# Measuring maternal autonomy and its effect on child nutrition in rural India

Wiji Arulampalam[*], Anjor Bhaskar[**] and Nisha Srivastava[***]

January 2024

[*]Corresponding author: Department of Economics, University of Warwick, Coventry, CV4 7AL, UK. Email: wiji.arulampalam@warwick.ac.uk. Tel: +44 (0)2476523471

[**]Azim Premji University, Bangalore, India. Email: anjorbhaskar@gmail.com

[***] Institute for Human Development, Delhi, India. nisha2000@ gmail.com

Acknowledgements: We are grateful to Marco Alfano, Laxmi Kant Dwivedi, James Fenske, Edwin Leuven, Neil Lloyd, Steve Pudney, Roland Rathelot, Mario Sanclemente, Chris Woodruff, and two anonymous referees for providing insightful comments. The paper has also benefited from comments from participants at various conferences and workshops: International Conference, Harvard University, Cambridge, USA; All India Labour Economics Conference, Udaipur; National Seminar held on the 12th Five Year Plan, University of Allahabad; the Giri Institute of Development Studies, Lucknow; 10th Annual Conference on Economic Growth and Development; as well as Economics Departments of: Aberdeen, CHSEO Oxford, UC3M Madrid, Oslo, HERC Oxford, Hull, Jaffna University (Sri Lanka), Manchester, Sheffield, Warwick and Azim Premji University. An earlier version of the paper was circulated under the title “Does greater autonomy among women provide the key to better child nutrition?". Financial support from the Economic and Social Research Council (grant number RES-238-25-0005: ESRC PATHFINDER RESEARCH PROJECTS: Women’s Autonomy and the Nutritional Status of Children in India) is gratefully acknowledged. We remain responsible for any remaining errors.

**Abstract**

This paper examines the link between a mother's autonomy - the freedom and ability to think, express, make decisions, and act independently - and the nutritional status of her children. We treat 'autonomy' as a latent variable and design a novel statistical framework to measure this. This method allows us to separate the direct associations of maternal and family characteristics in our model for nutrition, from their indirect associations that work through maternal autonomy. Using data from India, we explore the sensitivity of our estimates to endogeneity caused by sample selection in the presence of son preference. We find: (i) one standard deviation (SD) higher autonomy score is associated with a 0.16 SD higher Height-for-Age Z-scores (HAZ); and a (ii)10% lower prevalence of stunting (HAZ <-2 SD). The latter is equivalent to the prevention of approximately 300,000 children from stunting, indicating the important role of maternal autonomy.

Keywords: *Endogenous Selection; Latent Factor Models; Maternal Autonomy; Indian National Family Health Survey; Son preference.*

*JEL Classification*: I15, I14, C38

## 1. Introduction

In addition to playing a pivotal role in increasing child mortality, poor nutrition in childhood causes irreversible damage to cognitive development and future health (Dreze, (2004), Sumner, *et al.*, (2009); Saxena, (2018); Victora, *et al.*, (2008)). Child undernutrition is also strongly associated with shorter adult height, less schooling, reduced economic productivity, lower adult body-mass index, and mental illness (see Victora, *et al.*, (2008) for a systematic review). Thus, the importance of good nutrition during childhood cannot be emphasised enough. Recognising this, the Government of India introduced the Integrated Child Development Services (ICDS) Scheme as far back as 1975 in select blocks (administrative units) in the country. The scheme was eventually expanded to all administrative blocks in the country. In 2014-215, the Government of India had budgeted nearly Rs. 181.95 billion to run the scheme through its 1.346 million Anganwadi (Mother and Childcare) Centres across all villages and towns of India.[1] The budget allocated for the scheme increased to around Rs. 205.5 billion for the year 2023-24 (£1.94 billion).[2] These Centres provide a vast range of health and nutrition services to children, adolescents, and pregnant and lactating women. Yet, despite the massive spread of the policy and the huge investments in it, child undernutrition has been stubbornly high in India. India contributes to a third of the global burden of childhood stunting (a measure of chronic undernutrition).[3]

Given the importance of proper child nutrition and the persistence of high levels of undernutrition in India, various studies in recent decades have attempted to understand

---

1 Data obtained from the website of the Ministry of Women and Child Development, Government of India (http://icds-wcd.nic.in/icds.aspx) – accessed 09 March 2023.

2 Data obtained from the Union Budget, Government of India, Demand for Grants, Demand No. 101 (https://www.indiabudget.gov.in/doc/eb/sbe101.pdf) – accessed 20th April, 2023

3 https://www.unicef.org/india/what-we-do/stop-stunting accessed 10th March 2023.

the proximate and underlying factors relevant to child nutrition. These studies have helped identify various factors which are crucial for child nutrition (exclusive breastfeeding in the first six months, maternal health etc.) and have also contributed to policymaking. The focus of this paper, however, is on one factor whose relationship with nutrition is less understood in the literature - the role of maternal autonomy. In doing so, we need to overcome two important econometric challenges, which we discuss next.

The first challenge is how to define and measure autonomy. The term autonomy has often been confused with empowerment, though the latter is a process and the former the outcome (at least partly) of the process. We specifically focus on the outcome. Many different definitions and measurements exist in the literature. One strand of the literature assumes that 'autonomy' is a directly observed trait and measures it using an arithmetic average of binary answers to a set of questions that are elicited by surveys (Jensen and Oster, (2009), Paul and Saha (2022)), or the answers to these questions directly in the equation (Dancer and Rammohan (2009), Imal, et al. (2014)).[4] [5] For instance, Paul and Saha (2022) define 'autonomy' to be low/medium/high based on the values of the sum of dichotomous variables defined over nine different answers. Another strand of the literature uses definable and easily measurable variables such as education and health (for example, see Imai, et al (2014)) as proxies for autonomy. In the same vein, Chilinda and Wahlqvist, *et al.*, (2021) use a composite score to capture decision-making power,

---

4 Some but not all, of the questions that are used by Jensen and Oster (2009), are similar to the ones we use in this study although the surveys are different. In contrast to our approach, the authors use Autonomy as an *observable* variable and measure it using the average of answers given to six questions/measurements with some overlap with our measures. Unlike our method, all answers were equally weighted in the construction of the index. Also, see the replication study by Iversen and Palmer-Jones (2014) and the response by Jensen and Oster (2014). See Iversen and Palmer-Jones (2015) for the reply to Jensen and Oster (2014).

5 This is similar to the literature which assumes test scores measure unobserved ability (see for example, Heckman et al. (2006)).

tolerance of domestic violence, and financial independence as a proxy for maternal autonomy. Yet another strand of the literature, which is more related to what we do, assumes that the autonomy trait is essentially not observable and the answers to a set of questions (to be listed later), give you some proxy mismeasured information about autonomy and uses principal component analysis to construct/extract a measure of 'autonomy' (Chakraborty and De (2011)).[6]

In this paper, we build on the last approach (from the ones mentioned above) which assumes that autonomy is an underlying latent trait which cannot be observed directly (like traits such as confidence or empathy) but expresses itself in how one thinks and acts. We create an index of 'autonomy' based on the following: (i) autonomy *expresses* itself in several ways, such as: having decision-making power, mobility, and command and control over resources; (ii) socio-economic factors play a role in enabling women to exercise autonomy. These factors can be captured through indicators such as the level of education and occupation of the woman and her husband, the woman's caste, religion, age, exposure to media, region, etc. (iii) autonomy is an unobserved trait that is fixed in the short term, and the answers given to the set of questions are *fallible measures* of autonomy. We use Bayesian Shrinkage methods (Goldstein, (2003)) within a latent factor model, to create an index of autonomy which controls for relevant socio-economic factors. Our approach, which is new to this literature, allows us to separate the direct associations of maternal and family characteristics in our model for nutrition, from their indirect associations that work through maternal autonomy.

---

[6] Principal component analysis (PCA) is another data dimension reduction technique similar to what we use, and the first component is a linear combination of the observed data (measurements) and this explains the largest variation in the observed measurements. Results from this and other methods of constructing an autonomy index are provided in Appendix 2.

The second major challenge is how to deal with possible biases due to the endogenous sex composition of children in the sample and the observed birth intervals (Yamaguchi, (1989)). The prevalence of 'son preference' in India can manifest itself in differences in nutritional status across children with similar backgrounds (Barcellos et al. (2014), Jayachandran and Kuziemko (2011)). If a family sex-selects the second and subsequent children by using prenatal sex selection, even the nutritional status of the firstborn will be affected by the presence of subsequent children in this family.[7] To mitigate this bias, our preferred model restricts our analysis to firstborns, and we check for sensitivity of our results to the different age compositions of these children used in the analysis.[8] [9]

Our sample comes from the third round of the National Family Health Survey (NFHS3, 2005-06) (IIPS and Macro International, (2007a)). The survey provides information on the three commonly used anthropometric indicators of the nutritional status of children: Height for Age Z-score (HAZ score), Weight for Height Z-score (WHZ score) and Weight for Age Z-score (WAZ score).[10] [11] The survey indicates that 48% of

---

7 Information on nutritional status of children is usually collected for children born in the last 3 or 5 years of the survey.

