables that turn to one when the child has been fed (a) eggs and/or meat or (b) dairy products the previous day.[3] We include indicators of food consumption because Menon et al. (2018) identify children's diet as one of the key determinants of the differences in stunting prevalence between low and high burden districts within India. Other authors also conclude that children are less likely to be stunted when consuming animal sourced foods (Dror and Allen, 2011; Krebs et al., 2011; Menon et al., 2018; Puentes, Wang et al. 2016) We estimate the health inputs for the 2015 sample using the second presented specification by JP and adjusting for survey design (weights and standard errors) and sibling size.

Lastly, we highlight the AC argument that parental health investments might not be the decisive channel at play for the height difference between African and Indian children;

[3] For data around 2005 used for analysis in the appendix, we substituted this information to whether the child has been fed in the past seven days if the information for the previous day is not available. As this is the case for five surveys conducted in Africa around 2005, this might potentially create bias for this time period.

rather the Indian Enigma is driven by differences in what they refer to as health endowments such as maternal physiology. The idea is here that the height gap between African and Indian children persists due to different growth potential. Malnutrition induced forgone growth of the children's mothers are transmitted to their children (Alacevich and Tarozzi, 2017; Finaret and Masters, 2020).[4] Thus, we include mother's height in centimeters and with interactions with India.

3. Descriptive results

Table 1 presents unweighted descriptive statistics, by country/region and year (columns (1)-(4)), followed by descriptive statistics adjusted for sampling weights, again by country/region and year (columns (5)-(8)). Note that both our Indian and our African samples are considerably larger in 2015 than in 2005: The Indian sample rises from 42,069 to 230,220 children; the African sample increases from 126,066 to 168,490.

We begin with maternal characteristics in Panel A. Comparing the unweighted Indian results for 2005 and 2015 (columns (1) and (2)), we note the following. Maternal age is roughly unchanged as is maternal height, but maternal literacy rises from 58 to 67 percent. The number of children born falls from 2.74 to 2.38; with little change in desired fertility, concomitantly a lower percentage of mothers in 2015 report having completed fertility and mothers are more likely (41 percent compared to 34 percent in 2005) to want to have more children. Access to prenatal, delivery and postnatal care improves across all measures, most notably births delivered at a health facility (from 45 to 76 percent) and postnatal check-ups (from 9 to 36 percent). There is no meaningful change in the percentage of children under the age of 10 residing outside the household or in the number of adult females residing inside the household. Log GDP per capita, however, increases substantially, from 7.78 to 8.51.

The characteristics of African mothers change little between 2005 and 2015, with maternal age, height and notably (and unlike India) the percent of literate mothers all about the same in both years (columns (3) and (4)). As was the case in the Indian sample, the number of children born falls slightly and concomitantly a lower percentage of African mothers in 2015 reported having completed fertility and were more likely (71 percent compared to 67 percent in 2005) to want to have more children. Some measures of access to prenatal, delivery and postnatal care improved (iron supplementation, delivery at health care

[4] We note that the notion of health endowment potentially includes an epigenetic component, a genetic component but also intergenerational correlations in socioeconomic status that might affect nutritional status; see Behrman et al (2009) for a discussion.

facility, postnatal check-up) but others remained unchanged (number of tetanus shots) or declined slightly (number of prenatal visits to a health care facility). There is no meaningful change in the percentage of children under the age of 10 residing outside the household. The number of adult females residing inside the household increases. Log GDP per capita rises but the magnitude of this change, from 7.36 to 7.75, is smaller than what we observe for India.

Columns (5) and (6) report results for India using sample weights. The patterns described above persist, but the magnitudes of certain changes increase. Mean prenatal visits to a health care facility rise more markedly between 2005 and 2015 (an increase of 1.14 visits compared to a 0.15 increase in the unweighted data) as does the percentage of births occurring in a health facility (an increase of 41 percentage points compared to 31 percentage points in the unweighted data). When sample weights are applied to the African data (columns (7) and (8)), the patterns described above are largely unchanged with the exception of a decreasing number of adult females in the household from 1.67 in 2005 to 1.65 in 2015, Noteworthy are also the slightly higher percentage of women who are reported literate and a slightly larger number of prenatal care visits, delivery at health facilities, and postnatal checks.[5]

Next, we turn to child characteristics in Panel B. In both the unweighted and weighted Indian data, mean child age and the percentage of the sample that are girls are the same in 2005 and 2015. Consistent with the reduction in the number of children born, birth order is lower in 2015 than it was in 2005. Both the unweighted and weighted data show an increase in the percent of Indian children receiving iron supplements and vaccinations while diarrheal prevalence in the previous two weeks was unchanged. Undernutrition, as measured by HFA, improves, and stunting prevalence declines. However, the magnitude of this change is sensitive to the use of unweighted or weighted data. For example, mean HFA z-scores decline from -1.51 to -1.26 in the unweighted data but from -1.67 to -1.26 in the weighted data.

Our unweighted African data shows that mean child age, the percentage of the sample that are girls and birth order are the same in 2005 and 2015. Use of iron supplements and the number of vaccinations falls, the latter markedly from 6.24 to 4.92. Nutritional status improves with HFA z-scores rising from -1.35 to -1.11 and stunting declines. Accounting for survey design does only change these results slightly except for the number of total vaccinations that drop even more from 2005 to 2015[6]

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[5] In addition to increases in per capita GDP, the correlation between GDP and the HFA z-scores became stronger for India; see appendix Figure B.2.1.

[6] The drop is so high because of the particular data cleaning procedure that JP suggest that codes the total of number of vaccines of missing if the information for one of the nine vaccines is not a definite yes or no.

Summarizing, we note the following. In 2015, compared to African mothers, Indian mothers were more likely to be literate, had higher numbers of prenatal care visits, and were more likely to give birth in a health care facility. Indian children were more likely to have been vaccinated. Incomes, as measured by per capita GDP, increased in both Africa and India, but the increase in India was larger and the gap in per capita GDP between Africa and India widened. Yet, while the gap between child HFA z-scores has narrowed, child HFA z-scores continue to be worse in India. The Indian enigma would seem to persist.

4. Results (1): Re-assessing the existence and magnitude of the Indian enigma

We begin by graphing mean HFA by birth order, survey year, and the application (or not) of survey weights for both our African and Indian samples (Figure 1). Beginning with our African data for 2005, we see that there is a small difference by birth order, but the magnitude of the difference is small and not sensitive to whether we use unweighted or weighed data. In 2015, mean HFA improves for all African children irrespective of birth order. The weighted data produces a slightly larger birth order gradient compared to the unweighted data but the magnitude of this difference in gradients is small.

Now consider the Indian data also shown in Figure 1. The top left-hand panel shows the unweighted results for 2005, the decline in HFA by birth order; it is identical to that documented by JP in their Figure 2. However, unlike our African data, the application of sample weights markedly changes the magnitudes of mean HFA for Indian children of all birth orders, with mean HFA for first born children falling from -1.29 (unweighted) to -1.45 (weighted), second born children falling from -1.42 (unweighted) to -1.55 (weighted) and third and higher order children's HFA falling from -1.75 (unweighted) to -1.91 (weighted). By contrast, there is minimal difference in mean HFA by birth order between the unweighted and weighted Indian data for 2015.

We now move to our econometric results found in Table 2. Columns (1) through (4) use our 2005 data. Column (1) is an attempt to exactly replicate JP's results (specifically their Table 2, column 3). Column (2) uses the same specification but, unlike JP, adjusts the sample design with weights and standard errors at the PSU level. Column (3) assesses whether the results are robust to dropping the two countries with the largest number of observations, Mali and Nigeria, that make up a significant (18%) part of the 2005 African sample. In column (4), we take another approach to concerns about the sensitivity of these findings to the inclusion (or exclusion) of certain African countries. We run a Monte Carlo simulation with 10,000 draws, each with a different sample of African countries.

Column (1) finds exactly replicates JP's Table 2, column 3. Adjusting for survey design has a marginal effect on the estimates, reducing the adverse effects of higher birth order but the size of this change is trivial. Our columns (3) and (4) show that the JP findings are not sensitive to the choice of African countries that are included in the estimated models with parameter estimates nearly identical to those reported in column (1).

