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A child feeding a child: Early mother's marriage and child growth in India

Amal Ahmad* Sebastian Vollmer†

Abstract: *Hundreds of millions of Indian children are too short for their age. In this paper we explore whether early marriage of women in India contributes to this phenomenon. Using India's national health surveys and age at menarche as an instrument, we find that one year earlier mother's marriage reduces her child's height-for-age by 0.20 standard deviations. On mechanisms, earlier-married mothers delay infant complementary feeding and breastfeed for less time; these practices appear to be influenced by knowledge gaps and preference issues. Given slow evolution in marital age practices, supporting the nutrition efforts of early-married mothers can markedly improve intergenerational well-being.*

Keywords: Early marriage, child growth, health behavior, rural development
JEL Codes: I12, J12, O15

1 Introduction

India, home to 440 million children, suffers from one of the lowest child height-for-age distributions in the world. Among children under five, median height-for-age is 1.5 standard deviations below the World Health Organization's Child Growth Standards median; the stunting rate, defined as height-for-age at least 2.0 standard deviations below the standards median, stands at 35.5%, and is particularly high in rural India (**Figure 1**). Being short is not a *genetic* attribute of the Indian population: Indian children of immigrant parents in advanced economies grow to the height of their peers even if their parents are shorter (Alacevich and Tarozzi, 2017). Rather, low height-for-age often signals malnutrition and impaired physical growth early in childhood; for this reason, stunted children may also face delayed cognitive development later on in life (Alam et al, 2020).

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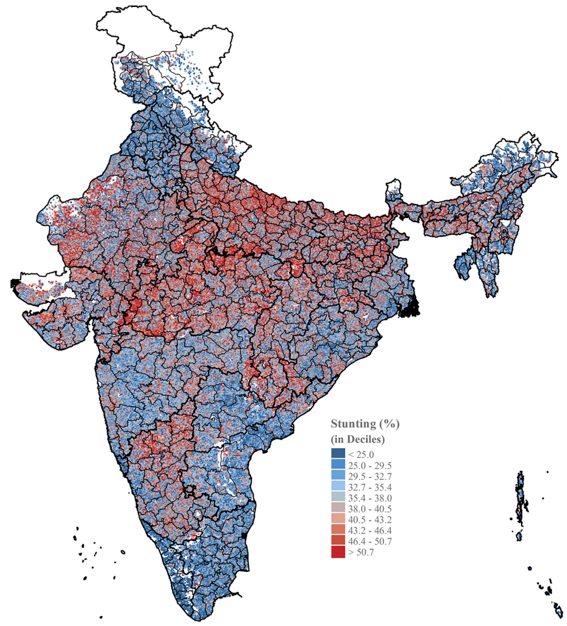


Figure 1: Stunting rates for children under five in rural India

Source: Reproduced from Kim et al (2021).

Child height-for-age in India has improved only slowly over time despite large-scale government feeding programs, and a plethora of research has explored the deeper socioeconomic factors behind malnutrition and stunted growth. Descriptive evidence includes associations between low height-for-age and facets of socioeconomic disadvantage such as extreme poverty, rural residence, and parental illiteracy (Khan and Mohanty, 2018; Chaudhuri et al 2023). Studies taking a more causal approach have focused on the height gap of Indian children relative to sub-Saharan African children, looking to understand why Indian children tend to be even shorter for their age than their African counterparts despite better national development indicators. This latter literature has identified widespread firstborn son preference as well as nutrient loss from exposure to open defecation as factors exacerbating stunting in India relative to other developing countries (Jayachandran and Pande, 2017; Spears, 2020).

In this paper, we explore the contribution to low height-for-age of a phenomenon widespread in, albeit not unique to, India: early marital age of the mother. India is home to 223 million out of 650 million women worldwide alive who were married as minors (UNICEF, 2021), and the country's median age of marriage for women, currently at 19, remains low by global standards. Mothers play a key role in early child nutrition, so that, as noted by an Indian journalist, India may have a problem of "a child mothering a child" (Bhattacharya, 2019). Supporting this intuition, the health literature has documented negative correlations between early marriage of mothers and child health in various settings (Fall et al, 2015), and between early pregnancy and childhood undernutrition (Nguyen et al, 2019). At the same time, age of marriage is correlated with various family of origin characteristics (Paul, 2019; Ahonsi et al, 2019), necessitating a cautious interpretation of these correlations.

To further motivate our investigation, we note two empirical regularities which arise in all of India's National Family Health Surveys (NFHS), containing half a million mother-child observations from 1993 to 2021. First, most mothers married young, with a median marital age of 18 over the period. Therefore, half of them married as minors.[1] Second, there is a persistent correlation between mother's marital age and her child's height-for-age, with children having lower height-for-age on average when born to earlier married mothers. Only for the minority of mothers married after their mid-twenties does this correlation disappear.

To investigate whether early marriage of mothers India has reduced offspring height-for-age or whether the correlations reflect confounders, we use the woman's age at her first menstrual period - also known as *menarche* - as an instrument for her age at marriage. The intuition for the instrument, first proposed by Field and Ambrus (2008), is that in societies with early marriage norms, the timing of marriage can be influenced by the onset of puberty, while the latter is largely biologically determined and independent of potential confounders. We discuss this assumption in detail in the Indian context.

Our data comes from three of the five waves of the National Family Health Survey (NFHS-1 in 1993, NFHS-4 in 2016, and NFHS-5 in 2021), which are the waves containing data on age at menarche.[2] Our main sample focuses on women married by 18, i.e. minor or barely legal marriage, which is one-half of all married women in India over the period. In addition to having sociopolitical significance, this allows for potentially strong relevance of menarche. We also focus on mothers who were at most 24 years old by survey time, to limit the potentially serious problem whereby older women may use marriage age to recall age at menarche, creating false correlation between the instrument and endogenous variable.

With over 92,000 mother-child observations in the subsequent sample, we show that earlier menarche clearly precipitated marriage age among this group of women. Regarding validity, we highlight evidence that the strongest contribution to age at menarche is genetic. For the remaining environmental factors, while too-late menarche may be driven by severe undernutrition in childhood, we show that, after excluding outlier menarche ages from the sample as we do, there is little correlation between age at menarche and mother's height as proxy for her earlier nutrition. We note that, even if a connection were present between

[1]For comparison, note for instance that this median age held in China in 1950, whereas today average women's marital age in China stands at about 26.

[2]The second and third rounds (1999 and 2006) did not ask about age at menarche.

undernutrition and later menarche, it would attenuate the estimated impact of marital age on child height-for-age, and our estimates would be too conservative, not too large.[3]

Using this IV approach, we first document *large* adverse effects of early mother's marriage on child height-for-age, with (instrumented) one year earlier marriage reducing offspring height-for-age by 0.20 standard deviations. To put this magnitude into perspective, the average child height-for-age in India over the period was -1.57 standard deviations, so that the coefficient represents a 13% drop from the mean with each earlier year of mother's marriage. We show that this relationship is not driven by a specific survey but rather holds across time. Our specification controls for, among other things, mother birth year and the child's birth order, so that we compare same birth-order children of same-age mothers who married at younger versus later ages due partly to earlier versus later menarche. We also show that this result is robust to specification and to sample choice.

We then turn to an in-depth examination of underlying mechanisms. First, we explore whether the results are mediated by the effect of marital age on conception age and/or mother educational attainment, as both may be impacted by marriage and may have intergenerational consequences. We find that (instrumented) earlier marriage precipitates time at conception *and* reduces educational attainment. However, only the former appears to act as a link to lower offspring height-for-age. In other words, the key to the intergenerational impact on child growth appears to be that the early married mother also becomes a young mother, and less so that she is being pulled out of school earlier as a result of early marriage.

This begets the question of what it is that early married, and as a result younger, mothers *do* which may adversely impact child growth. We document no perceptible impact of early marriage on prenatal behavior of the mother, birth weight of the child, or probability of premature birth, suggesting that the key mechanisms are likely postnatal. Guided by the medical literature on infant growth, we investigate whether (instrumented) age at marriage impacts breastfeeding of the infant for the first four to six months, as this provides the optimal mix of nutrients for this period (Lessen and Kavanangh, 2015), and whether it impacts the timing of complementary solids feeding, as liquids alone are no longer sufficient for infant growth after six months (Fewtrell et al, 2017; WHO, 2023). We also study how early marriage affects child intake in the past day of protein-rich foods such as dairy and legumes, and occurrence of child diarrhea, which can cause nutrient loss.

We find that early marriage of the mother contributes to delays in critical complementary feeding of infants and to suboptimal breastfeeding practices. One year earlier marriage

[3]Mother's own-undernutrition is likely associated with family of origin characteristics, e.g. poorer or more illiterate family of origin, that hurt offspring health and growth. Subsequently, if later menarche is largely driven by mother's own-undernutrition, the estimator of the impact of later marriage - instrumented by later menarche - on child height-for-age would be biased downward relative to the true population parameter.

reduces the probability that a child was introduced to complementary feeding during the critical age of 6-8 months by 10.9 percentage points, equivalent to a 33.5% decrease over the mean. It also delays the time at which complementary feeding begins in general by 0.36 months. We also find a small but statistically significant impact on breastfeeding, with one year earlier marriage reducing the probability of a child being breastfed for a full 4 or 6 months by 1.6 percentage points, equivalent to 1.8% over the mean.[4]

Given the evidence on suboptimal feeding practices, do early-married mothers simply not *know* how to best feed their children, or is something else also at play?

We provide further evidence and an accompanying theoretical model of mother behavior which suggest mothers' knowledge *and* preferences mediate the impact on their children's height-for-age. Differentiating the main results by child birth order and gender, we find that the impact of marital age on child height-for-age is more severe for girl children than for boy children, and that it is more severe for firstborns than for laterborns but only when it comes to boys. By contrast, early mother's marriage continues to reduce girl children's height-for-age strongly regardless of the girl's birth order. An accompanying theoretical model shows these findings are consistent with a situation in which (i) mother's early marriage adversely affects child nutrition and growth, (ii) mother effort can mitigate this impact, (iii) effort is higher when the child is a boy, reflecting son preference, and (iv) later children can benefit from the mother's childbearing experience but also suffer from resource constraints, with the latter more likely to dominate when effort is low.