8 For example, Hu and Schlosser (2015) present some indirect evidence of possible pre-natal sex selection in India.

9 Barcellos et al (2014) use the *first round* (1992) of the same data source (NFHS-1) as ours, to look at the effect of child sex on parental investments to avoid the issues related to sex selective abortions. Since it is assumed that there is no prenatal sex selection in the early '90s, their concern was regarding families possibly following a male-biased stopping rule. They address this by selecting a sample of last born children aged less than 15 months at the time of the interview, assuming that the family has not had time to react to the sex composition of the existing children.

10 The Z scores are the number of standard deviations above or below a set of standard deviation-derived growth reference curves by the Centre for Disease Control obtained from a reference population from the U. S. National Centre for Health Statistics, as recommended by the WHO (2006). The recommendations are based on evidence that differences in "unconstrained growth" across children of different ethnic and racial background, socioeconomic status and feeding, are so minor for children under 5 years of age that it is appropriate to use a common reference.

11 Children with a HAZ (WHZ, WAZ) score less than -2 std deviation are classified as stunted (wasted, underweight). Each index provides different information about the growth of a child. The HAZ score provides information about long-term nutritional status; it does not vary according to recent dietary intake. The WHZ score is an indicator of current nutritional status; a low WHZ score can indicate recent

children under 5 years of age in India are chronically malnourished (i.e., stunted); 43% are underweight; and 20% are acutely malnourished (i.e., wasted) (IIPS and Macro International, (2007a, 2007b)). These figures are extremely high since statistically, one would expect about 2-3% of the population of children aged less than five, to fall in the range below -2SD.[12]

Our main results indicate that our autonomy index is a positive and significant predictor of better nutrition among rural children.[13] Among the sample of firstborn children aged less than 18 months, the estimated association is positive and significant in the long-term child nutrition (i.e., HAZ score) equation, and negative on the probability of the child being stunted.[14] Based on these magnitudes, a back-of-the-envelope calculation indicates that a one-standard-deviation (SD) higher autonomy score is associated with a 10% lower (0.3 million) number of stunted children among the firstborns (2.1 million) (30.5% to 27.3%).[15] These numbers indicate the important role of maternal autonomy in child nutrition. We do not find any differential effects of autonomy by sex of the child.

The paper is organized as follows: the next section discusses the relevant literature for India. Discussions on the data and sample selected are in Section 3. Section 4 sets out

inadequate food intake, or a recent episode of illness. The WAZ score, which reflects body mass relative to chronological age, is a composite indicator.

12 Even in the latest NFHS-5 survey (2019-21), the percentage of children under 5 years of age stunted (wasted) is still high at 36% (19%).

13 Quality of education, dietary habits, access to nutrition, the concept of autonomy, etc., vary widely between rural and urban areas and hence pooling the sample for analysis does not make sense. Hence, we have chosen to focus on rural women in this paper. 61% of our sample of women reside in an area classified as rural. Results using the urban sample are provided in Appendix 3 Tables A3 & A4 for comparison, but the focus here is on the rural sample estimates.

14 The results are very similar when we select the sample of firstborns born after 2003 where the interviews were held during 2005 and 2006 (see Table 5 – Panel [3] Columns (1) and (2)). Essentially, this method also restricts the sample to younger children less than 24 months.

15 The autonomy index is normalised to have zero mean and unit variance.

the methodology, while Section 5 provides some sample descriptive statistics. Section 6 presents the main results and addresses the issue of sample selection in the presence of son preference. Final section 7 presents the summary and conclusions.

## 2. Overview of the literature

One of the earliest studies by Dyson and Moore (1983) on kinship structures and women's autonomy, defined autonomy as the capacity to obtain information and make decisions about one's private concerns and those of one's intimates. In a similar vein, Safilios-Rothschild (1982) in the context of demographic change in the third world, defines autonomy as 'the ability to influence and control one's personal environment'. The essential elements of autonomy - namely the ability and capacity to make decisions in a way that can influence one's environment - are reflected in other definitions, such as that by Jejeebhoy (2000), according to whom, autonomy is the "extent to which women exert control over their own lives within the families in which they live at a given point of time." As stated by Agarwala and Lynch (2006), "These definitions assert a single construct that captures the multifaceted ability to gain control over the circumstances of one's life."[16]

The nutritional status of a child is strongly related to the characteristics of the mother, as many studies have shown. Mother's education is associated with child survival (Murthi, *et al.,* (1995); Cleland, (2010)), and the nutritional status of a child (Borooah, (2004); Frost, *et al.,* (2005)). Mother's health is also reflected in health outcomes for children. At birth, one-third of Indian infants are underweight, and 20% are stunted

[16] For other definitions, see for example Caldwell (1986) who defines opportunities for women to receive an education and work outside the home to proxy autonomy, while Mason (1986) uses control over household and societal resources to the same purpose.

because of poor intrauterine growth (Mamidi, *et al.*, (2011); Ramachandran and Gopalan, (2011)). Using the Indian National Family Health Survey Round 4, Paul and Saha (2022) find autonomy to be significantly associated with lower odds of a child being malnourished. Rahman, Saima and Goni (2015) use the Bangladesh 2011 Demographic and Health Survey to find that children of mothers who are engaged in decision-making in the household are less likely to be undernourished. Carlson, *et al.,* (2015), review some of the current literature on the relationship between maternal autonomy, children's nutritional status, and child-feeding practices. The authors conclude that while enhancing maternal autonomy is important for improving children's nutritional status, gaps in the current knowledge exist that are confounded by complexities of how autonomy is measured.

In summary, autonomy has intrinsic relevance for a woman's own well-being and also contributes to enhancing the quality of life for the family. It determines largely her ability to make effective choices and to exercise control over her life. While most studies have looked at readily definable and easily measurable variables to proxy for autonomy, this paper treats 'autonomy' as a latent trait that is fixed in the short-run and only fallible measures of this trait are available to researchers.

## 3. Data and the sample

The data are from the third round of the National Family Health Survey (NFHS-3) for India, 2005, which is part of the Demographic and Health Survey (DHS). DHS surveys collect extensive information on population, health, and nutrition, with an emphasis on women and young children. In addition, the data contain information concerning household decision-making, as well as answers to some questions relating to the "autonomy" status of surveyed women.[17]

The NFHS-3 interviewed over 230,000 women (aged 15-49) and men (aged 15-54) from 29 Indian states, during the period December 2005 to August 2006 (IIPS, 2007a). All children aged less than 60 months and living in the household at the time of the survey, were weighed, and their heights were measured.

We select our sample based on the following criteria: (i) currently married women who are 'usual' residents and living in an area classified as rural; (ii) mothers who had at least one surviving child born in the past 60 months; (iii) had non-missing values for the main variables of interest. We keep our autonomy index fixed over our different sample cuts in the estimations of the nutrition equation. All our estimations account for the clustering of the error variance at the primary sample units.

[17] Currently, five rounds of the National Family Health Survey (NFHS) are available for India. These are: NFHS1 (1992-93), NFHS2 (1998-99), NFHS3 (2005-06), NFHS4 (2015-16), and NFHS5 (2019-21). The data collection for the latest round of the survey (NFHS5) was interrupted during the Covid pandemic and and was only released for public access in July 2022. In this paper, we make use of data from NFHS3 (2005-06). This is primarily because access to NFHS4 only became available in 2018 after we had completed a significant part of our analysis. Although the main part of the questionnaires is similar across the NFHS3 and the NFHS4, there are slight differences - in particular, the sample selected for the empowerment questions and the questions asked, are different. We comment on the benefits and costs to using NFHS3 against NFHS4, in the final section of the paper.

## 4. Empirical Models

We begin this section with a discussion of how we model the presence of 'autonomy' in the nutrition equation and then discuss how we estimate the autonomy index which is treated as a latent unobserved characteristic.

### *4.1 Nutritional status*

We focus on two outcome variables: Height-for-Age Zscore (HAZ) and 'stunted', which indicate long-term nutritional status. 'Stunted' is a binary indicator for HAZ less than -2 according to the WHO definition. All children in the family who were aged less than 60 months at the time of the interview, and who had valid measurements for these variables, form the main sample.