We now turn to our 2015 data. Columns (5) and (6) use the same model specification as columns (1) (results unadjusted for survey design) and (2) (results adjusted for survey design). Two results are immediately apparent: (a) The coefficients on the India×birth order terms are considerably smaller, falling by about half; and (b), as was the case with the 2005 data, accounting for survey design makes no meaningful difference to these results.[7]

Next, we consider the sensitivity of our 2015 results to alternative sampling and modelling approaches. The findings using JP's strategy in column (5) are not that sensitive to changes in survey design in column (6) or the choice of African countries in column (7). In column (8), we exclude children without siblings. When we do so, the India×2nd child interaction term falls to nearly zero and is no longer statistically significant. The India×3^{rd+} child interaction term remains statistically significant but is roughly one third smaller in magnitude compared to the JP specification for 2015 in column (5) and is two-thirds smaller than their 2005 results. In column (9), we again exclude children without siblings but change the interaction terms, now including India×first born and India×last born. The omitted category are Indian children who are neither first nor last born. As we saw in earlier specifications, first born Indian children are advantaged compared to their siblings but so too – and unlike previous specifications – are last born Indian children.

Lastly, we follow SBC by including sibling size dummy variables (column (10)) to address concerns regarding omitted variable bias. The India×2nd child interaction term is, again, essentially zero; The India×3^{rd+} child interaction term is now positive and statistically significant. Controlling for a wide range of confounding factors, Indian children of birth order third or higher is 0.09 standard deviations taller than their African counterparts.

Summarizing, we can exactly replicate the JP findings for 2005 and we show that those results are not sensitive to the survey design or the inclusion or exclusion of countries in

[7] In the appendix Table B.3.1 to B.3.3, we test for Table 2 to 5 that the coefficients for the interactions with India differ statistically significantly from each other. We compare model I with V and II with VI. We find statistically significant differences for Table 2 I vs V as well as Table 3 I vs V and II vs VI for interaction of year, India, and birth order variables. The interactions with year, India, and girl are statistically significant for Table 4 I vs V and II vs VI. In Table 2 II vs VI only the interaction of year, India, and third or higher birth order is statistically significant. The interaction of year, India, girl, and birth order is only significant for the comparison of model II vs VI as in Table 3 when considering third or higher birth order girls.

the Africa data set. However, if we apply the JP specification to our 2015 data, we find that the Indian birth order gradient is half the size that we observed in 2005. Further, this result is sensitive to sample specification and how birth order is modelled. Including sibling size dummy variables reverses the India×3^{rd+} child association with HFA.

5. Results (2): Re-assessing eldest son preference

Our next step is to assess whether eldest son preference is the driver behind the birth order preference result found in the JP study. We do so in Table 3, using the same ten specifications reported in Table 2.

Starting with column (1), we replicate the JP finding that the triple interaction terms of India×birth order×girl in the 2005 sample are not statistically significant. This finding is not sensitive to the adjustment to the survey design (column (2)) and the inclusion/exclusion of the African countries used in the 2005 sample (columns (3) and (4)). Columns (5) and (6) again use the 2015 sample. Using the JP specification without and with adjustments for survey design, they would appear to show that higher birth order Indian girls have lower HFA z-scores unlike the 2005 results; this is especially marked for girls of third or higher birth order.[8] For example, column (6) shows that compared to their African peers, Indian girls of second-birth order are on average 0.14 standard deviations shorter and ones of third-and-higher birth order, 0.19 standard deviations shorter. As we saw in Table 2, the general Indian birth order gradient is sensitive to sample specification, how birth order is modelled, and the inclusion of sibling size dummy variables. With any of those changes (columns (7), (8), and (9)) or all (column 10), the Indian birth order effect seen in column (5) disappears.

Next, in Table 4, we focus solely on African-Indian differences by child sex. As we seen with other findings, our column (1) results nearly identically replicate JP (specifically their Table 5, column (5)) and their 2005 results are robust to the adjustment to the survey design and are not sensitive to the sample of African countries that are used (columns (2), (3) and (4)). However, using exactly their specification but applying it to the 2015 data (column (5), we see that the magnitude of the coefficient for Indian girls halves, with the coefficient on India×girl falling to -0.07. This result is not sensitive to the adjustment to survey design (column (6)) or a variation of African countries included in the sample (column (7)), but the parameter estimate falls slightly further when we include sibling size dummies. The results in

[8] When testing the equality of coefficients in the appendix Table B.3.3, we do find evidence for a difference in coefficients for the triple interaction of year, India, and birth order. However, we only find a statistically significant difference for year, India, girl, and 3^{rd} or higher birth order for the survey adjusted models (II vs VI).

column (8) show that, controlling for a wide range of confounding factors, the disadvantage faced by Indian girls, relative to their African counterparts has fallen from -0.15 SD (model I: 2005, JP basic result) to -0.06 (model X: 2015 data with sibling size dummies included), a 40 percent reduction with the latter now only significant at the 5 percent level.

6. Results (3): The role of health inputs

We now reassess whether high-birth order children, particularly girls, are disadvantaged in access to the inputs that ultimately determine their health and their height. In Table 5, we apply JP's second introduced estimation strategy to our 2015 data, considering a wide range of prenatal and postnatal inputs as well as an average of total pooled inputs by JP as outcomes.[9] We adjust the specification for survey design and include sibling size dummies. If there are gender-specific or birth order gradients in child height, then we should also see these in the inputs that affect height.

The striking feature of Table 5 is how few statistically significant associations that we observe across the ten inputs that we consider. There is no evidence in these data that higher birth order Indian girls are disadvantaged in terms of access to prenatal inputs, postnatal inputs, or consumption off animal source foods. Averaging across all pre- and post-natal inputs, higher birth order Indian children appear to be somewhat disadvantaged (and the point estimates for these are statistically significant) but the magnitude is small relative to the Indian mean.

7. Results (4): Health investments and health endowments

If birth order is not the driver of the height difference between African and Indian children, what else could explain the Indian Enigma? Here we focus on health endowments. Our summary statistics have already shown that mothers in Africa are taller than in India. Figure 2 complements this by showing boxplots of the height distribution of mothers using weighted and unweighted as well as data from around 2005 and 2015. In all comparisons African mothers' *median* heights lie only slightly below the *90th* percentile of mothers' heights in India. Thus, we contrast the sensitivity of the health investment channel to the health endowment channel by including mother's height and its interaction with India.

[9] We have coded the prenatal inputs and postnatal inputs as well as average pooled inputs following JP. The average of total inputs is composed of the seven prior health input indicators. The indicators with original multiple values (total prenatal visits, total tetanus shots, and total vaccines) are transformed into dummy variables that turn to one if the measure of the original variable has a value larger than the sample median.

In Table 6, we address this issue using our 2015 data. The first column repeats, for reference, the JP specification model V, showing a birth order gradient in height. Simply adding maternal height to this model slightly reduces the magnitude of the India×birth order interaction terms, but arguably the magnitude of this reduction is not meaningful. By contrast, adding both maternal height and sibling size dummies and adjusting for survey design renders all Indian India×birth order interaction terms both small (not more than 0.02 SD) and insignificant.

Next, in Table 7, we consider the sensitivity of our findings on child sex. For reference, column (1) and column (4) repeat our initial results for model V found in Table 3 and Table 4, respectively. Including maternal height in column (2) of Table 7 and maternal height, sibling size dummies, and adjustments of survey design (column (3)) appear to eliminate any lingering associations between birth order, child sex, and HFA z-scores.[10]

Column (4), for reference, repeats our initial results found in Table 4 model V. Adding in maternal height by itself causes little change in the India×girl interaction term (column (5)). However, the inclusion of maternal height, sibling size dummies, and also adjustments to survey design (column (6)) causes the parameter estimate on India×girl to fall to near-zero (0.02). It is not statistically significant. With the inclusion of those controls, there is no longer a gender gap between the heights of African and Indian girls.

Given this result, we do the following back-of-the-envelope calculation. We re-estimate model XI in Table 6, excluding the interaction terms with India and running the regression separately for the Indian and the African sample for the period around 2015. We then estimate the average predicted marginal effects for children's height for both samples. We extract the average height of African mothers and again calculate the predicted marginal effects for children's height in India at the average African mothers' height level. If we compare children's height differences of the marginal effects between Africa and India and between Africa and the adjusted India sample to the mean African mothers' height, we find that the height gap is larger in the latter case: Once we substitute height in the India sample, Indian children are *taller* than their African counterparts.[11] This difference is larger than the height gap between the Africa and India sample before. We plot the predicted levels of HFA z-scores for Indian and African children at five points with each point using a different level

[10] Our data also include mothers who may not have yet reached full physical maturity. This could potentially affect our results because the same factors that shape child growth could also shape the growth of mother' height. We conducted an additional robustness check with a sample of mothers who have attained at least the age of 19 at their child's birth. We assume that women are growing until the age of 18. Results shown in Appendix Table B.3.4 imply that our main findings are robust to this concern.