In sum, it appears that while early mother's marriage contributes to poor infant nutrition and subsequently depressed height-for-age, circumstances relating to the experience and/or burden from raising other children, combined with priorities or preferences in the household vis-a-vis children, act to buttress or amplify the impacts on the child. Our results therefore also complement findings on firstborn son preference and child stunting in India (Jayachandran and Pande, 2017), by showing one way in which son preference exacerbates the impact of adversities - here, early parenthood of the main caretaker - on child growth.

Our paper speaks directly to the question of and mechanisms behind low height-for-age in India, establishing a link between mother's early marriage, child nutrition, and child growth in the world's most populous country. In addition, on early marriage, we contribute to the literature using an IV approach to study the consequences of this practice. Much of this literature focuses on the impact of early marriage on outcomes for the mother (e.g. Roychowdhury and Dhajima, 2021; Carpena and Jensenius, 2021). Closer to our paper is Chari et al (2017), which quantifies the impact of early marriage in India on a different set

[4]In contrast, we find little consistent impact on the child's prior-night consumption of other protein rich foods or on the prevalence on diarrhea, and also no impact on non-nutrition health variables such as whether the infant has a health card or has received vaccinations.

of child health indicators and using the smaller India Human Development Survey of 2005.[5] Of methodological note is Asadullah and Wahhaj (2019), which has data on Bangladeshi sister-pairs that can be used for a menarche IV with household-of-origin fixed effects; there are minor or no differences in outcomes when these fixed effects are used, suggesting that family of origin concerns are not plaguing the analysis.[6]

The policy implications of our findings are nontrivial. Although the Indian government recently raised the legal age at marriage for women (The Hindu, 2023), it is doubtful that *practiced* age at marriage, which has flouted legal thresholds for decades, will rise quickly. Our results suggest that, in the presence of sticky marital age norms and weak enforcement, improving the nutritional practices of early-married mothers toward offspring is key, as is understanding why prior policy has not been successful at doing this. Beyond India, and because early marriage is widespread elsewhere - including other South Asian nations and sub-Saharan Africa - our paper points to the possibility of an understudied connection between early marriage, feeding practices, and high rates of stunted growth elsewhere in the global South, which may be a fruitful avenue for future research.

2 Data and Methods

2.1 Data and sample construction

The National Family Health Survey is a multi-round survey conducted by the Ministry of Health and Family Welfare of India, coming out in five waves beginning in 1992-1993 (NFHS-1) and continuing to 1998-1999 (NFHS-2), 2005-2006 (NFHS-3), 2015-2016 (NFHS-4), and 2019-2021 (NFHS-5).[7] A repeated cross-sectional panel, it provides the largest-scale representative source of information on population and family health in India. The majority of waves survey ever-married between the ages of 15 and 49 and ask about motherhood attributes as well as health information on children up to five years old. Between the five waves there are nearly half a million mother-child observations in total, making the NFHS the largest worldwide within the umbrella Demographic and Health Survey program.

Using the entirety of this data, **Figure A1** in **Appendix A** plots, for each National Family Health Survey, the distribution of age at marriage for women and of height-for-age of their children. It documents the aforementioned stylized facts: that the majority of women

[5] The authors look at the effect on antenatal care, home birth, vaccination completion, and breastfeeding duration. The IHDS sampled married women between 15 and 49 in 40,000 households.

[6] In particular, including sister fixed effects changes the impact of age of marriage on the woman's education slightly, but it does not alter the effect of age of marriage on the woman's age at first birth. The latter variable is particularly important in any study of intergenerational effects of age of marriage.

[7] For brevity we use the end date of the surveys when referring to them throughout the paper.

married young, the majority of children's height-for-age falls below 0 standard deviations and many hover in the stunted range, and a positive correlation exists between marital age and offspring height and only dissipates for women married in mid-twenties and after.

We construct our analytical sample using the waves that elicited information on mother's menarche (NFHS-1, NFHS-4, and NFHS-5). Within these, we restrict along three age-related dimensions: (i) mother's age at marriage, (ii) age at interview time, and (iii) age at menarche. Specifically, we select mothers who were aged at most 18 at marriage, who were at most 24 years old by survey time, and who who did not have menarche too late, calculated as an upper limit of third quartile menarche age plus one year.[8] The first condition improves the relevance of age at menarche for age at marriage. The second aims to stem issues arising from possible recall bias, whereby older women may forget age at menarche and erroneously recollect it using remembered age at marriage.[9] The last aims to exclude outlier menarche ages possibly influenced by nutritional issues in childhood (see below).[10] In the robustness checks, we confirm that the main results do not hinge on these sample restrictions.

The resulting sample contains over 92,000 unique mother-child observations with information on mother age at marriage and at menarche, child health and nutrition, and family characteristics relating to religion, rural/urban status, and wealth quintile, among others.

Table A1 in the Appendix presents an overview of our key variables, including the number of observations and the mean in the sample. It shows that, despite covering the same range of topics, the different waves are not homogeneous in all the variables elicited. For our purpose, a key difference is in questions asked about the nutrition of the child. The NFHS-1 inquired about duration of breastfeeding as well as the time at which complementary feeding was introduced, for every child under five, but contains little on feeding of the child in the prior day and night. In contrast, the NFHS-4 and NFHS-5 did not collect information on time at which complementary feeding was introduced, for any children. They collected information on breastfeeding duration for the last child born in the past five years, as well as on feeding of an array of nutrients for the last child in the prior day and night.

2.2 Empirical strategy

Early marriage of women in India (and elsewhere) is usually facilitated by the family, and the descriptive empirical evidence is robust that earlier-married mothers tend to come from less educated as well as more rural families (UNICEF, 2023). Ethnographic research

[8] This is subsequently age 16 for NFHS-1, and age 15 for NFHS-4 and NFHS-5. We also remove the very small minority of girls who had their menarche before age 10, as they are outliers.

[9] In email correspondence with NFHS officials, the potential severity of recall problems was cited as the reason that information was collected *only* on mothers who were up to 24 by interview time in the NFHS-4.

[10] We also remove the minority of twins in order to be able to differentiate meaningfully by birth order.

suggests that a mix of social norms and incentives particularly among rural Indian families drive early marriage of daughters (Abbhi et al, 2013). These include the belief that the daughter cannot attract a good husband if she is older, an ability to lower the dowry paid (an illegal but still widespread practice) if she is younger, the desire to have one less mouth to feed, the desire to protect communal reputation around daughter chastity, and social judgment from neighbors the longer a daughter remains single.

To the extent that differences in family of origin and in mother characteristics cannot be controlled for fully with observables, and since these likely influence not only marital age but also offspring health, a quasi-experimental approach is necessary to capture the effect of marital age on child health. We utilize the following two-stage least squares:

$$H_{ij} = \beta_0 + \beta_1 \widehat{M_i} + \mathbf{X}'\mathbf{\Psi} + \varepsilon_{ij} \tag{1}$$

and

$$\widehat{M_i} = \alpha_0 + \alpha_1 Z_i + \mathbf{X}'\mathbf{\Phi} + \nu_{ij} \tag{2}$$

where H_{ij} is the height-for-age of child j of mother i, M_i is the mother's age at marriage, Z_i is the mother's age at menarche, $\widehat{M_i}$ are the fitted values for age at marriage derived from the first stage regression, and $\mathbf{X}$ is a controls vector.[11] Mother-specific controls include her age and her birth year (so that similarly aged mothers are compared within the same survey wave), while child-specific controls include the child's birth order and gender. Other controls are household-specific and include urban/rural status, religion, wealth, and state.

The specification therefore compares the outcomes of children of a similar birth order and gender, born to similarly aged mothers of the same generation, but one of whom married earlier than the other in part because of earlier onset of puberty. The use of an age-adjusted outcome for the child allows us to avoid controlling for child age, so that marital timing variation can drive conception timing variation.

To the extent that the instrument is relevant and valid, β_1 is a consistent estimator of the impact of marital age on child height-for-age. The next subsection explores instrument relevance and validity more closely.

2.3 Age at menarche as an instrument

While social acceptability, weak enforcement, and legal loopholes in India have allowed marital practices to remain somewhat detached from *de jure* minimum-age requirements, an alternative *de facto* lower bound on marital age has historically been age at puberty, which

[11] In the study of mechanisms, we replace H_{ij} with the appropriate variable (such as probability of being introduced to complementary feeding), with similar requirements for instrument validity.

is usually between 11 and 15 for most girls. As the onset of fertility, puberty is viewed in various religious and cultural contexts as the age above which consummation of marriage may be sanctified (Haar and Duncan, 2023).

Figure 2 uses the sample data to plot age at menarche on the x-axis, and average age at marriage for the women who had menarche at that age, on the y-axis. It illustrates that while the average parent in India did not marry their daughter *as soon as* she reached puberty, puberty still influenced the timing of marriage, with daughters who reached it earlier on average also marrying earlier.

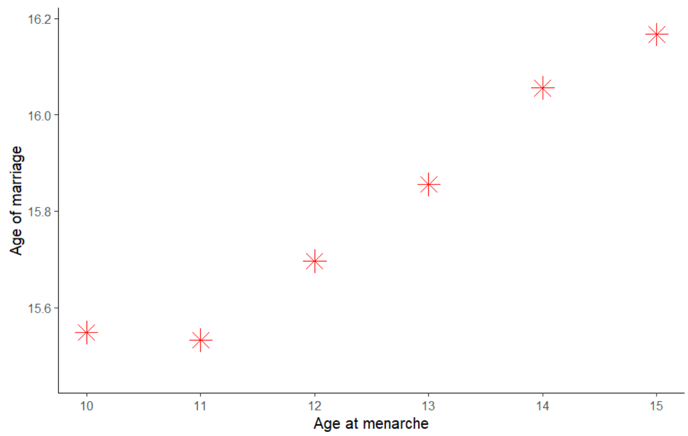


Figure 2: Menarche and mean age at marriage

Figure 2 plots age at menarche on the x-axis and the average at marriage for women who had their first bleeding at that age on the y-axis.