All equations are specified as a linear regression model and estimated by OLS. All reported standard errors are bootstrapped.[18]

The equation for the measure of nutritional status *y* (HAZ and Stunted) for child *k* of mother *i* is specified as:

$$y_{ik} = x_{ik}^{'}\beta + z_i^{'}\gamma + \delta a_i + \varepsilon_{ik} \qquad i=1,..,n \text{ and } k=1,..,K \qquad (1)$$

$a_i$ is the mother's autonomy trait which we assume to be *unobserved*. $x_{ik}$ contains child-specific characteristics: age in months and indicators for sex and whether the child is a twin. $z_i$ contains the variables associated with mother *i* in her family, and hence also contains her partner's, and her family characteristics. More specifically, the characteristics included are as follows: (i) mother-level variables: age, education, caste,

[18] Reported standard errors are bootstrapped to account for the fact that the autonomy measure is a 'generated regressor'. We chose to use a linear-probability model instead of either a logit or a probit because of the generated regressor issue in the specification as it does not make sense to calculate bootstrapped standard errors when the model specification is fully parametric. The average partial effect associated with maternal autonomy in the logit was very similar to the one obtained from ordinary-least-squares.

religion, occupation, employment status in the last 12 months, some exposure to common media; (ii) father-level variables: education and occupation; and (iii) family-level variables: whether it is a nuclear family, household wealth index factor score[19], and the State of residence.

The challenge here is to obtain a consistent estimator of equation (1) coefficients, where the parameter of interest is $\delta$. Covariates that are correlated with the equation error term, for whatever reasons, will be 'endogenous' in the estimation equation. The question is what is the reason for the correlation? One of the reasons for this correlation could be the existence of `son-preference', which will make the observed sex composition and birth intervals endogenous and hence the sample used in the estimation becomes crucial. We attempt to mitigate this by selecting the sample of firstborns who are aged<18 months as our preferred specification. See Section 6 for further discussions on the issue of how 'son-preference' may affect the observed sex composition of children and the observed birth intervals in the sample, and on the discussion of sensitivity to different choices of the sample. Generally, the lower the chances of including a firstborn who has another sibling in the family, the lower the chances that the OLS estimator is biased and inconsistent.

We next discuss how we proceed with the measurement and the generation of the autonomy measure ($a_i$).

---

[19] Provided with the dataset.

### 4.2 *Defining and measuring maternal autonomy*

Based on the literature, we choose the answers given to the following questions in the NFHS as indicative of a woman's "*autonomy*" to think, speak, decide, and act independently.[20]

The following responses, categorised in terms of the three dimensions we consider, are all coded as binary indicators.

<u>Related to Physical Autonomy</u>: The woman is allowed to go <u>alone</u> to (i) the market (m1), (ii) the health clinic (m2), and (iii) places outside the community (m3).

<u>Related to Decision Making Autonomy</u>: The woman decides <u>alone</u> on purchases for daily needs (m4); Woman decides <u>alone</u> or <u>jointly</u> with her husband on (i) her own health care (m5), (ii) large household purchases (m6), (iii) when they could visit family and friends (m7), and what to do with husband's money (m8).

<u>Responses Related to Economic Autonomy</u>: The woman has money of her own that she can decide how to spend (m9).

We let the data tell us about the importance of the differential role of autonomy on different dimensions by using a latent factor model.[21] Since all measurements $m_j$ ($j$=1,.,9) are binary, we use a logit model, specifying for woman $i$ (conditional on her autonomy trait $a_i$) as:

$$Pr\,o\,b(m_{ij} = 1|\eta_i) = \Delta(\mu_j + \lambda_j a_i) \quad (2)$$

---

[20] We experimented with many more measurements and found the additional measures did not significantly add to the estimation of the autonomy index. The ranking of mothers in terms of their estimated autonomy status did not change with the addition of other measures.

[21] Results from the estimation of our preferred model using commonly used measures of autonomy are provided in Appendix 2.

and $a_i \sim N(\theta' s_i, \sigma_a^2)$ (3)

$\Delta$ is the logistic distribution function, and $\mu_j$ and $\lambda_j$ are the intercepts and factor loadings for measurement *j* respectively, in (2).

Unlike in the literature, we control for maternal and family characteristics and enabling factors by allowing the trait to be correlated with a set of characteristics via the specification of *s* in (3). i.e. the mean of the distribution of *a* is allowed to be dependent on a set of characteristics relevant for woman *i*. These are the characteristics of the woman (age, caste, religion, education, occupation, employment status in the last 12 months, type of media exposure), her partner (education and occupation), and family (nuclear family, household wealth index factor scores and the State of residence). Taking education as an example, the above specification (3) allows, on average, the autonomy trait to be different between women with different levels of education, *ceteris paribus*.

We impose the normalisation that the first loading is 1 in (2) for identification. The Model given by equations (2) and (3) is jointly estimated using maximum likelihood methods. We then use the estimated posterior conditional mean (Empirical Bayes) $E(a_i|\text{data})$ of the latent variable $a_i$, to construct our index of autonomy for every woman in the sample.[22]

In the language of Item Response Theory (IRT) (Carlson and von Davier (2013)), the intercepts $\mu_j$ are called the item "difficulty" and factor loadings (i.e. slope coefficients) $\lambda_j$ are called item "discrimination". Comparing two intercepts, the smaller intercept

---

[22] This is the Bayesian shrinkage estimator, see Goldstein (2003), which can be used for estimating unobserved individual specific heterogeneity (Train, 2009: Chapter 11) within a random-effects model specification. Simply put, this estimator is

$$E\left(a \mid m_1,\ldots,m_9\right) = \int a \; f(a \mid m_1,\ldots,m_9)\,da = \frac{\int a \; f(m_1,\ldots,m_9 \mid a)\, f(a)\,da}{f(m_1,\ldots,m_9)}.$$

implies a lower probability of saying yes to that question relative to the other one. In terms of the factor loadings, the probability of saying yes to the measurement that has a larger slope (factor loading) will be more sensitive to small changes in the autonomy trait compared to the one with the lower slope and hence measurements with higher slope coefficients are said to be more discriminatory. Hence (i) a larger intercept implies that women are more autonomous in this dimension, in general; (ii) the larger the slope, the better would be the measurement in distinguishing autonomy traits between different women. In our model, even a small change in the autonomy index will be associated with a larger probability of the response to the autonomy question being positive. It is important to account for the differential role of autonomy in different dimensions.

The main advantage of our approach is that we are able to separate the direct associations of maternal and family characteristics in our model for nutrition conditional on 'autonomy', from their indirect associations that work through maternal autonomy. For identification of these separate effects, we do not require any additional variables as our index is a non-linear function of the variables s in the equation. Including additional variables provides extra variation in the index without relying on functional form for identification. This is similar to the issues in the 2-step Heckman method for correcting for sample selection. We, therefore, include an additional variable that measures the age difference between the partners. The assumption is that this variable only affects the nutritional outcome of children via *a (the index of autonomy)*, and conditional on *a*, it is uncorrelated with the equation error term in (1). Findings from the literature generally support the idea that a smaller age gap is associated with greater autonomy (Hogan, et al. (1999), Magali et al., (2005), and Sharma, et al., (2021)).[23]

## 5. Descriptive statistics of the variables

The anthropometric information was collected on surviving children who were under 5 years old at the time of the interview. In the interest of space, we provide descriptive information for the main outcome variables and some child characteristics in Table 1. The full list of summary statistics of all the variables is in Appendix 1 Table A1, which also contains the full set of estimation results. The sample consists of rural women who had at least one child aged<60 months at the time of the interview and had non-missing values for the nutritional status variables.

***Child Characteristics***: As per Panel [1] of Table 1, 48% of children are female children. The average age of children in the main sample is 30 months, and 53% are either first or second-born. It is interesting to note that around half of the births were after 2-3 years of the previous birth. There are two possible explanations for this: either the births are properly spaced, or some families are engaged in pre-natal sex selection. We will come back to this issue when we discuss the results in Section 6.

***Nutritional status variables***: Summary statistics for the nutritional status variables are in Panel [2] of Table 1. 48% of children are stunted according to the WHO definition. This is very large compared to the predicted proportion of children who would be classified as stunted according to the WHO distribution. The HAZ scores, the smoothed

---

[23] The expectation is that the larger the age difference between the partners, the lower the autonomy of the wife *ceteris paribus* because the husband will be able to influence decisions more easily (Sharma et. al., (2021)). A smaller age gap has also been shown to be related to greater women's autonomy as it facilitates spousal communication and increases the woman's participation in reproductive decisions (Hogan et al., (1999)). Similarly, Magali et al. (2005) find that lower spousal age difference is associated with a higher probability of using contraception which is indicative of higher woman's autonomy.

HAZ score by age in months, and the probability of being stunted by age are provided in Figures 1 to 3 respectively. Three points are noteworthy here. First, the distribution of HAZ is shifted to the left relative to the WHO distributions. Second, HAZ scores deteriorate with age but stabilise after the child reaches approximately 24 months. Third, the proportion of children classified as stunted also rapidly increases with age till the age of about 36 months.