[11] Note that we only change maternal height and not other covariates.

of maternal height: Indian women's heights applied to Indian and African children; and African women's heights applied to Indian and African children (Figure 3). The predicted HFA z-scores for Indian children using Indian maternal heights are virtually indistinguishable from the predicted HFA z-scores for African children using African maternal heights (-1.26 and -1.20 respectively). The highest predicted HFA z-score is found for Indian children with African mothers' height (-0.94). Put simply, if Indian mothers were as tall as African mothers, their children would be on average taller than African children.

8. Summary

In this paper, we re-visit the contested discussion surrounding the Indian Enigma. Our paper encapsulates the approach taken in the seminal paper by JP as well as those outlined by AC and SBC. We find the following.

As emphasized by AC and SBC, careful attention to sampling design (especially as it relates to incomplete fertility) and model specification is crucial; many of our findings are sensitive to the inclusion, or exclusion, of the controls they describe. Second, the gap between the heights of pre-school African and Indian children is closing. Third, the gap that remains does not appear to be driven by differential associations by birth order and child sex. Fourth, the remaining gap is associated with differences in maternal heights. Indeed, if Indian women had the heights of their African counterparts, pre-school Indian children would be taller than pre-school African children. Fifth, once we account for survey design, sibling size and maternal height, the coefficient associated with being an Indian girl is no longer statistically significant (Table 7, model specification XII).

Despite our careful attention to key methodological issues, we note that our study has limitations. Our study is associational. It includes women with incomplete fertility. It assumes that the DHS data collected in different countries at different times use survey instruments that are sufficiently comparable that these data can be aggregated. It is limited by the narrow choice of additional explanatory factors of the Indian Enigma. For example, Spears (2018) argues that the disease environment caused by the externality of open defecation is an important contributor to poor anthropometric outcomes in India. We can only partially capture these negative externalities through PSU fixed effects. The decomposition analysis of drivers of child stunting in South Asia by Headey et al. (2016) lists other factors such as access to prenatal care that may be important to consider. Other alternative explanatory factors that we do not focus on but might also be driving anthropometric outcomes is birth spacing (Dhingra and Pingali, 2021).

We end by noting the following. Indian women are shorter than African women for a variety of reasons, including past discrimination in access to inputs necessary for optimal growth in utero and in infancy. Mindful of this, current divergences in the heights of Indian and African pre-school children reflect past gendered differences in access to these inputs. We see much less evidence of gendered differences in access to these inputs by Indian girls in more recent (2015) data, but these results are averages; they should not be taken to imply that these differences have disappeared everywhere in India. Lastly, both the intrinsic and instrumental value of improving early life nutrition outcomes in both in India and Africa imply the value of public action in this area.

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Table 1: Summary Statistics

Panel A. JP Table 1 Column 1

Model	JP: unweighted				Authors: weighted			
Country/Region	India		Africa		India		Africa	
Data	2005	2015	2005	2015	2005	2015	2005	2015
Mother's age at birth (years)	24.75	25.12	26.96	27.23	24.25	24.72	26.95	27.11
	(5.23)	(4.96)	(6.86)	(6.71)	(5.19)	(4.76)	(6.85)	(6.70)
Mother's total children born	2.74	2.38	3.88	3.81	2.87	2.30	3.81	3.63
	(1.82)	(1.49)	(2.54)	(2.48)	(1.91)	(1.42)	(2.50)	(2.42)
Mother's desired fertility	2.47	2.42	4.62	4.73	2.45	2.28	4.43	4.43
	(0.96)	(0.99)	(1.47)	(1.41)	(0.89)	(0.88)	(1.52)	(1.50)
Mother wants more children	0.34	0.41	0.67	0.71	0.34	0.39	0.63	0.64
	(0.47)	(0.47)	(0.46)	(0.44)	(0.47)	(0.47)	(0.48)	(0.47)
Mother completed her fertility	0.67	0.61	0.33	0.28	0.67	0.63	0.38	0.35
Mother is literate	0.58	0.67	0.49	0.48	0.49	0.68	0.51	0.55
	(0.49)	(0.47)	(0.50)	(0.50)	(0.50)	(0.47)	(0.50)	(0.50)
Mother's height (meters)	1.52	1.52	1.58	1.58	1.52	1.52	1.58	1.59
	(0.06)	(0.06)	(0.07)	(0.06)	(0.06)	(0.06)	(0.07)	(0.06)
Mother took iron supplements	0.69	0.77	0.62	0.76	0.66	0.78	0.63	0.78
Mother's total tetanus shots	1.87	1.91	1.41	1.42	1.86	1.93	1.46	1.48
	(0.94)	(0.78)	(1.20)	(1.09)	(0.95)	(0.78)	(1.20)	(1.13)
Total prenatal visits	4.04	4.19	3.85	3.77	3.49	4.63	3.94	4.05
	(3.48)	(3.86)	(3.07)	(2.92)	(3.32)	(4.20)	(2.92)	(2.76)
Delivery at health facility	0.45	0.76	0.47	0.58	0.39	0.80	0.49	0.65
Postnatal check within 2 months	0.09	0.36	0.30	0.49	0.08	0.38	0.43	0.50
Average pooled inputs	0.33	0.46	0.38	0.40	0.29	0.54	0.38	0.45
	(0.28)	(0.25)	(0.30)	(0.29)	(0.26)	(0.22)	(0.29)	(0.28)
Percent non-resident among children	0.02	0.02	0.10	0.09	0.02	0.02	0.10	0.09
	(0.04)	(0.04)	(0.08)	(0.00)	(0.03)	(0.03)	(0.09)	(0.00)
Number of adult females in household	1.85	1.91	1.60	1.94	1.89	1.94	1.67	1.65
	(1.09)	(1.03)	(1.06)	(1.66)	(1.11)	(1.04)	(1.14)	(1.18)
Log GDP per capita (in child's birth year)	7.78	8.51	7.36	7.75	7.77	8.50	7.32	7.71
	(0.10)	(0.08)	(0.65)	(0.68)	(0.10)	(0.08)	(0.68)	(0.68)

Panel A. JP Table 2 Column 2

Model	JP: unweighted				Authors: weighted			
Country/Region	India		Africa		India		Africa	
Data	2005	2015	2005	2015	2005	2015	2005	2015
Child's age (months)	30.20	30.14	28.27	28.90	30.18	30.18	28.22	28.65
	(16.90)	(16.92)	(17.06)	(17.02)	(17.01)	(16.88)	(17.05)	(17.04)
Child is a girl	0.48	0.48	0.50	0.50	0.48	0.48	0.50	0.50
Child's birth order	2.62	2.26	3.74	3.70	2.74	2.18	3.66	3.51
	(1.80)	(1.47)	(2.48)	(2.42)	(1.88)	(1.40)	(2.43)	(2.35)
Child's HFA z-score	-1.51	-1.26	-1.35	-1.11	-1.67	-1.26	-1.32	-1.14
	(1.81)	(1.82)	(1.94)	(1.73)	(1.80)	(1.82)	(1.90)	(1.71)
Child is stunted	0.40	0.35	0.38	0.29	0.45	0.35	0.36	0.30
Child's WFA z-score	-1.53	-1.43	-0.88	-0.86	-1.70	-1.47	-0.82	-0.75
	(1.33)	(1.30)	(1.42)	(1.31)	(1.30)	(1.28)	(1.40)	(1.31)
Child's hemoglobin	10.28	10.60	10.15	10.33	10.10	10.55	10.13	10.45
level (g/dl)	(1.57)	(1.51)	(1.68)	(1.63)	(1.56)	(1.48)	(1.69)	(1.63)
Child is deceased	0.05	0.04	0.07	0.05	0.06	0.04	0.07	0.05
Child taking iron pills	0.06	0.23	0.11	0.07	0.05	0.25	0.13	0.09
Child's total	6.61	7.30	6.24	4.92	6.42	7.43	6.30	1.15
vaccinations	(2.80)	(2.70)	(3.12)	(3.55)	(2.75)	(2.60)	(3.18)	(2.74)
Birth spacing	36.16	37.26	38.69	38.83	35.43	37.16	40.06	41.41
(months)	(20.32)	(21.45)	(20.63)	(20.79)	(19.42)	(21.61)	(21.70)	(22.84)
Diarrhea in last 2 weeks	0.09	0.09	0.16	0.16	0.09	0.09	0.17	0.16
Open defecation	0.46	0.44	0.32	0.25	0.63	0.47	0.34	0.23
Number of PSUs	3,822	28,215	10,366	12,684	3,822	28,215	10,366	12,684
Main sample of children	42,069	230,220	126,066	168,490	42,069	230,220	126,066	168,490