As another illustration, **Figure 3** plots the distribution of age at marriage in our sample for each age at menarche. This distribution shifts to the right - i.e. marriage is somewhat later - for each later age at menarche.

These correlations are a precursor to the strong first stage results in the analysis in Section 3, and hold in the overall sample as well as in each of the surveys separately.

Regarding validity of the instrument, the age at which a girl's first bleeding occurs is understood to be a complex trait with a strong genetic component. Twin and familial studies indicate that up to 80% of variation in menarche timing is driven by hereditary genes involved in steroid - especially estrogen - metabolism (Dvornyk and Waqar-ul-Haq, 2012), and genome mapping projects show that timing of puberty is a "highly polygenic childhood trait" (Day et al, 2017) influenced by dozens of genes. This estrogen-metabolizing genetic component contributes only very marginally to the woman's adult height, making it

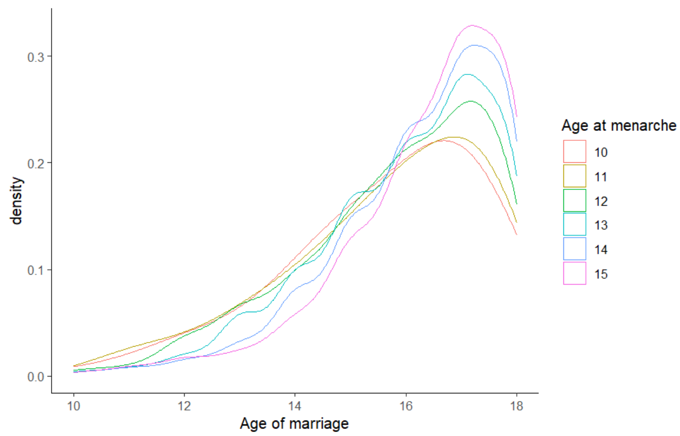


Figure 3: Menarche and distribution of age at marriage

Figure 3 plots the distribution of marital age for each age at menarche in the sample.

unlikely to influence height-for-age of young children via inherited height-relevant genes.[12]

Given a strong genetic component to age at menarche which is orthogonal to offspring outcomes, it remains to address the residual environmental factors that influence mother's age at menarche and that can be intergenerationally significant. Most importantly, menarche is linked to body fat increases which signal hormonally that the girl's body is ready for reproduction (Deardoff et al, 2014), making adequate nutrition in childhood relevant to age at menarche. For this reason, girls who have severe malnutrition during childhood may have their menarche delayed above and beyond what can be accounted for by genetic components (Soliman et al, 2014).

Validity would thus be violated if the woman's age at menarche is driven significantly by her childhood nutrition, and we argue this would bias our results toward a null coefficient in the Indian context. In India, higher fat intake in childhood is associated with higher socioeconomic status (Mathew et al 2023); earlier menarche, and earlier marriage, would be associated with unobservables that *improve* offspring health outcomes. Hence, if the instrument suffers from such validity issues, β_1 in Equation (1) would be pressured downward even if the true population parameter is $\beta_1 > 0$, and we would interpret our results as *underestimating*, not overestimating, the impact of marital age on offspring height-for-age.

[12]There are few studies on the impact of this genetic component of age at menarche on the woman's adult height. The one comprehensive study (Onland-Moret et al, 2005) finds that although one year later age at menarche may cause the woman to grow taller by allowing for more leg bone growth, it would do so by only 0.35 cm per later year of menarche, and therefore with menarche age variation accounting for at most 1% of the height variation between adult women. Other later studies touching on this find no clear patterns of increased or decreased adult woman height with these estrogen metabolizing genes (Geczik et al, 2022).

To examine this possibility more closely, we examine the relationship between age at menarche and the woman's adult height as a proxy for her childhood nutrition. **Figure 4** illustrates that the distribution of women's height by distinct ages at menarche is largely similar, and we certainly do not see the leftward shift (women being shorter for later menarche ages) that we would expect if later menarche was associated with malnutrition in childhood.[13] Despite the absence of a clear correlation between our instrument and the woman's height, we also include the latter as a control in the robustness checks.[14]

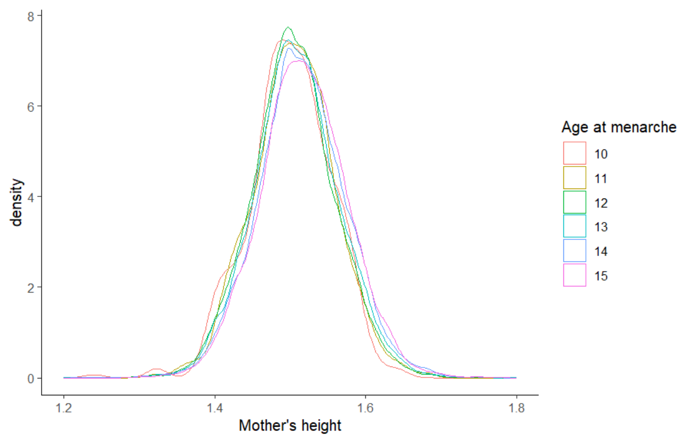


Figure 4: Distribution of mother height for each age at menarche

Figure 4 plots the distribution of the mother's height, for each age at menarche in the sample.

Before presenting the main results, we note a distinct selection issue, related not to the validity of the instrument but to the interpretation of the results, of possible selection in the *offspring*. This would occur if early marriage induces significantly higher child mortality, in which case the remaining pool of children would be the healthier survivors and possibly also with higher height-for-age. This too would cause us to underestimate, not overestimate, the impact of marital age on offspring height-for-age. We explore and rule out this possibility, of selection in offspring via differential survival rates, in Section 4.

[13]The very small shifts to the right may be a consequence of the marginal genetic contribution of later menarche to woman bone leg growth (see prior footnote) in which case it would not be correlated with the socioeconomic confounders of concern.

[14]We do not use the woman's height as a control in the main results (pooled sample) because the NFHS-1 does not have data on the woman's height.

3 Main results

Table 1 displays the results of the two stage least-squares analysis in Equations (1)-(2), for the pooled sample as well as for the individual surveys separately. In this and subsequent tables, robust standard errors - clustered by mother year-of-birth and state - are shown below the estimated coefficients.

Table 1: Impact of marriage age on child height-for-age.

	All (Pooled)	NFHS-1	NFHS-4	NFHS-5
	(1)	(2)	(3)	(4)
	PANEL A. Second stage. Outcome: child height-for-age			
Age at marriage	**0.196*****	0.196**	0.248**	0.289*
	(0.062)	(0.069)	(0.095)	(0.147)
	PANEL B. First stage. Outcome: Age at marriage			
Age at menarche	0.134***	0.330***	0.111***	0.083***
	(0.020)	(0.037)	(0.023)	(0.011)
First stage F-stat	367.8	416.3	94.4	70.9
Observations	74,551	7,833	36,425	30,293
Mother, child, and HH controls	Yes	Yes	Yes	Yes

Note: *p<0.1; **p<0.05; ***p<0.01

Table 1 reports the results of 2SLS regression in Eq. (1)-(2), first for the pooled sample then by survey wave. Panel A demonstrates the results of the second stage whereas Panel B demonstrates the results of the first stage.

Panel A presents the estimated impact of instrumented age at marriage on offspring height-for-age, i.e. the second stage results (β_1 in Equation (1)). For the pooled sample (Column 1), one year later marriage increased offspring height-for-age by about 0.20 standard deviations over the period from 1993 to 2021. This is around 13% of the magnitude of mean height-for-age over the period, which was -1.57 standard deviations. Importantly, these results are not driven by a single survey but rather obtain across time, as shown in the survey-specific Columns (2)-(4). For the pooled sample, at the 95% confidence interval, we cannot exclude effects as large as 0.32 standard deviations.

Panel B presents the estimated impact of age at menarche on age at marriage, i.e.

the first stage relationship (α_1 in Equation (2)). We find that one year later menarche postponed marriage by about 0.13 years over the period (Column 1). Examining the trend over time in Columns (2)-(4), age at menarche has played a smaller role in marital decisions in the past decade relative to the 1990s. However, the instrument remains relevant, with a significant positive coefficient and a high F-statistic even in the fifth survey.

4 Mechanisms

We first explore how marital age may affect the mother's age at conception and her educational attainment, and ask whether outcomes for children are mediated by changes to these mother-level variables. The remaining discussion then turns to possible direct mechanisms, examining the impact of early mother's marriage on child nutrition and on other (prenatal and non-nutrition postnatal) child-level variables.

4.1 Mother's conception age and education

In India, marriage almost universally precedes conception, and birth occurs after marriage in over 99% of cases (Social Trends Institute, 2011). Early marriage can therefore precipitate the time at which a woman becomes a mother for the first time (and, generally, not vice versa). In addition, especially for girls who marry by the age of 18, early marriage can accelerate the likelihood of the girl being pulled out of school.

There is evidence in our sample of early marriage precipitating time of first conception *and* decreasing schooling attainment. As demonstrated in **Table 2**, one year earlier marriage - instrumented by early menarche - precipitates the age at which a woman conceives her first child by 0.67 years. Looking beyond first conception and comparing similar birth-order children, one year earlier marriage precipitates conception time by a similar magnitude. With regard to education, one year earlier marriage reduces the woman's schooling attainment by 0.91 years. It also results in marrying less educated husbands, likely through spousal matching on education characteristics.

To check whether motherhood age and/or formal schooling are mediating the effects on offspring height-for-age, we re-run the main specification in Equations (1)-(2) with additional controls, separately, for conception age and for education. In columns (2) and (3) in **Table 3**, we control for age at first conception and for age at conception of the specific child, respectively. In column (4) we control for the woman's education years, while in column (5) we restrict the analysis to women who never completed primary schooling. Because the majority of the latter women were already out of school *before* being married, there is unlikely to be an educational channel for this subsample; the impact on child height-for-age would be much weaker *if* educational channels were largely responsible.