***Autonomy measurements:*** As shown in Panel [3] of Table 1, the sample average score created by summing all the means of the autonomy-related measures is only 4.24. That is, on average, rural women only have autonomy in four dimensions. The frequency distribution of the summed score is provided in Table 2. Around 8% of women do not have any autonomy at all according to our chosen measurements. Only a very small proportion of women (2.2%) are recorded saying that they have full autonomy based on the answers to the selected questions.

***Variable only in the autonomy equation* (*3*) – s:** 41% of the women are married to a man who is at least 6 years older than her (Panel [4]).

## 6. Results

### *6.1 Autonomy index*

In the interest of space, we focus on the coefficient estimates of equation (2) which are provided in Table 3. The rest of the results are provided in Appendix 1 Table A1.

The factor loading related to whether the woman is allowed to go to the market alone is normalized to 1, for identification.[24] As shown in Table 3, the decision-making

---

[24] We normalise on this factor loading since we expect autonomy to have a non-zero effect on this measurement.

measurements have high discriminatory power individually, relative to the reference category (i.e., they have a factor loading that is larger than 1). A higher factor loading indicates that a small difference in the autonomy trait is associated with a larger change in the probability of saying "yes" to these questions relative to other measurements.

The "reliability" measure calculated as the proportion of variance explained by the autonomy index in the total variation of the measures (m1-m9) *individually* is provided in Table 3.[25] The latent autonomy trait is estimated to explain more than 60% of the variations in the observed measure related to whether the woman has a role in the decisions concerning large household purchases, and visiting family and friends; the latent autonomy trait also explains over 40% of the variation in the woman's participation in decisions regarding her own health care. Unequal factor loadings estimated in this model reiterate the importance of allowing for different dimensions of autonomy to play different roles in the construction of the autonomy index; thus, they illustrate why an index derived by simply averaging the measures might be problematic.

### ***6.2 Choice of the estimation sample***

In order to facilitate the discussion of selecting the appropriate sample to address the possible issue of 'son preference', we first provide some relevant summary statistics in Table 4.

We first discuss how best to mitigate the effect of 'son preference' possibly biasing our estimator. As discussed in the Introduction, son preference is likely to lead to differential care and feeding practices, and hence to differential nutritional outcomes.

[25] In our model, this is given by $\hat{\lambda}_j^2 * \hat{\sigma}_a^2 / [\hat{\lambda}_j^2 * \hat{\sigma}_a^2 + v\hat{a}r(psu - level\ unobservable) + \pi^2/3]$ - see equation (2). A specific measurement with a larger 'reliability' measure is able to explain larger proportion of the variability in the observed pattern of answers to that specific question across the women relative to another measurement with a smaller reliability measure.

That is, nutritional outcomes can depend significantly not only upon the sex of the child, but also upon the sex composition of existing children, and how this compares with parents' desired number of boys and girls.

There are two ways in which son preference may cause our sample to be endogenously selected. First, son preference may lead to sex-selective abortion and hence may lead to a lower proportion of girls at birth. Second, son preference is likely to have an impact on birth intervals and fertility choices. Parents may use a stopping rule for their fertility choice that depends on the number of girls and boys they already have (Barcellos et. al. 2014). Additionally, the birth intervals between children also might depend on the sex of the previous child if the mother tries to conceive faster in the hope of having a boy after a girl (Jayachandran and Kuziemko, 2011). Both these practices would imply that the number and sex of children in the sample are not randomly determined but depend upon various other observed and unobserved factors that may have been omitted from the specification - thereby causing the OLS estimator to be biased and inconsistent.[26]

While son preference could lead to sex-selective abortion of pregnancies at all birth orders, the likelihood of sex-selective abortion is negligible in first-order pregnancies but increases with higher-order pregnancies (Saikia et al. (2021)). Jha et. al (2006) also use data from 1.1 million Indian Households and find evidence of sex-selective abortion for second and higher-order births but no clear evidence for first-order births. Apart from being an emotional decision, childbirth is often a social and economic decision as well. Son preference also means that households may desire at least one or two male children.

[26] The survey collected information on what the ideal number of boys and girls the woman would like to have. We created a binary indicator for women who stated that they preferred a higher number of boys than girls. We do not report results with this variable included because of the possibility of this variable being highly correlated to the number of children already in the family and their sex composition.

If there are resource constraints for raising children, they may have to limit the number of children they can have to two or three children. This is what often leads to sex-selective abortions. If the first child is a girl, families often still have the hope that the second or the third child will be a boy. But if the second child also turns out to be a girl, families may not wish to spend additional resources on raising a child they do not desire. Instead, they may choose to abort the foetus in the hope that the next child will be a boy. This leads to a higher probability of sex selection among higher-order births.

The data on nutrition were collected for children born within the last five years at the time of the interview and currently alive. In Table 4, we provide some descriptive statistics on the characteristics of the children observed in terms of age, birth order, and year-of-birth, to help us with the selection of the sample for the estimation.

To shed some light on possible sex selection through abortion of female foetuses, we first look at the number of children born to the mothers in our sample. 69% of mothers had only one child born during this time interval and 97% of mothers only contributed one or two observations to the sample (Panel [1]). Among all children, except for the firstborns, the sex imbalance is exacerbated (Panel [2]).

The other issue (i.e., son preference affecting birth spacing, stopping rules, and care and feeding practices) is more complicated. If the firstborn is a girl, the family may try to conceive sooner in the hope of having a boy. This would reduce the amount of time that the child can receive undivided care and attention (especially, breast milk) (Jayachandran and Kuziemko, 2011). Therefore, the nutritional status of the firstborn may depend upon the parents' attitude (i.e., their son preference) as well as upon the birth interval, and the sex of the second child.

Panel [3] of Table 4 describes how many firstborn children were observed with a second-born by the birth year of the firstborn. We find that 35% (2,252 out of 6,434) of firstborns have a second sibling in the sample. As one would expect, the older the firstborn at the interview time, the higher the chances of observing a second child in the sample. Since this pattern is dictated by the birth intervals, selecting a sample of firstborns without a sibling [Panel [6]), will not deal with the problem of endogeneity caused by son preference as discussed earlier. This can be illustrated with an example. If the first child is a girl, the mother may have the second child quickly in the hope of having a boy. On the other hand, if the first child is a boy, the woman may delay the second pregnancy to allow the boy to receive full care and attention. Thus, if we use this criterion, i.e., firstborns without a sibling, *boys* may have a higher probability of inclusion into the sample (Panel [3]). We, therefore, need an additional criterion to restrict the sample of firstborns, either in terms of the birth year or in terms of the child's age.

In Panels [4] and [5], we provide the breakdown of the age of all firstborns and those born after 2004, respectively, as some may feel that a calendar-year-based criterion is likely to suffer less from endogenous selection bias. We focus on the year 2004 as the interviews took place in 2005 and 2006. As we compare these two panels, we find the majority of the firstborns aged less than 18 months were born in 2005 or 2006. The chance of finding a younger sibling becomes higher as we increase the calendar time interval (say choose 2003 instead of 2004).[27]

[27] Barcellos et. al (2014) select a sample of last-born children less than 15 months from the first round of the same survey, arguing that this will ensure that "*the parents have not had a chance to respond to the gender of the last child by having more children (Barcellos, et. al* (*2014*): *pp 187*). Since our sample is drawn from a later round of the same survey, we are not able to assume that pre-natal diagnostic tools were not widely available during the period covered by our data.

An additional issue we will have to consider is whether there has been any child death in the family. If a child had died in a family because of severe malnutrition, then the sample of surviving children for whom we have valid nutritional information is endogenously selected. 6% of the mothers in the original sample had experienced a child death (Table 1). However, in the sample of firstborns aged less than 18 months, only 3 mothers had experienced a child death. We do not expect this to be a problem.

In summary, based on the discussions above, our preferred specification is the one that restricts our sample to those firstborns who are aged less than 18 months, i.e., who are young enough that they are not very likely to be affected by the birth (and hence sex) of the second child. We have chosen to restrict our sample in this way rather than choosing the eldest children without a younger sibling because the choice of the "only child" as a sample group will lead to endogenous selection if the mother conceives sooner after a girl (Barcellos et al., 2014). We also provide estimates based on the other sample selections as discussed in this section.

### *6.3 Nutritional status*

We next summarize the estimates of the parameter of interest – the coefficient of our autonomy variable, by different cuts of the sample used in the estimations, in Table 5. As discussed in the Introduction, the HAZ score measures the long-term nutritional status of the child. An additional interaction term between the autonomy variable and a girl child was included in the model to assess whether female children benefit more than male children when the mother is more "autonomous", ceteris paribus. However, the interaction term was insignificant in all the regression models reported in Table 5.

The most important finding is that, in general, maternal autonomy is a significant positive predictor of better HAZ, and a negative one of stunting. We defer discussions on the magnitudes of these estimates until later in this section and summarise the main results here.