Notes The means of the specified variables are calculated separately for the India and Africa subsamples. Standard deviations appear in parentheses. As information about total prenatal visits, mother took iron supplements, total tetanus shots, postnatal check within two months are only available for the most recent birth, these variables are also shown here for family level variables. Variables summarized at the child level in Panel A include: mother's age at birth, delivery at health facility, average pooled inputs, open defecation, percent nonresident among children, number of adult females in the household, and log GDP per capita in

child's birth year. Variables are summarized at the child level in Panel B. Birth spacing indicates the birth interval between a child and his or her older sibling.
Source: Adapted from JP using data from IPUMS DHS (ICF, 2004) and DHS (Heger Boyle & Sobek, 2019)

Table 2: Associations between height-for-age z-score and birth order, JP Model Table 2 Column 3, and alternative specifications

Period	2005				2015					
Specification	JP	Alternative			JP	Alternative				
Model	I	II	III	IV	V	VI	VII	VIII	IX	X
India×2nd child	-0.16***	-0.16***	-0.16***	-0.16**	-0.07***	-0.07***	-0.07**	-0.03		0.02
	(0.03)	(0.04)	(0.03)	(0.03)	(0.02)	(0.02)	(0.02)	(0.02)		(0.02)
India×3rd+ child	-0.23***	-0.18***	-0.22***	-0.23***	-0.11***	-0.12***	-0.11**	-0.07***		0.09***
	(0.03)	(0.04)	(0.03)	(0.04)	(0.02)	(0.03)	(0.03)	(0.02)		(0.03)
2nd child	-0.01	0.01	-0.01	-0.01	-0.05***	-0.07***	-0.05*	-0.14***		-0.16***
	(0.02)	(0.02)	(0.02)	(0.03)	(0.01)	(0.02)	(0.02)	(0.02)		(0.02)
3rd+ child	-0.12***	-0.14***	-0.12***	-0.12**	-0.16***	-0.16***	-0.15**	-0.24***		-0.31***
	(0.02)	(0.03)	(0.02)	(0.03)	(0.01)	(0.02)	(0.03)	(0.02)		(0.03)
India×first-born									0.12***	
									(0.02)	
India×last-born									0.18***	
									(0.02)	
First-born									0.10***	
									(0.02)	
Last-born									-0.15***	
									(0.01)	
Africa mean of outcome	-1.35	-1.32	-1.37	-1.35	-1.11	-1.14	-1.11	-1.15	-1.15	-1.11
Survey design adjusted	No	Yes	No	No	No	Yes	No	No	No	No
Sample	Full	Full	ML & NG excluded	Varies	Full	Full	Varies	No singletons	No singletons	Full
Sibling size	No	No	No	No	No	No	No	No	No	Yes
Observations	167,765	167,765	106,955	136,276	397,702	397,702	317,178	312,320	312,320	397,702

Notes: The outcome, HFA z-scores, is measured in standard deviations. Standard errors appear in parentheses and are clustered on the PSU level for column 2 and 6 and mother level for all other columns. Statistical significance is indicated by * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. 2nd child is an indicator for children whose birth order is 2; 3rd+ child is an indicator for children whose birth order is 3 or higher; First-born is an indicator for children who are born first to their mother; Last-born is an indicator for children who are born last to their mother. PSU fixed effects are included in all columns. Controls include a linear and a quadratic variable for mother's age at birth, mother's literacy, children's age dummies in months and their interactions with India. In column 3, the two surveys of the African sample with the highest number of observations are excluded: Mali (ML) in 2006 and Nigeria (NG) in 2008. The coefficients, standard errors, p-values, and Africa mean of outcome, and observation number for column 4 and 7 are averages of a Monte Carlo simulation of 10,000 repetitions using random draws of the African countries. Sibling size dummies and their interaction with India are included in column 10. The main effect India is absorbed by PSU fixed effects.

Source: Adapted from JP using data from IPUMS DHS (ICF, 2004) and DHS (Heger Boyle & Sobek, 2019)

Table 3: Associations between height-for-age z-score, child sex and birth order, India, JP Model Table 5 Column 2, and alternative specifications

Period	2005				2015					
Specification	JP	Alternative			JP	Alternative				
Model	I	II	III	IV	V	VI	VII	VIII	IX	X
India×2nd child	-0.15***	-0.16***	-0.15***	-0.15**	-0.04*	0.02	-0.04	-0.01		0.04
	(0.04)	(0.05)	(0.04)	(0.06)	(0.02)	(0.04)	(0.04)	(0.03)		(0.03)
India×3rd+ child	-0.22***	-0.22***	-0.21***	-0.22**	-0.07**	-0.02	-0.07	-0.03		0.14***
	(0.05)	(0.06)	(0.05)	(0.06)	(0.03)	(0.0)	(0.04)	(0.04)		(0.05)
India×2nd child×Girl	-0.04	-0.01	-0.06	-0.05	-0.06*	-0.14***	-0.06	-0.03		-0.05
	(0.06)	(0.08)	(0.06)	(0.08)	(0.03)	(0.05)	(0.05)	(0.05)		(0.05)
India×3rd+ child×Girl	-0.05	0.07	-0.08	-0.05	-0.09**	-0.19***	-0.10	-0.07		-0.13*
	(0.07)	(0.09)	(0.07)	(0.09)	(0.04)	(0.06)	(0.06)	(0.05)		(0.07)
India×first-born									0.12***	
									(0.04)	
India×last-born									0.21***	
									(0.03)	
India×First-born×Girl									-0.02	
									(0.05)	
India×Last-born×Girl									-0.07*	
									(0.04)	
Africa mean of outcome	-1.35	-1.32	-1.37	-1.35	-1.11	-1.14	-1.11	-1.15	-1.15	-1.11
Survey design adjusted	No	Yes	No	No	No	Yes	No	No	No	No
Sample	Full	Full	ML & NG excluded	Varies	Full	Full	Varies	No singletons	Siblings only	Full
Sibling size	No	No	No	No	No	No	No	No	No	Yes
Observations	165,623	165,623	134,151	105,591	390,071	390,071	310,385	301,844	301,844	390,071

Notes: See Table 2 for construction of outcome, standard errors, definition of birth order, list of controls, statistical significance, and model specifications for columns (3),(4), (7) and (9). The main effect of Girl, 2nd child and 3rd+ child, 2nd child×Girl, and 3rd+ child×Girl are included but not shown. Column (9) also includes interactions of sibling size dummies with Girl.

Table 4: Associations between height-for-age z-score and India *x* child sex, JP Model Table 5 Column 6, and alternative specifications

Period	2005				2015			
Specification	JP	Alternative			JP	Alternative		
Model	I	II	III	VI	V	VI	VII	X
India×Girl	-0.15***	-0.17***	-0.15***	-0.15***	-0.07***	-0.09***	-0.10***	-0.06**
	(0.02)	(0.02)	(0.02)	(0.02)	(0.01)	(0.02)	(0.01)	(0.03)
Girl	0.17***	0.17***	0.18***	0.18***	0.15***	0.16***	0.17***	0.22***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)
Africa mean of outcome	-1.35	-1.32	-1.37	-1.37	-1.11	-1.14	-1.16	-1.11
Survey design adjusted	No	Yes	No	No	No	Yes	No	No
Sample	Full	Full	ML NG excluded	Varies	Full	Full	Varies	Full
Sibling Size	No	No	No	No	No	No	No	Yes
Observations	167,765	167,765	136,276	136,276	397,702	397,702	397,702	397,702

Notes: See Table 2 for construction of outcome, standard errors, definition of birth order, list of controls, and model specifications for columns (1) through (6). Column (7) is the model specification with sibling size dummies and their interaction with India. The main effect India is absorbed by PSU fixed effects. The main effect of Girl is included in all regressions but not shown.