Table 2: Impact on age at conception and on education

	Outcome: conception		*Outcome: education years*	
	Age at first conc.	Age at conc.	Mother	Father
	(1)	(2)	(3)	(4)
Age at marriage	0.674***	0.545***	0.905***	0.725***
	(0.091)	(0.067)	(0.175)	(0.135)
Observations	67,049	91,892	64,848	19,414
Mother and HH controls	Yes	Yes	Yes	Yes
Child birth-order control	No	Yes	No	No

Note: *p<0.1; **p<0.05; ***p<0.01

Table 2 reports the second stage results of a 2SLS regression on instrumented age at marriage of: age at first conception (Column 1), age at conception of the specific child (Column 2), mother's own educational attainment (Column 2) and her husband's educational attainment (Column 4).

Table 3: Conception age and education as mediating channels.

	Outcome: child height-for-age				
	No controls	Conception controls		Education controls	
	(1)	(2)	(3)	(4)	(5)
Age at marriage	**0.196*****	0.135	0.028	0.166**	0.203**
	(0.062)	(0.097)	(0.072)	(0.063)	(0.078)
Age at first conception		0.180***			
		(0.041)			
Age at conception			0.275***		
			(0.033)		
Mother schooling years				0.029***	
				(0.005)	
Observations	74,551	54,939	74,519	74,519	26,115
Only no-primary-education obs.	No	No	No	No	Yes
Mother, child and HH controls	Yes	Yes	Yes	Yes	Yes

Note: *p<0.1; **p<0.05; ***p<0.01

Table 3 reports the second-stage results for the 2SLS in Eq.(1)-(2) with additional controls in Columns (2)-(4). Column (2) controls for age at first conception of the mother, Column (3) for age of conception of the specific child, and Column (4) for mother schooling years. In column (5) the 2SLS is run with no additional controls, but only using a subsample of the mothers who did not complete primary schooling, i.e. five years of education.

The results in **Table 3** suggest a main mediating role for age at motherhood, but not for mother education. The impact of instrumented early marriage on child height-for-age largely dissipates and becomes insignificant when we control for age at conception. In contrast, it remains strong and robust when we control for mother's education or when we restrict the analysis to mothers without a primary school education. This begets the question of what it is that early married (and as a result younger) mothers do which precipitates lower child height-for-age, which we turn to next.

4.2 Nutritional mechanisms

There is medical concensus that nutrition in the first years of infant life is key for growth. In addition to the aforementioned evidence on complementary feeding and breastfeeding, there is some evidence that protein intake generally is important for growth, although this is more robust for preterm infants (Tonkin et al, 2014) than in general (Millward, 2017). Besides direct intake, loss of nutrients through exposure to disease, primarily diarrhea, can expose children to stunted growth (Nasrin et al, 2023). We are therefore interested in complementary feeding after six months, breastfeeding duration, protein intake, and nutrient loss from disease as possible nutritional channels. A number of points stand out from a descriptive overview of these variables, shown in Panels C and D of **Table A1**.

First, complementary feeding, on which we have information from the first wave, takes place too late for young infants in India. Only one in three infants between the ages of 6 to 8 months was introduced to mushy solids, and the average age of initiating complementary feeding was about 9.6 months, well above the World Health Organization's recommendation of 6 months. Second, about nine out of ten infants above the age of 4 months or 6 months is breastfed for at least 4 months or 6 months, respectively. Third, with the exception of non-breast-milk, most children below the age of five did not consume a source of protein within the last day and night from dairy, eggs, or legumes. Fourth, the prevalence of recent diarrhea is consistent, standing at about one in every ten surveyed children over the period.

To examine whether mother's age at marriage influences these nutritional variables, we regress the latter on age at marriage instrumented by age at menarche. We do this by replacing child height-for-age in the second stage, i.e. Equation (1), with the nutritional variable for the child as the dependent variable.[15] The identification assumption is similar

[15] While the test for complementary feeding start and breastfeeding duration follow the same specification on the RHS, we note that for prior day nutrition and on diarrhea, we need to compare children of the same age. For example, it is not realistic to expect the intake of legumes or other food to be the same for a one year old as for a two year old. It is not possible to control for both child and mother age without omitting variation in age at conception. Therefore, in these regressions we omit mother age and birth year as controls and control for child age. Effectively, we compare same-age and same birth-order children born to mothers

to before: that age at menarche of the mother influences the child's nutrient intake only through influencing the mother's age at marriage. The results are presented in **Table 4** and illustrated in **Figure 5**.

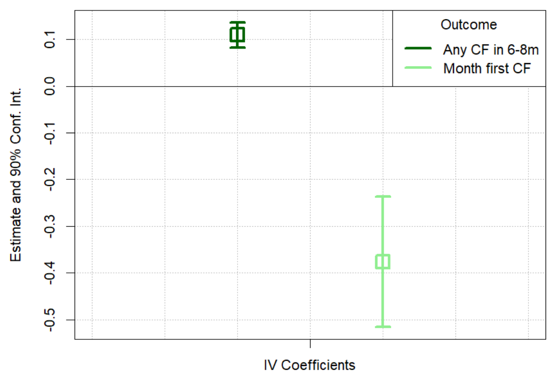
Table 4: Impact of marriage age on nutrient intake and loss.

Outcome	*PANEL A. Complementary feeding initiation*
Any CF for 6-8 month olds (y/n)	0.109^{***}
	(0.016)
Age CF introduced (months)	-0.376^{***}
	(0.085)
	PANEL B. Breastfeeding duration
At least 4 months, for ≥4m olds (y/n)	0.016^{***}
	(0.006)
At least 6 months, for ≥6m olds (y/n)	0.016^{***}
	(0.006)
	PANEL C. Prior day nutrition
Any non-BF milk (y/n)	0.026^{**}
	(0.012)
Any dairy (y/n)	0.004
	(0.015)
Any legumes (y/n)	-0.03^{*}
	(0.017)
Any eggs (y/n)	-0.07^{**}
	(0.025)
	PANEL D. Diarrhea prevalence
Diarrhea in last two weeks (y/n)	0.011
	(0.008)

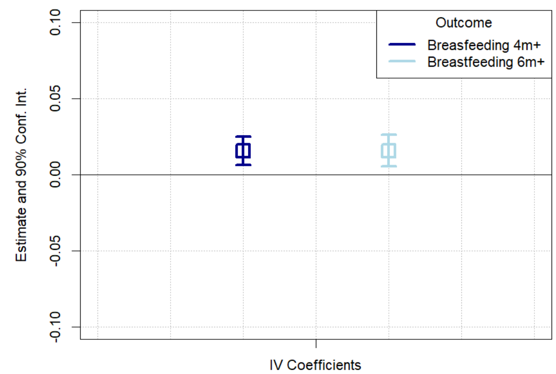
Note: *p<0.1; **p<0.05; ***p<0.01

Table 4 reports the second-stage results of regressing the specific nutritional outcome for the child, on the mother's instrumented age at marriage. The regressions control for relevant child, mother, and household level variables.

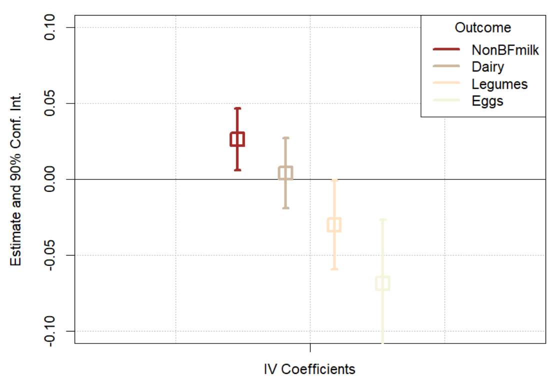
who married earlier versus later, and who may therefore be on average younger versus older mothers.



(a) Complementary feeding



(b) Breastfeeding



(c) Other proteins in last 24hr

(d) Recent diarrhea

Figure 5: Impact of marriage age on nutrition intake and loss

Figure 5 illustrates the results in Table 4, showing the point estimates for the impact of instrumented age at marriage on child nutrition intake and loss, and the 90% confidence intervals.

We find that early marriage postpones complementary feeding and reduces duration of breastfeeding of young infants. More precisely, one year earlier marriage reduced the probability that an infant aged between 6 and 8 months had been introduced to mushy foods by 10.9 percentage points, equivalent to a 33% decline, and it delayed the infant's introduction in general to foods by about 11 days. Utilizing non-sample NFHS data, it can be shown that only for mothers married after 24 is the mean of complementary feeding introduction as low as the recommended six months old (omitted). On breastfeeding, one year earlier marriage reduced the probability that an infant aged at least four (six) months was breastfed for at least four (six) months by 1.6 percentage points - equivalent to 1.7% -

a magnitude which is small but statistically significant.

In contrast, we find no consistent impact of early marriage on prior-day other-protein intake. The nutrient most widely consumed in this group is non-breast-milk (such as fresh cow or powdered milk) and the intake of this is positively impacted by later marriage, while the coefficients on nutrients whose base intake is low (dairy, legumes, and eggs) is either insignificant or slightly negative. We are also unable to reject a null for the coefficient on child's recent diarrhea incidence.[16]

4.3 Other mechanisms

While nutrition in the first years of life is undoubtedly key to child development and has been the focus of medical studies on child growth, there is nevertheless a debate about the possible contribution of *prenatal* mechanisms to child growth. Prenatal supplementation has been a particularly active field of study; earlier RCTs find some impact on child growth (Kusin et al 1992; Huy et al, 2009; Khan et al, 2011) while more recent RCTs tend to focus on the impact of prenatal supplements on gestational variables and birthweight (Oh et al, 2020). More broadly, some medical studies highlight preterm birth and smallness relative to gestational age as risk factors for later impaired growth (e.g. Christian et al, 2013), although it is unclear whether this is because of associated factors (including worse later-on infant nutrition) or through independent mechanisms.

For our purposes, it suffices to examine whether early age at marriage influences variables such as antenatal supplements and healthcare, as well as birth-related variables such as gestational length, child birth weight, and delivery complications. If so, it may be possible, albeit not certain, that prenatal mechanisms mediate some of the impact of early mother's marriage on child height-for-age. If on the other hand there are no such effects of early marriage, then it is unlikely that prenatal channels are key to the outcomes we see.