(i) The Autonomy index coefficient is not significant in the HAZ model estimated using all children aged 0-59 months, regardless of whether the sample contains all children or only the firstborn (Panel [1]). As discussed, however, the estimator of the coefficients for this sample may be biased because the sex composition of children in this sample may suffer from endogeneity acting through 'son preference'.

(ii) In terms of the firstborn sample, a one SD higher autonomy score is estimated to be associated with about 0.16 higher HAZ score, depending on how we cut the sample (column (1) of Panels [2] and [3] and [3], and column (3) of Panel [2]. When we focus only on the firstborns in terms of their age (our preferred sample), the longer the observation period (15 months vs 18 months), the higher the chances of another younger child in the family. However, these estimates are similar to whether we select the firstborns in terms of their age at the time of the interview (age<15 or age<18) or in terms of the birth year being greater than 2004. All three of these sample selections are used to reduce the probability of another younger sibling in the family (Table 4, Panel [3]). In all three samples, the estimated effect of 1 SD increase in women's autonomy index on the child's HAZ score is around 0.16 and is significantly different from zero.

(iii) We next turn to the results presented in Panel [3] Column (3), where we focus on the firstborns but without a sibling. The estimations carried out using this may suffer from 'endogenous' selection due to the reasons discussed earlier in this section. The estimated coefficient of the autonomy variable is not significant.

(iv) The association between women's autonomy and child stunting is generally significant - ranging from an estimate of -0.01 to around -0.03. In particular, among the firstborn children aged under 18 months (or <15 months or born after 2004), the predicted probability of stunting when we shift our autonomy index by +1 SD is generally significant and lower by about 0.03 points (Panel [2] Columns (2) and (4), and Panel [3] Column (2)). The model estimated using a logit specification using the sample of firstborns aged <18 months, produced an estimated average partial effect for this 'autonomy index of -0.034.

We, therefore, conclude that there is a positive association between the long-term nutritional status of the firstborn and maternal autonomy.

It is well known that the first two years of life are the most important "window of opportunity" to make a long-term impact on children's nutritional status (UNICEF, 2013), and their lifelong health and well-being. Thus, the finding that more autonomous mothers can contribute to better health for their children specifically during this key window of time is very crucial for policy purposes.

### ***6.4 Interpretation of the magnitude of the coefficient of autonomy***

We next turn to the interpretation of the estimated coefficients of autonomy in the HAZ score, and the probability of stunting. As seen in Figures 1 to 3, relative to the HAZ scores of children younger than 6 months of age, the HAZ scores of older children become worse as they grow older; the probability of being stunted increases as well. These findings are reiterated in Table 6 (Model results same as Table 5 Panel [2] columns (3) and (4)) where we report a few coefficient estimates for the specification that uses a sample of firstborns aged under 18 months. A 6-11-month-old child is estimated to have a HAZ score of about 0.3 SD lower than that of a child aged less than 6 months, *ceteris paribus*. This deteriorates even more for a child who is between 12 and 17 months old. The observed average HAZ score and the proportion who are classified as stunted, for our sample of firstborns aged less than 18 months, are -1.15 (SD 1.72) and 0.31, respectively. The estimated coefficient of the autonomy index for this sample is 0.161 (for HAZ) and -0.032 (for Stunting) (Table 6). Hence, one SD higher (relative to the mean of 0) autonomy index is associated with a higher HAZ score of 0.09 (0.161 divided by 1.72) giving a new HAZ score of -1.06 and a new probability of stunting of 0.28. In terms of the WHO distribution of HAZ scores, this is equivalent to a shift of a child from the $13^{th}$ to the $15^{th}$ percentile position. Interestingly, the effect of a change in +1 SD of our autonomy index both in our HAZ and in stunted regressions, is about half the age effect for 6-11-month-old children and about 15% for 12-17-month-old children, relative to those aged less than 6 months. An estimated 22 million children aged less than 18 months live in rural India (Census of India, 2011). Given the sample proportion (30%), this translates to an estimated 6.6 million firstborn children in this age group; among them, approximately 2.1 million children (30.5%) would be classified as stunted. A one SD higher autonomy is associated with 300,000 fewer cases of stunting among firstborn *children aged less than 18 months* (as evidenced by a decline from 30.5% of this population to 27.3%). As this group of children aged from under 5 months of age group to the 6-11 month age category, this level of increase in maternal autonomy would effectively halve the average deterioration in HAZ scores experienced.

## 7. <u>Summary and conclusions</u>

This paper has attempted to address two important econometric challenges when exploring the link between maternal 'autonomy' and child nutrition: (i) the definition and measurement of ‘maternal autonomy’, and (ii) the estimation of this link using a sample of children born that might be ‘endogenously’ selected due to ‘son preference’ in India.

In order to address the first challenge, we start with the distinction between ‘empowerment’ and autonomy, and the premise that maternal autonomy is a latent trait, and hence can only be inferred through measures that are impacted by autonomy, such as decision-making, freedom of movement etc. We then construct a measure of ‘autonomy’ allowing the data and the model to tell us how each measure or the relative extent to which autonomy is related to each measure. Unlike the models used in the literature, our methodology enables us to empirically assess the role of socio-economic factors such as the age difference between the husband and wife, the level of education, employment, caste, religion etc of the partners, in informing us of their relationship with autonomy. However, some of these factors are also likely to have a direct impact on nutrition – through their impact on the availability of food, environmental conditions, health and nutrition practices etc. Our methodology enables us to separate the direct associations of maternal and family characteristics in our model for nutrition, from their indirect associations that work through maternal autonomy.[28]

The second challenge was the possible endogenous selection of the sample of children used in the analysis, due to the existence of ‘son preference’ in India. We provide some sensitivity analysis to different selections of the estimation sample to address possible biases. Our preferred model estimates, therefore, restricts the sample to firstborns

[28] As shown in Appendix 2, not only the role of autonomy in child nutrition is different when different autonomy indexes are used in the analysis, but it is also the case that the relative positions of women in terms of the degrees of autonomy the woman has, changes depending on which measure one uses.

less than 18 months of age. The results are similar if we select the sample of firstborns less than 15 months of age or firstborns born after 2004.

We conclude that there is a positive association between the long-term nutritional status of the firstborn and maternal autonomy. The finding that more autonomous mothers have an important role specifically during this key window of time is very crucial for policy purposes.

While this paper establishes the links between maternal autonomy and the long-term nutritional status of children, it does not delve into the specific pathways which have been explored earlier.[29] Future research can utilise the proposed methodology to create an index of autonomy and to explore the impact and identify the effectiveness of various policies on women's autonomy. As this paper has argued, such policies would not only improve women's autonomy – a desirable outcome in itself – but also help to reduce persistently high levels of child undernutrition in India which acts via the effect on the mother's autonomy.

A limitation of the analyses presented here is the use of an earlier round of the survey – the NFHS3 (2005-06) instead of the NFHS4 (2015-16) (see footnote 17).[30] There were differences in the survey design, sample sizes, and the nature of questions asked across the two surveys.[31] For example, only 20% of women who were selected for the State module were surveyed regarding the questions on 'empowerment', which we use.

---

[29] See for eg, Durrant and Sathar (2000), and Dyson and Moore (1983)) for many pathways by which autonomy-related factors may influence child health outcomes.

[30] NFHS5 was disrupted by the Covid Pandemic which caused havoc across the country as regular programmes stopped functioning and state governments, local governments as well as civil society organisations evolved their own unique strategies to ensure food and nutrition security while trying to control the spread of the pandemic and the consequent mortalities. Further, these policies, programmes and interventions took place at varying points of time in the pandemic (and in the survey).

[31] See Supplement to: Johri M, et. al. (2021) for the differences in the sample design – Appendix 4 Section 1.1.

This does not mean that NFHS4 cannot be used for the analysis. Rapid technological advancement over the years would however require a complete rethinking of how one defines ‘women’s autonomy’.[32] However, we believe that our methodological approach is unique and provides another way to estimate an index of autonomy where the concept is difficult to measure precisely.

One of the benefits of using the NHFS3 is estimating a cleaner effect of the role of autonomy in shaping child nutrition, as not only new national and state-level policies have been introduced since the NFHS3 was conducted, but some of the old policies also have been scaled up or reformed. For instance, the Indian Parliament passed the National Food Security Act in 2013 which made 75% of the country’s population eligible for highly subsidized food grains and also implemented policies for the nutrition of children and women such as the Integrated Child Development Scheme and the Mid-Day-Meal Programme under the ambit of the law.[33] These programmes are likely to have varied and significant impacts on both women’s autonomy and children’s nutritional status. However, it is difficult to capture these impacts due to the unavailability of data and information on many of these measures, and to disentangle the effects of policies that affect autonomy from policies that were aimed to affect nutrition directly. It is important to note that, despite all the policies that have aimed to increase the levels of child nutrition, the levels of child nutrition are only getting better very slowly (footnote 12). Our paper

---

[32] Unsurprisingly, for example, the survey organisers felt that the question on decision-making regarding daily needs was not important anymore and was dropped in NFHS4. However, there were new questions that were added to capture the ‘autonomy/empowerment’ status of women.