Table 5: Associations between child health inputs, birth order and child sex

	Prenatal Inputs				Postnatal Inputs				Animal Sourced Foods	
	Total prenatal visits	Mother took iron supplements	Mother's total tetanus shots	Delivery at health facility	Postnatal check within 2 months	Child taking iron pills	Child's total vaccinations	Average pooled inputs	Meat or eggs consumed	Dairy products consumed
India×2nd child	0.34	0.00	0.09***	0.01	0.00	-0.00	0.11	-0.06***	0.03*	0.05***
	(0.55)	(0.01)	(0.03)	(0.01)	(0.01)	(0.01)	(0.08)	(0.01)	(0.02)	(0.02)
India×3rd+ child	-1.65	-0.62***	-1.64***	0.03	0.40***	-0.03*	0.08	-0.14***	0.27**	0.31***
	(1.15)	(0.19)	(0.25)	(0.02)	(0.01)	(0.02)	(0.14)	(0.01)	(0.12)	(0.11)
India×2nd child×Girl	0.77	-0.01	-0.02	0.00	0.00	-0.02	-0.03	0.01	0.01	0.02
	(0.17)	(0.02)	(0.05)	(0.02)	(0.02)	(0.02)	(0.12)	(0.01)	(0.02)	(0.02)
India×3rd+ child×Girl	-4.70	-0.23	-0.76	-0.03	0.45**	0.00	0.01	0.02	-0.27	-0.16
	(3.12)	(0.28)	(0.82)	(0.03)	(0.23)	(0.02)	(0.20)	(0.02)	(0.23)	(0.14)
2nd child	-0.23**	-0.02**	-0.17***	-0.05***	-0.01	0.00	-0.10	-0.07***	-0.01	-0.03**
	(0.09)	(0.01)	(0.03)	(0.01)	(0.01)	(0.01)	(0.07)	(0.01)	(0.02)	(0.01)
3rd+ child	-5.64***	-0.17	-0.30	-0.06***	-0.11	0.01	-0.07	-0.09***	1.24***	-0.30**
	(0.49)	(0.16)	(0.54)	(0.02)	(0.09)	(0.01)	(0.12)	(0.01)	(0.16)	(0.12)
Africa mean of outcome	4.05	0.78	1.48	0.65	0.50	0.09	1.15	0.45	0.31	0.20
India mean of outcome	4.63	0.78	1.93	0.80	0.38	0.25	7.43	0.54	0.14	0.13
Observations	32,068	271,028	269,621	389,768	261,524	366,654	207,135	390,003	129,737	129,731

Notes: Outcomes are defined as follows: Total prenatal visits, mother took iron supplements, mother's total tetanus shots, postnatal check within 2 months, consumption of meat and eggs, and consumption of dairy products are only available for the youngest living child in the family. Delivery at health facility, child taking iron pills, and total vaccinations are available for all births in the past five years; 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 the introduced prenatal and postnatal inputs is used to create the outcome just as in JP for Table 4. The sample for prenatal visits is reduced to PSUs with at least 18 observations to guarantee the calculation of the variance matrix to calculate standard errors. All columns include weights and standard errors clustered at the PSU level. See Table 2 for significance level and definition of birth order. The controls related to mothers include a linear and a quadratic variable for mother's age at birth, mother's literacy, and their interactions with India and/or gender. The controls related to children are child age dummies and interactions with India and/or gender are also included. Other controls are PSU fixed effects and the interactions of PSU and gender as well as sibling size dummies and their interaction with India. The main effect India is absorbed by PSU fixed effects. The main effect of Girl, 2nd child and 3rd+ child, 2nd child×Girl, and 3rd+ child×Girl are included in all regressions but not shown.

Table 6: Associations between height-for-age z-score and birth order, maternal height included

Specification	JP	Alternative	
Model	V	XI	XII
India×2nd child	-0.07***	-0.07***	-0.02
	(0.02)	(0.02)	(0.03)
India×3rd+ child	-0.11***	-0.08***	-0.00
	(0.02)	(0.02)	(0.05)
2nd child	-0.05***	-0.05***	-0.15***
	(0.01)	(0.02)	(0.03)
3rd+ child	-0.16***	-0.17***	-0.26***
	(0.01)	(0.02)	(0.04)
Mother's height in centimeter		0.04***	0.04***
		(0.00)	(0.00)
India×Mother's height in centimeter		0.01***	0.00***
		(0.00)	(0.00)
Africa mean of outcome	-1.11	-1.11	-1.16
Survey design adjusted	No	No	Yes
Sibling size	No	No	Yes
Observations	397,702	350,675	350,675

Notes: See Table 2 for construction of outcomes, standard errors, statistical significance, definition of birth order, and list of controls. Sibling size dummies and their interaction with India are included in column 3.

Table 7: Associations between height-for-age z-score, child sex and birth order, maternal height included

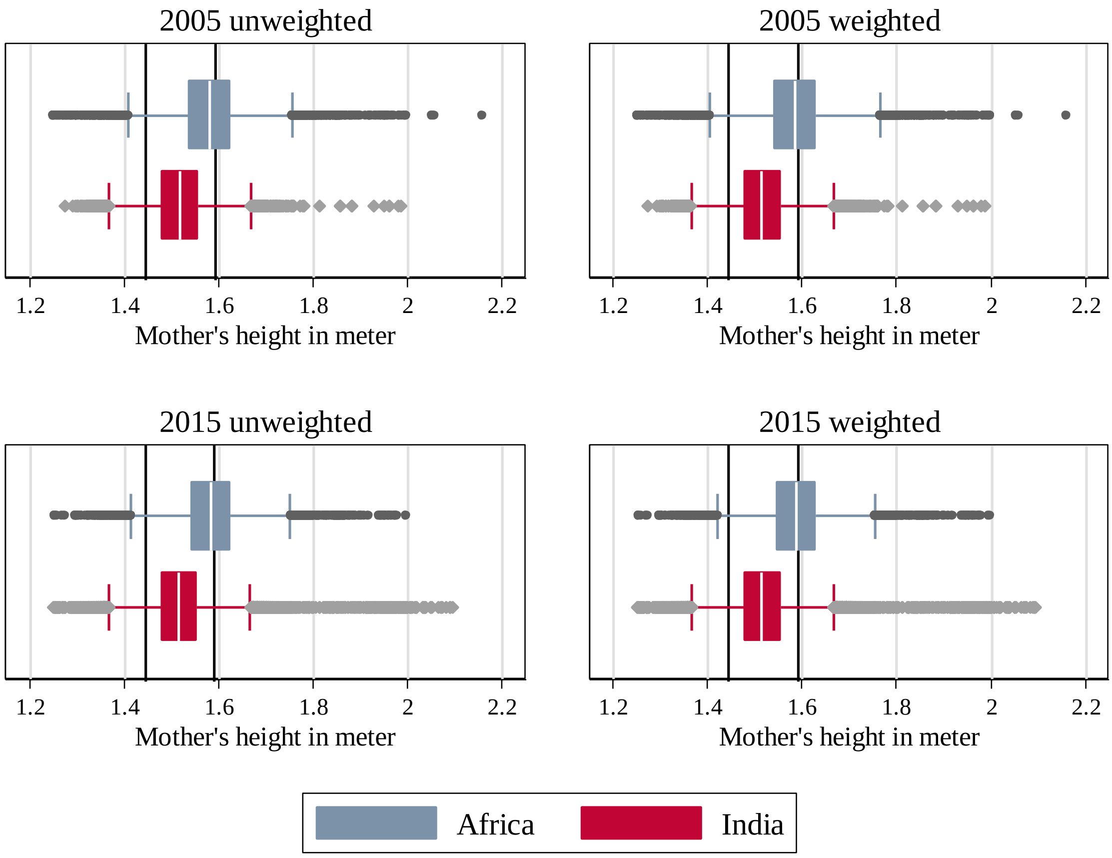
Column in JP Table 5	2			6		
Specification	JP	Alternative		JP	Alternative	
Model	V	XI	XII	V	XI	XII
India×2nd child	-0.04*	-0.03	-0.01			
	(0.02)	(0.03)	(0.05)			
India×3rd+ child	-0.07**	-0.04	0.03			
	(0.03)	(0.03)	(0.07)			
India×2nd child×Girl	-0.06*	-0.07*	-0.02			
	(0.03)	(0.04)	(0.07)			
India×3rd+ child×Girl	-0.09**	-0.09*	-0.07			
	(0.04)	(0.04)	(0.10)			
India×Girl				-0.07***	-0.08***	0.02
				(0.01)	(0.01)	(0.04)
Girl				0.15***	0.16***	0.14***
				(0.01)	(0.01)	(0.03)
Mother's height in centimeter		0.04***	0.04***		0.04***	0.04***
		(0.00)	(0.00)		(0.00)	(0.00)
India×Mother's height in centimeter		0.01***	0.00**		0.01***	0.00***
		(0.00)	(0.00)		(0.00)	(0.00)
Africa mean of outcome	-1.11	-1.11	-1.16	-1.11	-1.11	-1.16
Survey design adjusted	No	No	Yes	No	No	Yes
Sibling Size	No	No	Yes	No	No	Yes
Observations	390,071	342,822	342,822	397,702	350,675	350,675

Notes: See Table 2 for construction of standard errors, statistical significance, definition of birth order, and list of controls. The main effect of Girl, 2nd child and 3rd+ child, 2nd child×Girl, and 3rd+ child×Girl are included in all regressions but not shown.