In **Table 5** we test whether (instrumented) early marriage impacted two dimensions of antenatal behavior on which we have data: the mother taking iron pills during pregnancy and making antenatal visits to a health center (Columns 1 and 2, respectively). In **Table 6** we test the impact of instrumented age at marriage on preterm birth of the child, birth-weight, and presence of any delivery complications (Columns 1-3 respectively). To address the possibility that early married mothers have higher infant mortality and the remaining pool is healthier - the possible offspring selection issue noted earlier - we also test for impact of age at marriage on child mortality (Column 4).

[16]We interpret the results on prior day nutrition and diarrhea incidence with some caution because of the lack of control for mother age (see prior footnote). In contrast, our preferred specifications control for mother age and use outcomes which are already adjusted for child age (e.g. height-for-age) or which do not necessitate a continuous child-age control (e.g. comparing children within or above an age threshold).

As shown in both **Table 5** and **Table 6**, age at marriage does not drive significant variation in any of these variables. While we cannot entirely rule out an impact of early marriage on all possible prenatal channels, the latter do not appear to be salient in mediating the marital age-child growth relationship.

Table 5: Impact on mother's antenatal behavior

	Iron pills (y/n)	Antenatal visits (y/n)
	(1)	(2)
Age at marriage	0.016	−0.006
	(0.016)	(0.012)
Observations	68,987	68,525
Survey waves	All	All
Mother, child and HH controls	Yes	Yes

Note: *p<0.1; **p<0.05; ***p<0.01

Table 5 reports the second-stage results of regressing whether the mother took iron pills during her pregnancy (Column 1) or had any antenatal visits to a health professional (Column 2), on her instrumented age at marriage.

Table 6: Impact on birth variables and child mortality

	Preterm (y/n)	Birthweight (kg)	Comp. (y/n)	Alive (y/n)
	(1)	(2)	(3)	(4)
Age at marriage	−0.003	−0.015	0.015	0.003
	(0.012)	(0.030)	(0.011)	(0.004)
Observations	91,892	64,816	15,145	92,057
Survey waves	All	4^{th}, 5^{th}	1^{st}	All
Mother, child and HH controls	Yes	Yes	Yes	Yes

Note: *p<0.1; **p<0.05; ***p<0.01

Table 6 reports the second-stage results of regressing whether the child was born preterm (Column 1), the child's birthweight (Column 2), whether there were delivery complications (Column 3), and whether the child is alive (Column 4), on the mother's instrumented age at marriage.

Finally, we examine whether postnatal channels related to health but not directly to nutrition also mediate the main results. Drawing on the information in the NFHS, **Table 7** demonstrates the impact of mother's age at marriage on the probability the child obtained a health card (Column 1) or a BCG vaccination (Column 2). As shown, both coefficients are close to zero and insignificant. This too is not a comprehensive examination of all possible non-nutritional postnatal mechanisms, but it suggests that at least along the dimensions which are observed in the data, these variables are not driving the impact of early marriage on child growth.

Table 7: Impact on other health-relevant variables

	Health card (y/n)	BCG vaccination (y/n)
	(1)	(2)
Age at marriage	0.016	−0.006
	(0.016)	(0.012)
Observations	68,987	68,525
Survey waves	All	All
Mother, child and HH controls	Yes	Yes

Note: *p<0.1; **p<0.05; ***p<0.01

Table 6 reports the second-stage results of regressing whether the child has a health card (Column 1) or has received a BCG vaccination (Column 2) on the mother's instrumented age at marriage. To compare children of the same age, child age controls are added, while mother age controls are removed to allow for conception time variation.

5 Knowledge and preferences

To the extent that early-married mothers feed their children less well, deeper questions still emerge about these mechanisms and underlying mother behavior. An important question is whether early-married mothers simply know less and are less well-prepared, or whether their priorities and preferences are also key to the outcomes on children. On knowledge, we note that while Section 4.1 suggests formal schooling is not key to the marital age-child growth relationship, this does not exclude the potential for beneficial *informal* knowledge acquired with age or maturity. Informal knowledge and preparation may also be acquired with prior childbearing experience. At the same time, early-married mothers may not be behaving mechanistically in response to (lack of) age or experience. If there is a role for effort and attention in improving child nutrition and outcomes, then preferences and priorities would also mediate the effect on children.

The NFHS does not elicit questions directly on the extent to which mothers know how or when to feed their infants, nor on how they may prioritize child nutrition. To make some headway on these questions, we offer a simple theoretical framework which delineates some of these possible channels, and shows how they can be inferred about by differentiating results by child characteristics. We follow the model with relevant evidence from our sample.

5.1 Theoretical model

Consider child j of mother i, where j refers to the child's birth order. Denote the child's height-for-age as H_{ij}, and let it be a positive function of a composite variable of healthful nutrition in the first years of life, denoted as $h_{ij} \in (0, 1]$.

$$H_{ij} = f(h_{ij}) \qquad f' > 0 \tag{3}$$

In turn, healthful nutrition h_{ij} is partly a positive function of the age at which the mother married, m_i. We explain this with reference to age at marriage placing a lower bound on conception age, in line with the results in Section 4.1, but the model is in essence agnostic about this, so it could also be through educational or other channels as well. Specifically, we assume that for mothers married after some threshold age $\bar{m}$, healthful nutrition of the child is at its maximum of 1. By contrast, if the mother married at an earlier age, then h is adversely affected by the distance between marital age and the threshold age. Combining this with Eq. (3), we obtain:

$$H_{ij} = \begin{cases} f(1) & \text{if} \quad m_i \geq \bar{m} \\ f(1 - \beta(\bar{m} - m_i)); \quad \beta > 0 & \text{if} \quad m_i < \bar{m}; \end{cases} \tag{4}$$

with the subsequent restriction $0 < \beta(\bar{m} - m_i) < 1$. We note that if the model was based on conception age instead of age at marriage, the key results would hold.[17]

We now augment this basic setup in Eq. (4) as follows. First, in tending to her child j, the mother can exert some effort e_{ij} in order to mitigate adverse impacts on her child's nutrition, for example by seeking information about, or support for, good nutrition practices that she may not readily have, along with paying close attention to her child's cognitive and physical development. Second, once the mother has raised one child, she has gained experience E which she can also use, *if* she applies said effort, to improve nutrition practices for the current child; this is a type of effortful learning by doing, where it is necessary to not only observe but to actively apply the learned experience. But having a prior child can also exert a negative influence R on the current child's nutrition, by constraining the

[17] To see this, suppose conception age is $c_{ij} = m_i + aj$, where a is the birth interval between children, and $\bar{c}$ is the threshold conception age. Then the model would become

$$H_{ij} = \begin{cases} f(1) & \text{if} \quad m_i + aj \geq \bar{c} \\ f(1 - \beta(\bar{c} - (m_i + aj))); \quad \beta > 0 & \text{if} \quad m_i + aj < \bar{c}; \end{cases}$$

The partial derivative of height for age on age at marriage would still be $\frac{\partial H_{ij}}{\partial m_i} = f'\beta$, the same as obtained from the setup in Eq. (4). The subsequent results, from the augmented model, would similarly be left unaffected.

resources (such as attention) of the mother available; this too can be mitigated with the effort parameter.

The augmented model takes the following form:[18]

$$H_{ij} = \begin{cases} f(1) & \text{if} \quad m_i \geq \bar{m} \\ f\Big[1 - \Big(\beta(\bar{m} - m_i)\Big)\Big(1 + (1+E)^{j-1}e_{ij} - (j-1)\frac{R}{e_{ij}}\Big)^{-1}\Big]; & \text{if} \quad m_i < \bar{m}; \end{cases} \tag{5}$$

where the possibility of experience benefits and of resource constraints for later children imply $E > 0$ and $R > 0$, respectively. Note that if $E = 0$ and $R = 0$, the equation becomes the same for all children regardless of birth order j.

For illustrative purposes, and also because they comprise the majority of observations in our data, we focus on implications for firstborn ($j = 1$) and second born ($j = 2$) children.[19] The above becomes:

$$H_{ij} = \begin{cases} 1 & \text{if} \quad m_i \geq \bar{m} \\ f\Big[1 - \Big(\beta(\bar{m} - m_i)\Big)\Big(1 + e_{i1}\Big)^{-1}\Big]; & \text{if} \quad m_i < \bar{m} \quad \text{and} \quad j = 1; \\ f\Big[1 - \Big(\beta(\bar{m} - m_i)\Big)\Big(1 + (1+E)e_{i2} - \frac{R}{e_{i2}}\Big)^{-1}\Big]; & \text{if} \quad m_i < \bar{m} \quad \text{and} \quad j = 2; \end{cases} \tag{6}$$

In other words, for a firstborn, the mother's effort can improve healthful nutrition, mitigating the impact of early marriage, but there is no mother experience or current resource constraint from earlier siblings. A secondborn can (but does not necessarily, pending effort) additionally benefit from their mother's childbearing experience but can also be hurt by resources, including attention, spreading thinner.

The mother operates according to an implicit utility function in which effort is costly and its exertion is influenced by the perception (by her or possibly by the household more widely) of the importance of investing in the child's health and well-being. Drawing on evidence on son preference in India (Pande and Malhotra, 2006), we assume this is at least tangentially related to the child's gender. For simplicity and letting effort take one of two values $e_{ij} \in \{\underline{e}, \bar{e}\}$, effort takes the former value if child j is a girl and the latter if it is a boy. With roughly equal gender distribution in the population we denote the average effort expended for the population of children per child as the midpoint $\tilde{e}$, and we let $\Delta_e = \bar{e} - \underline{e}$.

From this model, we derive the following propositions, with proofs in **Appendix B**:

[18] We use linear forms to derive simple closed-form solutions.

[19] 92% of the children in our sample are first or secondborn children, so that focusing on these cohorts simplifies calculations without making the results less relevant.

Proposition 1. *For early married mothers, both healthful nutrition for the child and height-for-age for the child are positively impacted by mother's (later) age at marriage.*

Proof. See Appendix. □

Proposition 2. *The impact of age at marriage on boy children is lower than its impact on girl children if* $\Delta_e > 0$.