[33] Example of another program is the Pradhan Mantri Surakshit Matritva Abhiyan. The objective of this program is to provide assured, comprehensive and quality antenatal care, free of cost, universally to all pregnant women on the 9th of every month. This was launched in mid-2016 during the survey data collection for the NFHS4.

shows that policies to enhance maternal autonomy will have a positive impact on child nutrition.

## References

Agarwala, R. and Lynch, S. M. 2006. Refining the measurement of women's autonomy: An international application of a multi-dimensional construct. *Social Forces* 84 (4): 2077–2098.

Magali, B. and Veronique, H., 2005. Age difference between spouses and contraceptive practice in sub-Saharan Africa. *Population*, *60*(5-6), pp.725-764.

Barcellos, S. H., Carvalho, L. S., and Lleras-Muney, A. 2014. Child Gender and Parental Investments in India: Are Boys and Girls Treated Differently? *American Economic Journal: Applied Economics*, 6 (1): 157-89.

Borooah, V. K. 2004. Gender bias among children in India in their diet and immunisation against disease. Social Science & Medicine. 58(9), 1719-31.

Caldwell, J. C. 1986. Routes to low mortality in poor countries. *Population Development Review*, 12, 171-220.

Carlson, J. E., & von Davier, M. 2013. Item response theory. ETS Research Report Series, 2013(2), i-69.

Carlson, G. J., Kordas, K. and Murray-Kolb LE. 2015. Associations between women's autonomy and child nutritional status: a review of the literature. *Maternal Child Nutrition.* Oct. 11(4), 452-82. doi: 10.1111/mcn.12113.

Census of India. 2011. Provisional Population Totals: Paper 1 of 2011 India Series 1. Office of the Registrar General and Census Commissioner, Government of India.

Chakraborty, T., and De, P. K. 2011. Mother's autonomy and child welfare: A new measure and some new evidence. IZA DP. 5438, January.

Chilinda, Z. B., Wahlqvist, M.L., Lee, MS. *et al.* 2021. Higher maternal autonomy is associated with reduced child stunting in Malawi. *Scientific Reports, Nature,* **11,** 3882. https://doi.org/10.1038/s41598-021-83346-2

Cleland, J. 2010. The benefits of educating women. *The Lancet*. 376 (9745), 933-934.

Dancer, D. and Rammohan, A. 2009. Maternal autonomy and child nutrition Evidence from rural Nepal. *Indian Growth and Development Review*, Vol. 2 No. 1, pp. 18-38.

Dreze, J. 2004. Democracy and the Right to Food. *Economic and Political Weekly*, April 24.

Durrant, V., and Sarthar, Z. (2000). Greater investments in children through women's empowerment: a key to demographic change in Pakistan? Policy Research Division Working Paper No. 137. New York, NY: Population Council.

Dyson, T., and Moore, M. 1983. On Kinship Structure, Female Autonomy, and Demographic Behavior in India. *Population and Development Review*. 9 (1), 35-60.

Frost, M. B., Forste. R, and Haas, D. W. 2005. Maternal education and child nutritional status in Bolivia: Finding the links. *Social Science and Medicine.* 60, 395-407.

Goldstein, H. 2003. Multilevel statistical models. 3rd Edition, Kendall's Library of Statistics 3, Arnold, London.

Hogan, D.P., Berhanu, B. and Hailemariam, A. (1999). Household organization, women's autonomy, and contraceptive behaviour in southern Ethiopia. *Studies in family planning*, 30(4), pp.302-314.

Heckman, J. J., Stixrud, J., and Urzua, S. 2006. The effects of cognitive and noncognitive abilities on labor market outcomes and social behaviour. *Journal of Labor Economics*. 24 (3). 411-482.

Hu, L., and Schlosser, A. 2015. Prenatal sex selection and girls' well-being: evidence from India. *Economic Journal*. 125 (587), 1227–1261.

Imai, K. S., Annim, S. K., Kulkarni, V. S., and Gaiha, R.. 2014. Women's Empowerment and Prevalence of Stunted and Underweight Children in Rural India. *World Development.* 62 (C), 88–105.

International Institute for Population Sciences (IIPS) and Macro International Inc. 2007a. National Family Health Surveys (NFHS-3), 2005-06: India: Volume I. Mumbai: IIPS. India.

International Institute for Population Sciences (IIPS) and Macro International. 2007b. National Family Health Survey (NFHS-3), 2005-06, India: Key Findings. Mumbai: IIPS, India.

International Institute for Population Sciences (IIPS) and ICF. 2017. National Family Health Survey (NFHS-4), 2015-16: Mumbai: IIPS, India.

International Institute for Population Sciences (IIPS) and ICF. 2021. National Family Health Survey (NFHS-5), 2019-21, Volume I. Mumbai: IIPS, India.

Iversen, V. and Palmer-Jones, R. 2014. TV, female empowerment and demographic change in rural India. International Initiative for Impact Evaluation. Replication Paper 2.

Iversen, V. and Palmer-Jones, R. 2015. More Heat than Light? Rejoinder to Jensen and Oster, and Ozler (April 24, 2015). Available at SSRN: https://ssrn.com/abstract=2598461 or http://dx.doi.org/10.2139/ssrn.2598461

Jayachandran, S., and Kuziemko, I. 2011. Why do mothers breastfeed girls less than boys? Evidence and implications for child health in India, *The Quarterly Journal of Economics,* Oxford University Press, 126, 1485-1538.

Jejeebhoy, S. 2000. Women's autonomy in rural India: its dimensions, determinants and the influence of context, in Harriet, P., Gita Sen Editors. *Women's Empowerment and Demographic Processes: Moving beyond Cairo*. Oxford University Press, Oxford, UK.

Jensen, R., and Oster, E. 2009. The Power of TV: Cable Television and Women's Status in India. *The Quarterly Journal of Economics.* 124 (3): 1057-1094.

Jensen, R., and Oster, E. 2014. Response to Iversen and Palmer-Jones. www.3ieimpact.org/media/filer_public/2014/06/07/jensen_oster_response.pdf. Accessed on 22nd Feb 2015.

Jha, P., Kumar, R., Vasa, P., Dhingra, N., Thiruchelvam, D. and Moineddin, R., 2006. Low male-to-female sex ratio of children born in India: national survey of 1· 1 million households. *The Lancet*, 367(9506), pp.211-218.

Johri, M., Rajpal, S., Subramanian SV. (2021). Progress in reaching unvaccinated (zero-dose) children in India, 1992–2016: a multilevel, geospatial analysis of repeated cross-sectional surveys. Supplement. *Lancet Glob Health*, 9: e1697–706. DOI:https://doi.org/10.1016/S2214-109X(21)00349-1 accessed 24 December 2023.

Mamidi, R. S., Shidhaye, P., Radhakrishna, K.V., Babu, K.V. , and Reddy, P. S. 2011. Pattern of Growth Faltering and Recovery in Under Five Children in India using WHO growth Standards – A study on first and third National Family Health Surveys. *Indian Paediatrics*, March 15, 1-6.

Mason, K. O. 1986. The status of women: conceptual and methodological issues in demographic studies. *Sociological Forum*, 1(2), 284-300.

Murthi, M., Guio, A-C., and Dreze, J. 1995. Mortality, fertility and gender-bias in India: A district level analysis. *Population and Development Review*, 21(4), 745-782.

Paul, P., and Saha, R. 2022. Is maternal autonomy associated with child nutritional status? Evidence from a cross-sectional study in India, accessed from https://doi.org/10.1371/journal.pone.0268126.

Rahman, M.M., Saima, U. and Goni, M.A., 2015. Impact of maternal household decision-making autonomy on child nutritional status in Bangladesh. *Asia Pacific Journal of Public Health*, 27(5), pp.509-520.

Ramachandran, P., and Gopalan, H. S. 2011. Assessment of nutritional status in Indian preschool children using the WHO 2006 growth standards. *Indian Journal of Medical Research*, 134 (1), 47–53.

Safilios-Rothschild, C. 1982. Female power, autonomy and demographic change in the Third World in Anker, R., Buvinic, M., and Youssef, N. H. editors. Women's Role and Population Trends in the Third World. Croom Helm, London, UK.

Saikia, N., Meh, C., Ram, U., Bora, J.K., Mishra, B., Chandra, S. and Jha, P., 2021. Trends in missing females at birth in India from 1981 to 2016: analyses of 2· 1 million birth histories in nationally representative surveys. *The Lancet: Global Health*, 9(6), pp.e813-e821.