Figure 1: Child Height in India and Africa, by birth order

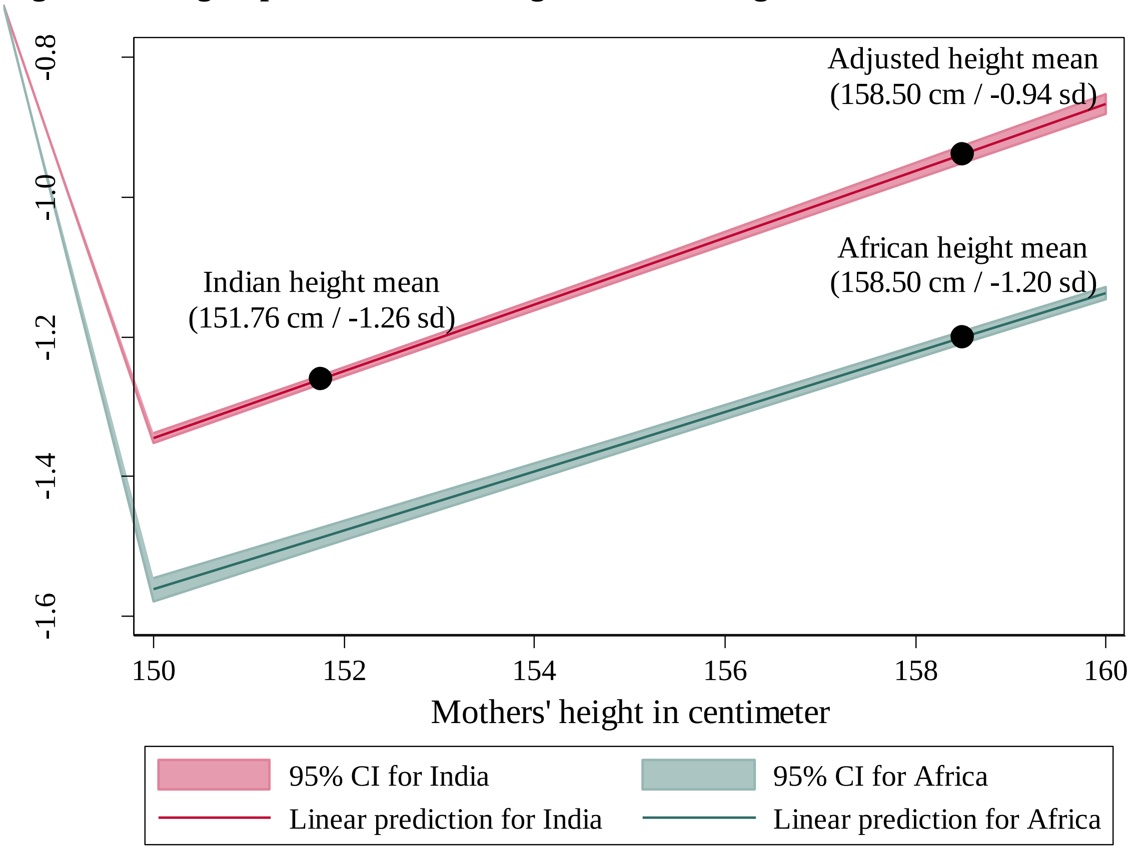
Source: Adapted from JP using data from DHS (ICF, 2004) and IPUMS DHS (Heger Boyle & Sobek, 2019)

Figure 2: Maternal height in India and Africa



Notes: The figure depicts boxplots of mothers' height for sub-Saharan Africa and India. Vertical rules show the 10th and 90th percentile of mothers' height in India.

Figure 3: Margins plot of maternal heights on child height



Note: CI stands for confidence interval. The linear predictions are based on predictie margins for the following mothers' heights sepearately regressed for the Indian and African sample: 150 cm, 155 cm, 160 cm, Indian height mean (151.76 cm), and African height mean (158.50 cm).

The Indian Enigma revisited

Supplementary Appendices

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Appendix A:

Comparison Original Results by JP and Replication Results for 2005 Sample

Appendix A.1 Summary Statistics

Table A.1.1: Summary Statistics (2004-2010): Original as in JP

	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)
Percent non-resident among children	0.02	0.10	Number of PSUs	3,822	10,366
	(0.04)	(0.08)			
Number of adult females in household	1.85	1.60	Main sample of children	42,069	126,039
	(1.09)	(1.06)			
Log GDP per capita (in child's birth year)	7.78	7.36			
	(0.10)	(0.65)			

Table A.1.2: Summary Statistics (2004-2010): Replication

	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	0.49	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)	(0.49)		(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)
Percent non-resident among children	0.02	0.10	Number of PSUs	3,822	10,366
	(0.04)	(0.08)			
Number of adult females in household	1.85	1.60	Main sample of children	42,069	126,066
	(1.09)	(1.06)			
Log GDP per capita (in child's birth year)	7.78	7.36			
	(0.10)	(0.65)			

Notes: Please consider the notes in Table 1 for further explanations.
Source: Adapted from JP using data from DHS (Heger Boyle & Sobek, 2019)

Appendix A.2 India’s Differential Birth Order Gradient in Child Height and Related Outcomes

Table A.2.1: India’s Differential Birth Order Gradient in Child Height and Related Outcomes (2004-2010): Original as in JP

	HFA z-score	HFA z-score	HFA z-score	HFA z-score	HFA z-score	Stunted	WFA z-score	Hb level	Deceased
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(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	-0.094	0.003
		(0.025)	(0.027)	(0.063)	(0.048)	(0.007)	(0.020)	(0.030)	(0.004)
India × 3rd+ child		-0.377	-0.227	-0.193	-0.436	0.064	-0.198	-0.159	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	-0.011	-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	-0.037	-0.011
		(0.013)	(0.019)	(0.074)	(0.044)	(0.005)	(0.014)	(0.025)	(0.003)
Africa mean of outcome	-1.351	-1.351	-1.351	-1.351	-1.351	0.375	-0.877	10.150	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	88,838	199,514

Table A.2.2: India's Differential Birth Order Gradient in Child Height and Related Outcomes (2004-2010): Replication

	HFA z-score	HFA z-score	HFA z-score	HFA z-score	HFA z-score	Stunted	WFA z-score	Hb level	Deceased
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
India	-0.083	0.092							
	(0.011)	(0.018)							
India × 2nd child		-0.144	-0.161	-0.110	-0.243	0.051	-0.147	-0.094	0.003
		(0.025)	(0.027)	(0.063)	(0.048)	(0.007)	(0.020)	(0.030)	(0.004)
India × 3rd+ child		-0.377	-0.228	-0.194	-0.436	0.064	-0.199	-0.158	0.002
		(0.024)	(0.032)	(0.092)	(0.085)	(0.009)	(0.024)	(0.036)	(0.004)
2nd child		0.024	-0.011	-0.096	-0.167	0.009	0.010	-0.010	-0.014
		(0.015)	(0.017)	(0.053)	(0.027)	(0.004)	(0.012)	(0.022)	(0.002)
3rd+ child		-0.065	-0.117	-0.168	-0.334	0.036	-0.063	-0.038	-0.011
		(0.013)	(0.019)	(0.074)	(0.044)	(0.005)	(0.014)	(0.025)	(0.003)
Africa mean of outcome	-1.351	-1.351	-1.351	-1.351	-1.351	0.375	-0.877	10.149	0.072
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	168,135	168,135	167,765	66,574	83,243	167,765	167,765	88,893	199,514

Notes: Please consider the notes in Table 2 and JP Table 2 for further explanations.