Proof. See Appendix. □

Proposition 3. *The impact of age at marriage on firstborns is higher than its impact on secondborns if* $\frac{R}{E} < \tilde{e}^2$. *Differentiating by gender, this holds for firstborn versus second born boys if* $\frac{R}{E} < \bar{e}^2$, *and for firstborn versus second born girls if* $\frac{R}{E} < \underline{e}^2$.

Proof. See Appendix. □

The intuition for the first proposition is straightforward, hinging on later age at marriage of the mother driving more healthful nutrition for the child ($\beta > 0$), and on the latter improving child growth ($f' > 0$). The magnitudes are equivalent to the absolute size of the *negative* effects of early marriage on nutrition and growth.

The second proposition is also straightforward. Higher effort toward a child buttresses potentially negative impacts of early marriage on their nutrition, in turn translating into a smaller positive coefficient (of later marriage) on child outcomes.

For the third proposition, the intuition is as follows. For a secondborn, to the extent that the potential scope for experience from previous childbearing is greater than the potential scope for resource constraints arising from it, then R/E is small. But this relative magnitude is not all that matters, as mother effort actually operationalizes the effects of both E and R on child nutrition and growth. Higher effort reduces the adverse impact of R on the second child while and augmenting the beneficial impact of E. Therefore, a second child will be more protected from the impact of early marriage relative to a first child if effort is high enough to offset R/E, and this in turn would translate into a smaller effect of later marriage on the second child.

5.2 Evidence

Our findings so far, of a positive impact of later marriage on child height-for-age and on nutritional mechanisms, can be interpreted as in support of Proposition 1. Roughly speaking, the impact of marriage age on child height-for-age supports $\frac{\partial H_{ij}}{\partial m_i} = f'\beta > 0$, while the impact of marriage age on nutritional variables supports $\frac{\partial hij}{\partial m_i} = \beta > 0$. Together, these also support $f' > 0$.

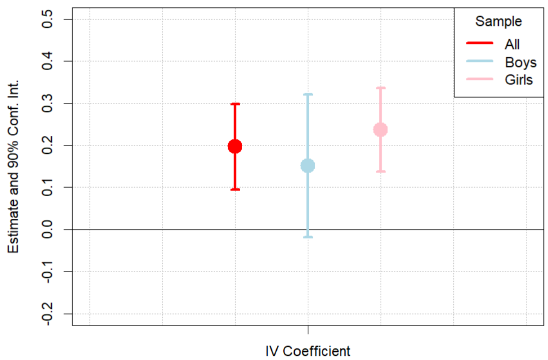
To provide evidence relevant to Propositions 2 and 3, which touch on whether preferences, experiences and constraints mediate marital age effects, it is necessary to further distinguish the results by child characteristics. To test for the presence of a gender-based preference (Proposition 2) we differentiate the main results by gender, looking at the impact of marital age separately on boy versus girl children. To test for the possibility of a role for experience and resource constraints alongside preferences (Proposition 3), we differentiate the results by birth order generally, and then by a combination of both gender and birth order. The results are displayed in **Table 8** and illustrated in **Figure 6**.

Table 8: Differentiating by child birth order and gender.

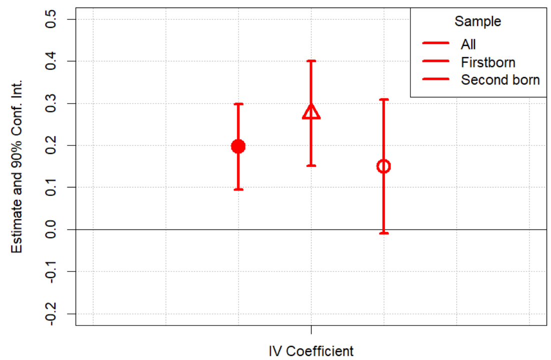
	(1)	(2)	(3)	(4)	(5)
	Panel A. By gender and birth order separately				
	All	Boys	Girls	Firstborn	Secondborn
Age at marriage	**0.196*****	0.151	0.236***	0.276***	0.150
	(0.062)	(0.103)	(0.060)	(0.076)	(0.097)
Observations	74,551	38,276	36,275	38,153	26,648
Mother, child, HH controls	Yes	Yes	Yes	Yes	Yes
	Panel B. By combination of the two				
	All	Boys		Girls	
And is:		Firstborn	Secondborn	Firstborn	Secondborn
Age at marriage	**0.196*****	0.280*	-0.002	0.261***	0.316***
	(0.062)	(0.151)	(0.131)	(0.067)	(0.107)
Observations	74,551	19,596	13,637	18,557	13,011
Mother, child, HH controls	Yes	Yes	Yes	Yes	Yes

Note: *p<0.1; **p<0.05; ***p<0.01

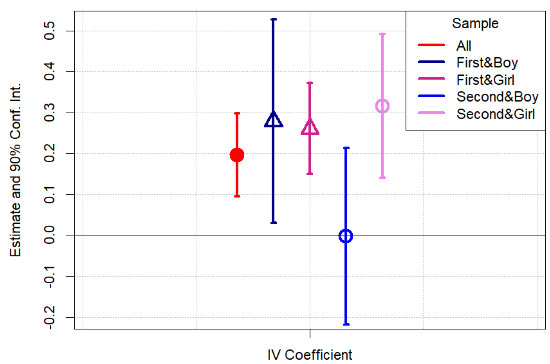
Table 8 reports the second-stage results of the 2SLS in Eq. (1)-(2), differentiated by gender and birth order of the child separately in Panel A, and differentiated by a combination of the two in Panel B. The outcome throughout is child height-for-age.



(a) By gender



(b) By birth order



(c) By combination of the two

Figure 6: Differentiating by child characteristics

Figure 6 illustrates the results in Table 8. It shows the point estimates for the impact of instrumented age at marriage on child height-for-age - differentiated by child characteristics - and the 90% confidence intervals.

First, as shown in Columns (2) and (3) of Panel A and illustrated in **Figure 6a**, girl children bear a higher brunt of the burden of early marriage of the mother. The coefficient of marital age on child height-for-age is 0.151 for boy children and insignificant (p=0.16), but 0.236 and significant at the 1% level for girl children. Second, as shown in Columns (4) and (5) of Panel A and illustrated in **Figure 6b**, firstborns bear a higher brunt of the burden of early marriage than secondborns. The coefficient for firstborns is 0.276 and significant at the 1% level, but 0.150 and insignificant (p=0.14) for secondborn children.

Third, differentiating by *a combination* of birth order and gender as shown in Panel B and illustrated in **Figure 6c**, childbearing experience *only* improves outcomes for boys.

The coefficient for firstborns who are boys is 0.280 and significant, but becomes very close to zero and highly insignificant for secondborns who are boys. It can be shown that this is the case both when the secondborn is the first son, i.e. firstborn was a daughter, and when he is the second son, so that this is not driven (only) by first-son preference (omitted).[20] In contrast, previous childbearing experience does *not* improve outcomes for girl children, with girls who are secondborns being even worse off in terms of the impact of early marriage than girls who are firstborn. The coefficient for firstborns who are girls is 0.261 and significant, and *rises* to 0.316 for secondborns who are girls.

Interpreting these findings in light of the model, what we see suggests that

$$\Delta_e > 0 \tag{7}$$

$$E > 0 \tag{8}$$

$$R > 0 \tag{9}$$

$$\underline{e}^2 < \frac{R}{E} < \tilde{e}^2 < \bar{e}^2 \tag{10}$$

In other words, respectively, (i) effort is higher on average for boy children than for girl children; (ii) prior childbearing experience and (iii) resource constraints both impact later children vis-a-vis firstborns; and (iv) effort is high enough to generate net gains for secondborns when the child is a boy but not when the child is a girl.

To sum, while early age at marriage contributes to poor nutrition of the infant and to reduced height-for-age, it does not do so in a mechanistic manner. Rather, the mother's circumstances in terms of experience and/or burden from raising other children, combined with her priorities or preferences, can buttress or amplify the impacts on her child.

6 Additional results

The following results are all presented in **Appendix C**. As mentioned prior, mother's height may serve as a proxy for her own nutrition in childhood. Along with descriptive evidence in Section 2 that mother's height seems to be distributed independently and almost identically by age at menarche, in **Table C1** we additionally include mother's height as a control in the surveys with data on this variable, NFHS-4 and NFHS-5. The nature of the results remains similar but the precision is reduced for the fifth wave; the first stage estimates are nearly identical to before.

[20]However, the impact of early marriage is even slightly more diminished for secondborns who are first-sons, evidence of some additional first-son preference.

In **Table C2**, we examine the robustness of our main results to different, less restrictive, samples. We relax the restrictions on mother age at marriage, mother age at interview time, and mother age at menarche, separately and respectively, in Columns (1), (2), and (3); in Column (4) we remove all of these restrictions, thereby running the regression on the largest possible sample size. This exercise is informative. It demonstrates that including mothers married later than 18 reduces the first-stage coefficient slightly, perhaps as menarche is less relevant for later-married mothers, and that including mothers up to age 49 by interview time raises the first-stage coefficient somewhat, perhaps (partly) artificially through recall error. Nevertheless, throughout, the results are robust: all samples show age at menarche significantly delaying age at marriage and (instrumented) later marriage significantly increasing child height-for-age.

In **Table C3**, we examine more closely the choice of how to control for mother age. We re-run the main regression in Equations (1)-(2) with controls only for mother age in dummies (Column 1), only for mother birth year in dummies (Column 2), for a combination of the two with mother age as a continuous variable (Column 3), and for a combination of the two with mother age as a continuous variable *and* its square, to test for nonlinear effects (Column 4). The main results remain robust across all specifications.

In **Table C4**, we re-run the main regression but with age at conception age, instead of age at marriage, as the endogenous variable. This serves as an additional check on whether conception age is driving the results, in which case we would expect a significant first and second stage. In Column (1) we use age at first conception for the mother whereas in Column (2) we use age at conception of the specific child in the observation. In both cases, we find a strong first stage, with one year later menarche postponing conception by 0.07-0.08 years, as well as a strong impact of age at conception on child height-for-age.