Saxena, N.C. 2018. Hunger, under-nutrition and food security in India. In, Mehta A., Bhide S., Kumar A., Shah A. (eds) Poverty, Chronic Poverty and Poverty Dynamics. Springer, Singapore.

Sharma, S., Akhtar, F., Singh, R.K. and Mehra, S., 2021. Early marriage and spousal age difference: predictors of preconception health of young married women in Delhi, India. *Journal of Health Research*, *36*(6), pp.1118-1130.

Sumner, A., Haddad, L., and Climent, L. G. 2009. Rethinking Intergenerational Transmissions(s): Does a Wellbeing Lens Help? The Case of Nutrition. IDS Bulletin, 40 (1), 22-30.

Train, K. 2009. Discrete Choice Methods with Simulation, Cambridge University Press, Cambridge, UK.

UNICEF. 2013. The right ingredients: the need to invest in child nutrition. Child Nutrition Report 2013. UNICEF, UK.

Victora, C. G., Adair, L., Fall, C., Hallal, P. C., Martorell, R., Richter, L., and Sachdev, S. H. 2008. Maternal and Child Undernutrition: Consequences for Adult Health and Human Capital. *The Lancet*. 26; 371(9609): 340–357.

World Health Organisation (WHO) Multicenter Growth Reference Study Group. 2006. WHO child growth standards: length/height-for-age, weight-for-age, weight-for-length, weight-for-height and body mass index-for-age-methods and development. Geneva: World Health Organisation.

Yamaguchi, K. 1989. A Formal Theory for Male-Preferring Stopping Rules of Childbearing: Sex Differences in Birth Order and in the Number of Siblings. *Demography*. 26 (3), 451-465.

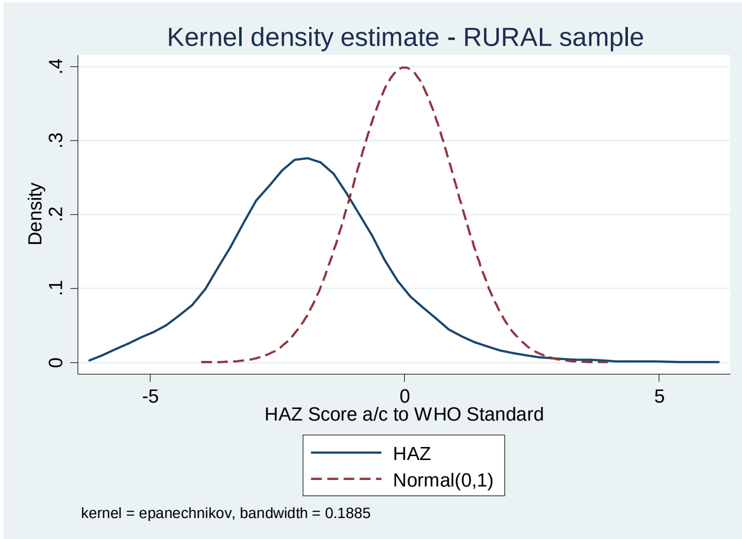


**Figure 1: HAZ scores – Rural Children aged 0-59 months**

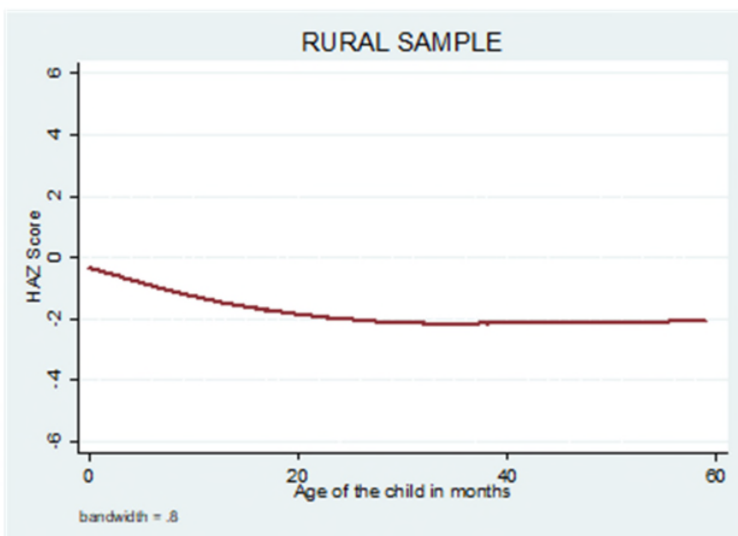


**Figure 2: Smoothed Plots of HAZ by Age – rural sample**

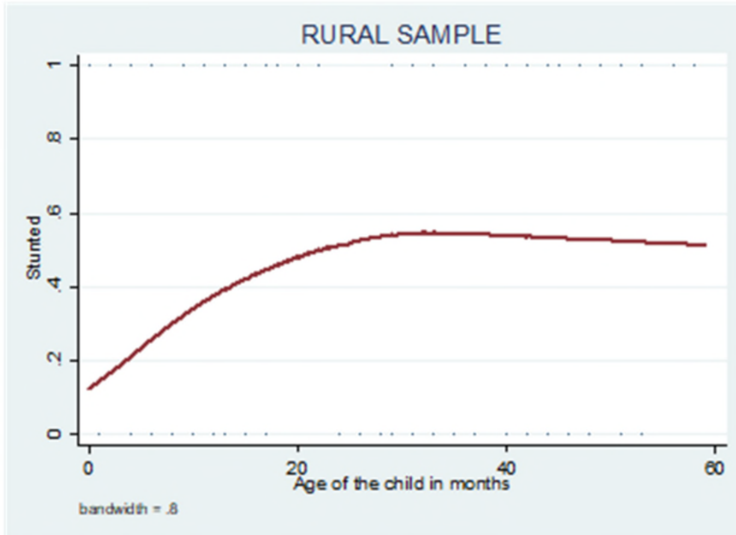


**Figure 3: Proportion of children who are classified as 'stunted' by age**

Notes to Figures 1-3: All figures are based on the authors' calculations from the sample used for the estimation of the model. The sample consists of rural women who had at least one child aged<60 months at the time of the interview and had non-missing values for the nutritional status variables.

**Table 1 – Descriptive Statistics**

| **Panel [1]:** Child covariates *z* (eq (1)) | Mean (S.D) |
|---|---|
| Girl | 0.48 |
| Age in months | 30.2 (17.0) |
| Part of a multiple birth | 0.01 |
| Birth Order 1 | 0.27 |
| 2 | 0.26 |
| 3 | 0.18 |
| 4 | 0.11 |
| 5 or more | 0.18 |
| Preceding birth interval | |
| < 18 months | 0.08 |
| 18-24 months | 0.15 |
| 25-36 months | 0.51 |
| >36 months | 0.27 |
| **Panel [2]**: nutrition status variables | Mean (S.D) |
| HAZ – Height for Age Z scores | -1.86 (1.66) |
| Stunted (children with HAZ<-2) | 0.48 |
| **Panel [3]**: measurements used in the construction of the autonomy index | Mean (S.D) |
| Woman is allowed to go to the: | |
| market alone (m1) | 0.48 |
| health facility alone (m2) | 0.45 |
| places outside the community alone (m3) | 0.36 |
| Woman has the final say alone on purchases for daily needs (m4) | 0.29 |
| Woman has the final say together: own health care (m5) | 0.61 |
| large household purchases (m6) | 0.5 |
| visiting family and friends (m7) | 0.58 |
| what to do with husband's money (m8) | 0.62 |
| Woman has money for her own use (m9) | 0.36 |
| Average Total Score (Std Dev) | 4.24 (2.48) |
| Mean of the average scores | 0.47 |
| Median of the average scores | 0.44 |
| Number of mothers | 17,749 |
| Number of children of 17,749 mothers | 23,878 |
| Proportion of mothers with one child in this sample | 0.59 |
| Mother has experienced at least one child death | 0.06 |

Notes: (i) The sample consists of women with children who were less than 60 months old at the survey time and thus were eligible to contribute to the ‘nutrition’ analyses. See text for further details; (ii) The nutritional status variable definitions are based on the World Health Organisation standards; (iii) All variables are binary except when a S.D is indicated in parenthesis.

**Table 2**
**Frequency distribution of the sum of the measurements (m1-m9) used in the construction of the autonomy index**

| Sum | # of women | % | Cumulative % |
|---|---|---|---|
| 0 | 1,454 | 8.2 | 8.2 |
| 1 | 1,729 | 9.7 | 17.9 |
| 2 | 1,589 | 9.0 | 26.9 |
| 3 | 1,976 | 11.1 | 38.0 |
| 4 | 2,800 | 15.8 | 53.8 |
| 5 | 2,355 | 13.3 | 67.1 |
| 6 | 1,784 | 10.1 | 77.1 |
| 7 | 2,103 | 11.9 | 89.0 |
| 8 | 1,564 | 8.8 | 97.8 |
| 9 | 395 | 2.2 | 100.0 |

Notes: (i) See Table 1 for the definitions of the measurements; (ii) Number of women in the rural sample=17,749; (iii) Sample average of the score is 4.2.