Source: Adapted from JP using data from DHS (Heger Boyle & Sobek, 2019)

Appendix A.3 Child Health Inputs

Table A.3.1: Child Health Inputs (2004-2010): Original as in JP

	Prenatal inputs				Postnatal inputs			
	Total prenatal visits	Mother took iron supplements	Mother's total tetanus shots	Delivery at health facility	Postnatal check within 2 months	Child taking iron pills	Child's total vaccinations	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

Table A.3.2: Child Health Inputs (2004-2010): Replication

	Prenatal inputs				Postnatal inputs			
	Total prenatal visits	Mother took iron supplements	Mother's total tetanus shots	Delivery at health facility	Postnatal check within 2 months	Child taking iron pills	Child's total vaccinations	Average pooled inputs
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
India × 2nd child	-0.525	-0.031	-0.019	-0.040	-0.008	-0.008	-0.204	-0.011
	(0.052)	(0.008)	(0.018)	(0.006)	(0.013)	(0.005)	(0.039)	(0.003)
India × 3rd+ child	-1.011	-0.072	-0.036	-0.092	0.015	-0.010	-0.462	-0.033
	(0.060)	(0.009)	(0.021)	(0.008)	(0.014)	(0.006)	(0.051)	(0.004)
2nd child	-0.182	-0.014	-0.111	-0.088	0.004	-0.004	-0.097	-0.044
	(0.029)	(0.005)	(0.013)	(0.004)	(0.010)	(0.004)	(0.025)	(0.002)
3rd+ child	-0.432	-0.031	-0.207	-0.133	-0.023	-0.014	-0.207	-0.071
	(0.033)	(0.005)	(0.014)	(0.004)	(0.011)	(0.005)	(0.030)	(0.003)
Africa mean of outcome	3.847	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	115,364	117,707	117,219	167,405	35,902	91,964	122,922	167,752

Notes: Please consider the notes in Table 5 and JP Table 4 for further explanations.

Source: Adapted from JP using data from DHS (Heger Boyle & Sobek, 2019)

Appendix A.5 Child Gender and the Birth Order Gradient in Height

Table A.5.1: Child Gender and the Birth Order Gradient in Height (2004-2010): Original as in JP

	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

Table A.5.2: Child Gender and the Birth Order Gradient in Height (2004-2010): Replication

	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	-0.112				-0.143	-0.147	-0.098	-0.116
	(0.036)				(0.020)	(0.019)	(0.032)	(0.014)
India × 2nd child	-0.107	-0.153	-0.228	-0.122				
	(0.036)	(0.040)	(0.069)	(0.030)				
India × 3rd+ child	-0.352	-0.222	-0.414	-0.176				
	(0.033)	(0.047)	(0.097)	(0.035)				
India × 2nd child × Girl	-0.077	-0.045	-0.024	-0.047				
	(0.053)	(0.057)	(0.101)	(0.042)				
India × 3rd+ child × Girl	-0.051	-0.048	-0.030	-0.063				
	(0.047)	(0.067)	(0.092)	(0.049)				
Africa mean of outcome	-1.351	-1.351	-1.351	-0.877	-1.351	-1.351	-1.351	-0.877
Age & other controls	No	Yes	No	Yes	No	Yes	No	Yes
Mother FEs	No	No	Yes	No	No	No	Yes	No
Observations	168,135	165,623	83,243	165,623	168,135	167,765	83,243	167,765

Notes: Please consider the notes in Table 3 and 4 and JP Table 5 for further explanations.

Source: Adapted from JP using data DHS (Heger Boyle & Sobek, 2019)

Appendix B: Additional Results

Appendix B.1 Data Description

Table B.1.1: State Sample Share of DHS in India 2005/6 and 2015/6

Indian State	Share of observations 2005/6 in percent	Share of observations 2015/6 in percent	Population share in 2001 census	Population share in 2011 census	Change of share from 2005/6 to 2015/6 of more than one percent and sex ratio
Andaman and Nicobar Islands		0.26	0.03	0.03	
Andhra Pradesh	4.31	1.13	7.41	6.99	lower with low sex ratio
Arunachal Pradesh	1.72	1.76	0.11	0.11	unchanged
Assam	2.95	3.92	2.59	2.58	unchanged
Bihar	4.8	9.83	8.07	8.6	higher with low sex ratio
Chandigarh		0.07	0.09	0.09	
Chhattisgarh	3.33	3.63	2.03	2.11	unchanged
Dadra and Nagar Haveli		0.13	0.02	0.03	
Daman and Diu		0.15	0.02	0.02	
Delhi	1.77	0.52	1.35	1.39	lower with high sex ratio
Goa	1.85	0.17	0.13	0.12	lower with low sex ratio
Gujarat	3.25	2.92	4.93	4.99	unchanged
Haryana	2.62	3.08	2.06	2.09	unchanged
Himachal Pradesh	2.06	1.11	0.59	0.57	unchanged
Jammu and Kashmir	2.38	3.13	0.99	1.04	unchanged
Jharkhand	3.23	4.73	2.62	2.72	higher with low sex ratio
Karnataka	3.55	2.9	5.14	5.05	unchanged
Kerala	2.16	1	3.1	2.76	lower with low sex ratio
Lakshadweep		0.12	0.01	0.01	
Madhya Pradesh	6.29	9.46	5.87	6	higher with high sex ratio
Maharashtra	5.41	3.61	9.42	9.28	lower with high sex ratio
Manipur	3.89	2.29	0.22	0.24	lower with low sex ratio
Meghalaya	1.88	1.73	0.23	0.25	unchanged
Mizoram	1.78	1.89	0.09	0.09	unchanged
Nagaland	4.13	1.69	0.19	0.16	lower with low sex ratio
Odisha	3.66	4.31	3.58	3.47	unchanged
Puducherry		0.43	0.09	0.1	

Punjab	2.69	2.1	2.37	2.29	unchanged
Rajasthan	4.17	6.65	5.49	5.66	higher with high sex ratio
Sikkim	1.21	0.39	0.05	0.05	unchanged
Tamil Nadu	3.58	3.08	6.07	5.96	unchanged
Tripura	1.32	0.53	0.31	0.3	unchanged
Uttar Pradesh	12.67	16.01	16.16	16.5	higher with high sex ratio
Uttarakhand	2.49	2.27	0.83	0.83	unchanged
West Bengal	4.85	2.11	7.79	7.54	lower with low sex ratio
Telangana		0.89			

Source: Own calculations using data from DHS (Heger Boyle & Sobek, 2019) and the Handbook of Statistics on Indian States (Reserve Bank of India, 2019)