Finally, in **Table C5**, we examine heterogeneity of the results by family structure. Many families in India live in joint households that include the woman's in-laws. From the surveys, 43.2% of the mothers report that the head of their household is an in-law while 38.5% report it is their husband.[21] Having mothers-in-law around may impact the knowledge available to, and/or burden from childraising for, the young mother. While we cannot assume that a mother-in-law is *not* living in a household when her son is the head (as she may be widowed and living with her son's family), it is at least more likely that a mother-in-law is present when an in-law is household head. As shown in Column (1), the impact of early mother's marriage on child height-for-age is reduced - and less precisely measured - in households where an in-law is head. This points to possibly beneficial knowledge or childcare effects

[21] Only a minority of women live with their own family; around 11% in our sample say the head of household is their parent. Notably, those women are more likely than others to be living separated from their husband.

of such joint family structures. However, we remain cautious in our interpretation of the results, as several socioeconomic dimensions are associated with family structure in India.[22]

7 Conclusion

Low height-for-age is widespread in India, with the stunting rate of children under five remaining among the highest in the world (World Bank, 2020). Child physical growth is strongly correlated with socioeconomic status of the family. However, since child growth has far-reaching implications for health and possibly for later-life economic and social outcomes (Hoddinott et al, 2013), it is key to understand how *specific* socioeconomic conditions and practices contribute to the prevalence of low height-for-age among children.

In this paper, we explore the contribution to low child height-for-age in India of early marriage, and subsequently early parenthood, of the mother. Our motivation arises from the fact that early marriage of women is widespread in India - where one in three of all women married as minors in the world live and where the current median age at marriage is among the lowest worldwide - and since the mother in turn is a key caretaker of young children. Therefore, this paper is concerned with the possibility that one of the socioeconomic pathways to child stunting lies in marital practices - driven themselves by a mix of economic constraints and social norms - which result in potentially adverse consequences for child growth.

Using age at menarche as an instrument for age at marriage, data from India's National Family Health Surveys over the past thirty years, and focusing on mothers who were married by the age of 18, we find large adverse effects of early marital age on child height-for-age. In particular, one year earlier marriage of the mother has decreased child height-for-age by 0.20 standard deviations over the period. To put the results into perspective, this suggests a 13% decline relative to average height-for-age in the period for each earlier year of mother's marriage. Our results are robust to different specifications and sample choices, and match descriptive evidence showing a correlation between mother marital age and child height-for-age among early married mothers in India.

Exploring mechanisms at length, we find that a key aspect relates to marriage age placing a lower bound on conception age, so that early married mothers become younger mothers. In turn, a core finding of our paper is that these early-married (and thus younger) mothers introduce their children to growth-critical complementary feeding later and breastfeed for less time. We additionally explore a number of other possible prenatal and postnatal chan-

[22] In India, being in a joint family is positively correlated with family affluence, while poorer families are the ones more likely to live in nuclear households (BBC, 2020).

nels, showing that they seem to be less salient in mediating the impacts of early marital age on child growth than direct nutrition. Further evidence, grounded in a simple theoretical model, suggests that the impacts of marital age on child height-for-age are mediated by both knowledge gaps and preference issues among early-married mothers.

Our findings shed light on a potentially devastating intergenerational effect of early marriage of women. Given slow evolution in marital age practices - itself an outcome of enduring underdevelopment and sticky social norms - successfully assisting young mothers in infant nutrition would help to stem lasting impacts on children's health. The policy challenges in doing so may be significant, but so may be the payoffs to health and development in the world's most populous nation.

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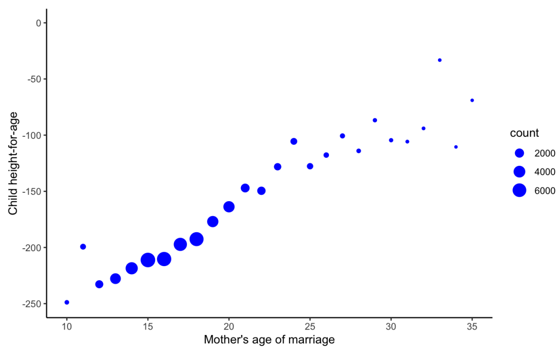
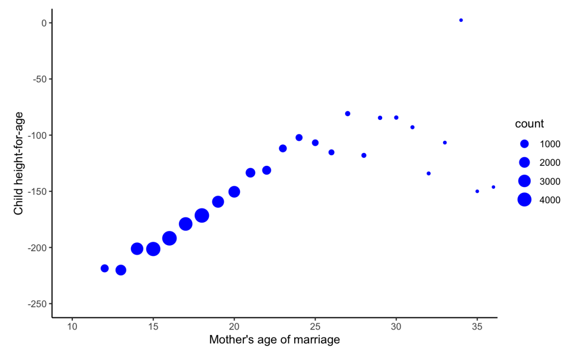
APPENDIX

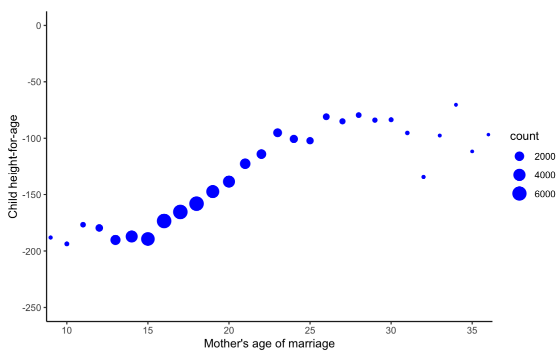
A Descriptive data



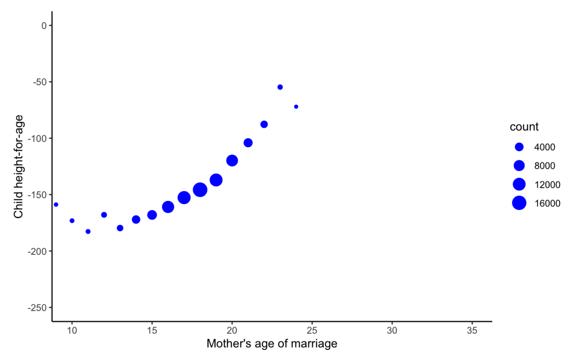
(a) NFHS-1, 1993



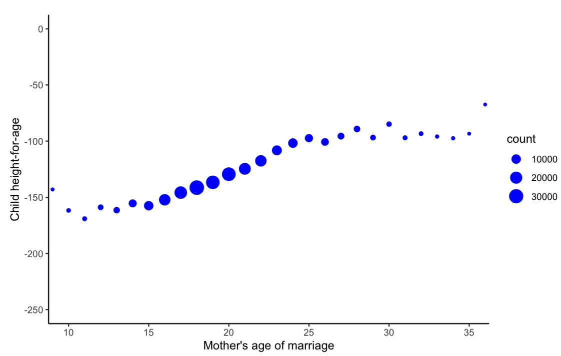
(b) NFHS-2, 1999



(c) NFHS-3, 2006



(d) NFHS-4, 2016



(e) NFHS-5, 2021

Figure A1: Correlations across surveys

For each of the five National Family Health surveys, Figure A1 plots each mother age at marriage (x-axis) and, for that age, average offspring height-for-age in '00 standard deviations (y-axis). Circle size represents the count density of mothers married at this age in the survey. Note that the NFHS-4 did not collect data on mothers older than 24, hence the sharp stop in plot (d).

Table A1: Variable distribution in the sample.

Variable	Survey	Available Obs.	Mean
	PANEL A. Child characteristics		
Age at survey	All	92,915	2.20
Height-for-age (standard deviations)	All	75,302	−1.57
Gender (share boys)	All	92,915	0.515
Birth order (1=firstborn)	All	92,915	1.658
	PANEL B. Mother and household characteristics		
Age at menarche	All	92,915	13.33
Age at marriage	All	92,915	15.93
Age at first conception	All	92,915	17.95
Age at survey	All	92,915	21.97
Education years	All	92,858	5.536
Rural household (share)	All	92,915	0.832
Religion (share Hindu)	All	92,072	0.679
	PANEL C. Nutritional variables for child		
Any CF for 6-8 month olds (y/n)	NFHS1	1,328	0.335
Age CF introduced (months)	NFHS1	10,075	9.560
BF at least 4 months, for ≥4m olds (y/n)	All	62,637	0.900
BF at least 6 months, for ≥6m olds (y/n)	All	58,514	0.887
Any non-BF milk in last day (y/n)	All	69,699	0.233
Any legumes in last day (y/n)	NFHS4, NFHS5	54,474	0.074
Any dairy in last day (y/n)	NFHS4, NFHS5	54,474	0.074
Any eggs in last day (y/n)	NFHS4, NFHS5	54,474	0.071
	PANEL D. Diarrhea prevalence		
Diarrhea in last two weeks (y/n)	All	87,928	0.096

Note: *p<0.1; **p<0.05; ***p<0.01

Table A1 reports, for key child, mother, and household level variables, (i) the surveys in which this is available, (ii) the total available observations within our sample, and (iii) the mean within our sample.

B Proofs of propositions

B.1 Proposition 1

The proof of Proposition 1 is obtained by calculating the partial derivatives of H_{ij} and h_{ij} with respect to m_i.

Beginning with h_{ij}, then for $m_i \geq \bar{m}$, $\frac{\partial h_{ij}}{\partial m_i} = \frac{\partial 1}{\partial m_i} = 0$. In contrast if $m_i < \bar{m}$ then:

$$\frac{\partial h_{ij}}{\partial m_i} = \frac{\beta}{1 + (1+E)^{j-1} e_{ij} - (j-1)\frac{R}{e_{ij}}} > 0$$

given the restriction that the denominator is positive.