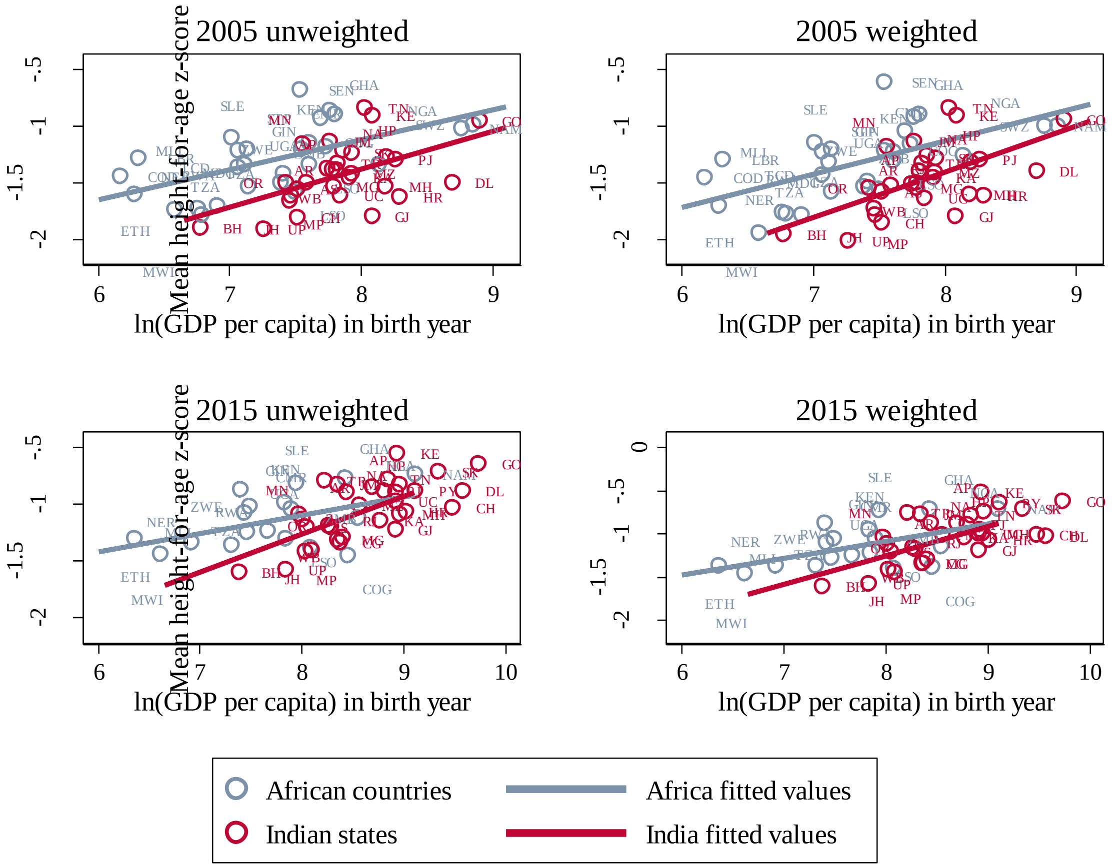
Table B.1.2: Sample Comparison

	2004-2010	2011-2017
Cameroon	2004	2011
Congo Democratic Republic	2007	2013/14
Republic of the Congo (Brazzaville)	2005	
Chad	2004	
Ethiopia	2005	2011 & 2016
Ghana	2008	2014
Guinea	2005	2012
Kenya	2008/09	2014
Lesotho	2004 & 2009	2014
Liberia	2007	
Madagascar	2003	
Malawi	2004	2016
Mali	2006	2012
Namibia	2006	2013
Niger	2006	2012
Nigeria	2008	2013
Rwanda	2005	2014
Sao Tome and Principe	2008/09	
Senegal	2005	2010/11 & 2012/13 & 2015 & 2016 & 2017
Sierra Leone	2008	
Swaziland	2006-7	
Tanzania	2004 & 2010	2015
Uganda	2006	2011 & 2016
Zambia	2007	2013
Zimbabwe	2005/06	2015
Total	27	24

Source: Own calculations based on JP

Appendix B.2 Correlation between GDP and HFA z-score

Figure B.2.1: Child Height versus National GDP in India and Africa Sample



Source: Adapted from JP using data from DHS (ICF, 2004) and IPUMS DHS (Heger Boyle & Sobek, 2019)

Appendix B.3 Robustness Check

Table B.3.1: Test for Equality of Coefficients Using Combined Models and Interactions for Table 2 I vs V and II vs VI

Specification	JP			Alternative		
Model	I	V	I vs V	II	VI	II vs VI
India×2nd child	-0.16***	-0.07***	-0.16***	-0.16***	-0.07***	-0.16***
	[0.03]	[0.02]	[0.03]	[0.04]	[0.02]	[0.04]
India×3rd+ child	-0.23***	-0.11***	-0.23***	-0.18***	-0.12***	-0.18***
	[0.03]	[0.02]	[0.03]	[0.04]	[0.03]	[0.04]
2nd child	-0.01	-0.05***	-0.01	0.01	-0.07***	0.01
	[0.02]	[0.01]	[0.02]	[0.02]	[0.02]	[0.02]
3rd+ child	-0.12***	-0.16***	-0.12***	-0.14***	-0.16***	-0.14***
	[0.02]	[0.01]	[0.02]	[0.03]	[0.02]	[0.03]
2015×India×2nd child			0.09***			0.09**
			[0.03]			[0.04]
2015×India×3rd+ child			0.12***			0.06
			[0.04]			[0.05]
2015×2nd child			-0.04*			-0.07**
			[0.02]			[0.03]
2015×3rd+ child			-0.04			-0.02
			[0.02]			[0.04]
Africa mean of outcome	-1.35	-1.11	-1.21	-1.32	-1.14	-1.24
Survey design adjusted	No	No	No	Yes	Yes	Yes
Sibling Size	No	No	No	No	No	No
Observations	167,765	397,702	565,467	167,765	397,702	565,467

Notes: See Table 2 for construction of standard errors, statistical significance, definition of birth order, and list of controls. In column (3) and (6) sample of period around 2005 and 2015 are estimated in one regression. All dependent variables are interacted with a dummy indicating the period around 2015.

Table B.3.2: Test for Equality of Coefficients Using Combined Models and Interactions for Table 3 I vs V and II vs VI

Specification	JP			Alternative		
Model	I	V	I vs V	II	VI	II vs VI
India×2nd child	-0.15***	-0.04*	-0.15***	-0.16***	0.02	-0.16***
	[0.04]	[0.02]	[0.04]	[0.05]	[0.04]	[0.05]
India×3rd+ child	-0.22***	-0.07**	-0.22***	-0.16***	0.02	-0.16***
	[0.05]	[0.03]	[0.05]	[0.05]	[0.04]	[0.05]
India # 2nd child # Girl	-0.04	-0.06*	-0.04	-0.01	-0.14***	-0.01
	[0.06]	[0.03]	[0.06]	[0.08]	[0.05]	[0.08]
India #3rd+child # Girl	-0.05	-0.09**	-0.05	0.07	-0.19***	0.07
	[0.07]	[0.04]	[0.07]	[0.09]	[0.06]	[0.09]
2015×India×2nd child			0.11**			0.17***
			[0.05]			[0.06]
2015×India×3rd+ child			0.16***			0.20***
			[0.05]			[0.08]
2015× India # 2nd child # Girl			-0.01			-0.13
			[0.07]			[0.09]
2015× India #3rd+child # Girl			-0.05			-0.25**
			[0.08]			[0.11]
Africa mean of outcome	-1.35	-1.11	-1.21	-1.32	-1.14	-1.24
Survey design adjusted	No	No	No	Yes	Yes	Yes
Sibling Size	No	No	No	No	No	No
Observations	165,623	390,071	555,694	165,623	390,071	555,694

Notes: See Table 3 for construction of standard errors, statistical significance, definition of birth order, and list of controls. In column (3) and (6) sample of period around 2005 and 2015 are estimated in one regression. All dependent variables are interacted with a dummy indicating the period around 2015.

Table B.3.3: Test for Equality of Coefficients Using Combined Models and Interactions for Table 4 I vs V and II vs VI

Specification	JP			Alternative		
Model	I	V	I vs V	II	VI	II vs VI
India× Girl	-0.15***	-0.07***	-0.15***	-0.17***	-0.09***	-0.17***
	[0.02]	[0.01]	[0.02]	[0.02]	[0.02]	[0.02]
Girl	0.17***	0.15***	0.17***	0.17***	0.16***	0.17***
	[0.01]	[0.01]	[0.01]	[0.01]	[0.01]	[0.01]
2015×India× Girl			0.08***			0.09***
			[0.02]			[0.03]
2015×Girl			-0.02			-0.01
			[0.01]			[0.02]
Africa mean of outcome	-1.35	-1.11	-1.21	-1.32	-1.14	-1.24
Survey design adjusted	No	No	No	Yes	Yes	Yes
Sibling Size	No	No	No	No	No	No
Observations	167,765	397,702	565,467	167,765	397,702	565,467

Notes: See Table 4 for construction of standard errors, statistical significance, definition of birth order, and list of controls. In column (3) and (6) sample of period around 2005 and 2015 are estimated in one regression. All dependent variables are interacted with a dummy indicating the period around 2015.

Table B.3.4: Reassessment of models with mother's height restricted to mothers who have given their first birth with at least age 19

Table and Column in JP	Table 2 Column 3		Table 5 Column 2		Table 5 Column 6	
Model	XI	XII	XI	XII	X	XII
India # 2nd child	-0.06***	-0.02	-0.02	0.01		
	(0.02)	(0.04)	(0.03)	(0.06)		
India # 3rd+ child	-0.08***	-0.00	-0.03	0.08		
	(0.02)	(0.06)	(0.03)	(0.08)		
2nd child	-0.06***	-0.16***	-0.07***	-0.17***		
	(0.02)	(0.03)	(0.03)	(0.05)		
3rd+ child	-0.17***	-0.26***	-0.16***	-0.26***		
	(0.02)	(0.05)	(0.03)	(0.07)		
India # 2nd child # Girl			-0.06	-0.02		
			(0.04)	(0.08)		
India # 3rd+ child # Girl			-0.08*	-0.12		
			(0.05)	(0.11)		
India # Girl					-0.07***	0.05
					(0.01)	(0.05)
Girl					0.16***	0.11**
					(0.01)	(0.04)
Mother's height in centimeter	0.04***	0.04***	0.04***	0.04***	0.04***	0.04***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
India # Mother's height in centimeter	0.01***	0.00**	0.00***	0.00**	0.01***	0.00***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Africa mean of outcome	-1.08	-1.13	-1.08	-1.13	-1.08	-1.13
Survey design adjusted	No	Yes	No	Yes	No	Yes
Sibling size	No	Yes	No	Yes	No	Yes
Observations	323,124	323,124	314,335	314,335	323,124	323,124

Notes: See notes for Table 6 and 7 for additional details.