For H_{ij},

$$\frac{\partial H_{ij}}{\partial m_i} = \frac{\partial H_{ij}}{\partial h_{ij}} \frac{\partial h_{ij}}{\partial m_i}$$

Therefore, if $m_i \geq \bar{m}$, then $\frac{\partial H_{ij}}{\partial m_i} = f' * 0 = 0$. In contrast, if $m_i < \bar{m}$, then

$$\frac{\partial H_{ij}}{\partial m_i} = f' \frac{\beta}{1 + (1+E)^{j-1} e_{ij} - (j-1)\frac{R}{e_{ij}}} > 0 \tag{B.1}$$

since both $f' > 0$ and $\beta > 0$. This completes the proof for Proposition 1. □

B.2 Proposition 2

The proof of Proposition 2 is obtained by calculating and comparing the partial derivative $\frac{\partial H_{ij}}{\partial m_i}$ for boy versus girl children. For mothers married $m_i \geq \bar{m}$, and following Proposition 1, $\frac{\partial H_{ij}}{\partial m_i} = 0$ for all children.

For mothers married $m_i < \bar{m}$, then for boy children

$$\frac{\partial H_{ij}}{\partial m_i}|_{boys} = f' \frac{\beta}{1 + (1+E)^{j-1} \bar{e}_{ij} - (j-1)\frac{R}{\bar{e}_{ij}}}$$

while for girl children

$$\frac{\partial H_{ij}}{\partial m_i}|_{girls} = f' \frac{\beta}{1 + (1+E)^{j-1} \underline{e}_{ij} - (j-1)\frac{R}{\underline{e}_{ij}}}$$

To see that the first part of the proposition holds, the former minus the latter yields:

$$
\begin{aligned}
&\frac{\partial H_{ij}}{\partial m_i}|_{boys} - \frac{\partial H_{ij}}{\partial m_i}|_{girls} \\
&= f'\frac{\beta}{1+(1+E)^{j-1}\bar{e}_{ij}-(j-1)\frac{R}{\bar{e}_{ij}}} - f'\frac{\beta}{1+(1+E)^{j-1}\underline{e}_{ij}-(j-1)\frac{R}{\underline{e}_{ij}}} \\
&= \frac{f'\beta\big(1+(1+E)^{j-1}\underline{e}_{ij}-(j-1)\frac{R}{\underline{e}_{ij}}\big) - f'\beta\big(1+(1+E)^{j-1}\bar{e}_{ij}-(j-1)\frac{R}{\bar{e}_{ij}}\big)}{\big(1+(1+E)^{j-1}\bar{e}_{ij}-(j-1)\frac{R}{\bar{e}_{ij}}\big)\big(1+(1+E)^{j-1}\underline{e}_{ij}-(j-1)\frac{R}{\underline{e}_{ij}}\big)} \\
&= f'\beta\frac{(1+E)^{j-1}(\underline{e}-\bar{e})-(j-1)R(\frac{\bar{e}-\underline{e}}{\bar{e}\underline{e}})}{\big(1+(1+E)^{j-1}\bar{e}_{ij}-(j-1)\frac{R}{\bar{e}_{ij}}\big)\big(1+(1+E)^{j-1}\underline{e}_{ij}-(j-1)\frac{R}{\underline{e}_{ij}}\big)} \\
&= f'\beta\big(\underline{e}-\bar{e}\big)\frac{(1+E)^{j-1}+\frac{(j-1)R}{\bar{e}\underline{e}}}{\big(1+(1+E)^{j-1}\bar{e}_{ij}-(j-1)\frac{R}{\bar{e}_{ij}}\big)\big(1+(1+E)^{j-1}\underline{e}_{ij}-(j-1)\frac{R}{\underline{e}_{ij}}\big)} \\
&< 0 \quad \text{iff} \quad \Delta_e = \bar{e}-\underline{e} > 0
\end{aligned}
$$

This completes the proof for Proposition 2. □

B.3 Proposition 3

The proof of Proposition 3 is obtained by calculating and comparing the derivative $\frac{\partial H_{ij}}{\partial m_i}$ for firstborns and secondborns. Once more, for mothers married $m_i \geq \bar{m}$ and following Proposition 1, $\frac{\partial H_{ij}}{\partial m_i} = 0$.

For mothers married $m_i < \bar{m}$, then for firstborns:

$$\frac{\partial H_{i1}}{\partial m_i} = f'\beta\frac{1}{1+e_{i1}}$$

For secondborn children,

$$\frac{\partial H_{ij}}{\partial m_i} = f'\beta\frac{1}{1+(1+E)e_{i2}-\frac{R}{e_{ij}}}$$

Since approximately half of all children regardless of birth order are boys and the other half is girls, average effort in both birth orders is $\tilde{e}$. Subtracting the derivative for firstborns minus secondborns yields:

$$\begin{aligned}
&\frac{\partial H_{i1}}{\partial m_i} - \frac{\partial H_{i2}}{\partial m_i} \\
&= f'\beta \frac{1}{\big(1+\tilde{e}\big)} - f'\beta \frac{1}{\big(1+(1+E)\tilde{e} - \frac{R}{\tilde{e}}\big)} \\
&= f'\beta \frac{\big(1+(1+E)\tilde{e} - \frac{R}{\tilde{e}}\big) - \big(1+\tilde{e}\big)}{\big(1+(1+E)\tilde{e} - \frac{R}{\tilde{e}}\big)\big(1+\tilde{e}\big)} \\
&= f'\beta \frac{\tilde{e}\big[E - \frac{R}{\tilde{e}^2}\big]}{\big(1+(1+E)\tilde{e} - \frac{R}{\tilde{e}}\big)\big(1+\tilde{e}\big)}
\end{aligned}$$

Given $f' > 0$ and $\beta > 0$, this difference will be positive if the expression in the square brackets is positive, i.e.

$$\frac{R}{E} < \tilde{e}^2$$

Otherwise, we would have $\frac{\partial H_{i1}}{\partial m_i} < \frac{\partial H_{i2}}{\partial m_i}$. Repeating the same arithmetic but for boys only, where $e = \bar{e}$, yields

$$\frac{\partial H_{i1}}{\partial m_i}|_{boys} - \frac{\partial H_{i2}}{\partial m_i}|_{boys} > 0 \quad \text{if} \quad \frac{R}{E} < \bar{e}^2$$

Similarly for girls only, where $e = \underline{e}$,

$$\frac{\partial H_{i1}}{\partial m_i}|_{girls} - \frac{\partial H_{i2}}{\partial m_i}|_{girls} > 0 \quad \text{if} \quad \frac{R}{E} < \underline{e}^2.$$

This completes the proof for Proposition 3. □

C Additional results

Table C1: Results when controlling for mother height.

	NFHS-4	NFHS-5
	(1)	(2)
	PANEL A. Second stage. Outcome: child height-for-age	
Age at marriage	0.161*	0.177
	(0.081)	(0.172)
	PANEL B. First stage. Outcome: Age at marriage	
Age at menarche	0.109***	0.081***
	(0.023)	(0.011)
First stage F-stat	91.5	68.4
Observations	36,277	30,094
Mother, child, and HH controls	Yes	Yes

Note: *p<0.1; **p<0.05; ***p<0.01

Table C1 reports the results of the 2SLS regressions in Equations (1)-(2) when mother height-for-age is added as a control, for the NFHS-4 (Column 1) and NFHS-5 (Column 2) surveys.

Table C2: Results with different sample restrictions

	(1)	(2)	(3)	(4)
	PANEL A. Second stage. Outcome: child height-for-age			
Age at marriage	0.198***	0.167***	0.272***	0.183***
	(0.048)	(0.053)	(0.057)	(0.037)
	PANEL B. First stage. Outcome: Age at marriage			
Age at menarche	0.122***	0.151***	0.098***	0.103***
	(0.013)	(0.022)	(0.016)	(0.013)
First stage F-stat	453.5	533.9	301.1	568.8
Observations	132,433	82,719	77,875	154,173
Mother, child, and HH controls	Yes	Yes	Yes	Yes

Note: *p<0.1; **p<0.05; ***p<0.01

Table C1 reports the results of the 2SLS regressions in Equations (1)-(2) with different sample restrictions. Column (1) removes the restriction of mother marriage by 18. Column (2) removes the restriction of mother age at time of interview. Column (3) removes the restriction on the mother's age at menarche. Column (4) removes all of these restrictions, thereby utilizing the maximum sample size possible.

Table C3: Results with variations of the mother-age control

	Outcome: child height-for-age			
	(1)	(2)	(3)	(4)
Age at marriage	0.196**	0.194***	0.202**	0.201***
	(0.089)	(0.057)	(0.061)	(0.062)
Observations	74,551	74,551	74,551	74,551
Mother, child and HH controls	Yes	Yes	Yes	Yes

Note: *p<0.1; **p<0.05; ***p<0.01

Table C3 reports the second-stage results in Equation (1), when different mother age controls are used. Column (1) controls only for mother age, through year-dummies, Column (2) controls only for mother birth year, through year-dummies, Column (3) controls for both as dummy variables, and Column (4) controls for a continuous mother age variable, its square, and birth-year dummies.

Table C4: Results using age at conception as endogenous variable.

	(1)	(2)
	PANEL A. Second stage. Outcome: child height-for-age	
Age at first conception	0.370***	
	(0.096)	
Age at conception		0.321***
		(0.090)
	PANEL B. First stage. Outcome: First/specific conception	
Age at menarche	0.072***	0.082***
	(0.011)	(0.009)
First stage F-stat	245.3	338.5
Observations	54,939	74,519
Mother, child, and HH controls	Yes	Yes

Note: *p<0.1; **p<0.05; ***p<0.01

Table C4 reports the results of the 2SLS setup in Equations (1)-(2) but with age at conception, instead of age at marriage, as the endogenous variable. In Column (1), age at first conception is used, while in Column (2), age at conception of the specific child is used.

Table C5: Heterogeneity of results by family structure

	Outcome: child height-for-age		
	(1)	(2)	(3)
Age at marriage	0.146	0.191***	0.305**
	(0.122)	(0.065)	(0.110))
Observations	33,100	30,811	10,627
Mother, child and HH controls	Yes	Yes	Yes

Note: *p<0.1; **p<0.05; ***p<0.01

Table C5 reports second-stage results for Equation (1) using narrower sub-samples reflecting heterogeneous family structure. Column (1) is for families where the woman's in-laws are household head, Column (2) is for families where the woman's husband is household head (and the small minority who are themselves household head), and Column (3) is for the remaining women who live with own-family members as household head.