**Table 3: Estimates of Equation (2) Parameters (Standard errors)**
**(Impact of Women's Autonomy on Probability of Positive Response to the Measurement Question)**

| | FACTOR LOADING | INTERCEPT |
|---|---|---|
| **MEASUREMENTS (binary indicators)** | **[1]** | **[2]** |
| woman is allowed to go to market alone – **intercept** (m1) | 1 | -1.407*** |
| | | (0.082) |
| woman is allowed to go to health facility alone (m2) | 0.886*** | -0.005 |
| | (0.026) | (0.046) |
| woman is allowed to go to places outside community alone (m3) | 0.894*** | -0.484*** |
| | (0.028) | (0.050) |
| final say alone on purchases for daily needs (m4) | 0.745*** | -0.653*** |
| | (0.030) | (0.060) |
| final say together on own health care (m5) | 2.171*** | -0.682*** |
| | (0.081) | (0.097) |
| final say together on large household purchases (m6) | 2.877*** | -2.420*** |
| | (0.119) | (0.150) |
| final say together on visiting family and friends (m7) | 2.959*** | -1.815*** |
| | (0.115) | (0.151) |
| final say together on what to do with husband's money (m8) | 1.463*** | 0.170*** |
| | (0.055) | (0.065) |
| woman has money for her own use (m9) | 0.023 | 0.758*** |
| | (0.020) | (0.085) |
| Estimated variance of woman-level heterogeneity | 0.815*** | |
| | (0.023) | |
| Estimated variance of PSU level heterogeneity# | 0.748*** | |
| | (0.015) | |
| 'RELIABILITY' MEASURE+ (percentage) | | |
| woman is allowed to go to market alone | 16.8 | |
| woman is allowed to go to health facility alone | 13.8 | |
| woman is allowed to go to places outside the community alone | 13.8 | |
| final say alone on purchases for daily needs | 10.2 | |
| final say together on own healthcare | 48.7 | |
| final say together on large household purchases | 62.6 | |
| final say together on visiting family and friends | 63.9 | |
| final say together on what to do with the husband's money | 30.1 | |
| woman has money for her own use | 0.0 | |
| Maximised log-likelihood value | -90899 | |

(i) ***, **, * p-value<0.01, 0.05 and 0.10 respectively. (ii) The 'reliability' measure provides the percentage of variation attributed to the autonomy variable in the total variation observed in that **particular** measurement. A measurement with a larger "reliability" measure is able to explain a larger proportion of the variability in the observed pattern of women's answers to that question relative to another measurement with a smaller reliability measure. # PSU is the primary sampling unit; (iii) Rest of the results are provided in the online Appendix 1 Table A1.

**Table 4 – Sample Characteristics**

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | **PANEL [1]: Number of children aged<60 months** | | | | | | | |
| Number of children | 1 | 2 | 3 | 4 | | | | Total (#) |
| % of mothers | 68.5 | 28.6 | 2.82 | 0.08 | | | | 17,749 |
| | **PANEL [2]: Distribution of Birth Order – Column %** | | | | | | | |
| Birth order | 1 | 2 | 3 | 4 | 5 | 6 | 7 or more | Total |
| Girls | 49.4 | 48.2 | 46.5 | 48.4 | 47.8 | 49.4 | 46.7 | 48.2 |
| Boys | 50.6 | 51.9 | 53.5 | 51.6 | 52.2 | 50.7 | 53.3 | 51.8 |
| Total (number) | 6,434 | 6,312 | 4,219 | 2,682 | 1,758 | 1,078 | 1,395 | 23,878 |
| Total - row % | 27.0 | 26.4 | 17.7 | 11.2 | 7.4 | 4.5 | 5.8 | 100 |
| | **PANEL [3]: FIRSTBORNS with SECOND-BORN in the sample by year of birth of firstborn** | | | | | | | |
| Year of birth | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | | Total (#) |
| Numbers | 649 | 829 | 569 | 193 | 11 | 1 | | 2,252 |
| % | 28.8 | 36.8 | 25.3 | 8.6 | 0.5 | 0.04 | | 100.0 |
| | **PANEL [4]: Age in Months of FIRSTBORNS** | | | | | | | |
| Age in months | 0-15 | 16-17 | 18-23 | 24+ | | | | Total |
| Numbers | 1,696 | 241 | 657 | 3,840 | | | | 6,434 |
| % | 26.4 | 3.8 | 10.2 | 60.0 | | | | 100.0 |
| | **PANEL [5]: Age in Months of FIRSTBORNS with birth-year>2004** | | | | | | | |
| Age in months | 0-15 | 16-17 | 18+ | | | | | Total |
| Numbers | 1,557 | 78 | 7 | | | | | 1,642 |
| % | 94.8 | 4.8 | 0.4 | | | | | 100.0 |
| | **PANEL [6]: Firstborns without a younger sibling** | | | | | | | |
| Age in months | 0-15 | 16-17 | 18-23 | 24+ | | | | Total |
| Numbers | 1,690 | 227 | 587 | 1,698 | | | | 4,202 |
| % | 40.2 | 5.4 | 14.0 | 40.4 | | | | 100.0 |

**Table 5 – HAZ & 'Stunted' regressions - Coefficient Estimate (std error)**

| VARIABLES | HAZ | 'STUNTING' | HAZ | 'STUNTING' |
|---|---|---|---|---|
| Column number | (1) | (2) | (3) | (4) |
| PANEL [1] | ALL BIRTH-ORDER AGE 0-59 months | | FIRSTBORNS AGE 0-59 months | |
| Autonomy | 0.022 | -0.011*** | 0.026 | -0.008 |
| | (0.015) | (0.004) | (0.025) | (0.008) |
| Constant | -1.880 *** | 0.467*** | -2.239*** | 0.623*** |
| | (0.088) | (0.026) | (0.173) | (0.051) |
| R-squared | 0.110 | 0.094 | 0.135 | 0.119 |
| Number of Children | 23,788 | 23,788 | 6,413 | 6,413 |
| PANEL [2] | FIRSTBORNS AGE<15 months | | FIRSTBORNS AGE<18 months | |
| Autonomy | 0.146** | -0.029* | 0.161*** | -0.032** |
| | (0.058) | (0.015) | (0.051) | (0.014) |
| Constant | -1.218*** | 0.325*** | -1.441*** | 0.382*** |
| | (0.377) | (0.098) | (0.364) | (0.088) |
| R-squared | 0.139 | 0.133 | 0.176 | 0.157 |
| Number of Children | 1,571 | 1,571 | 1,931 | 1,931 |
| PANEL [3] | FIRSTBORNS BIRTH-YEAR>2004 | | FIRSTBORNS with no younger sibling | |
| Autonomy | 0.158*** | -0.033** | 0.035 | -0.010 |
| Constant | (0.059) | (0.015) | (0.034) | (0.009) |
| | -1.129*** | 0.300*** | -1.922*** | 0.503*** |
| | (0.375) | (0.101) | (0.211) | (0.064) |
| R-squared | 0.151 | 0.132 | 0.134 | 0.123 |
| Number of Children | 1,640 | 1,640 | 4,185 | 4,185 |

Notes: (i)The full set of variables included in the regression is in Appendix Table A2; (ii) age dummies (0-5 (base), 6-11, 12-17, 18-23, 24+), as well as the birth order dummies, were included where appropriate; (iii) Bootstrapped standard errors (allows for clustering at the district level with 500 replications) in parentheses. (iv) R-squared is valid when errors are homoskedastic. (v) The number of observations used in the estimations relative to those reported in Table 4, can differ due to the missing values in some of the included variables in the regressions.

**Table 6 – Estimates of Equation (1): First-born rural children aged<18 months**

| | HAZ | 'Stunted' [binary] |
|---|---|---|
| Maternal Autonomy –z score | 0.161*** | -0.032** |
| | (0.051) | (0.014) |
| <u>Child Characteristics</u> | | |
| Age in months – binary – (base <6 months) 6-11 | -0.318*** | 0.058** |
| | (0.100) | (0.025) |
| 12-17 | -1.032*** | 0.237*** |
| | (0.099) | (0.027) |
| Girl | 0.178** | -0.039** |
| | (0.071) | (0.019) |
| Part of multiple births | -2.392*** | 0.630*** |
| | (0.442) | (0.162) |
| R-squared | 0.176 | 0.157 |
| Sample average of the dependent variable (SD) | -1.15 | 0.31 |
| | (1.72) | |
| Number of Children | 17,749 | 11,187 |

Notes: (i) This is the same as Table 5, Panel [2] Columns 2 and 3. (ii) ***, **, * p-value<0.01, 0.05 and 0.10 respectively. (iii) A full set of estimates is provided in Appendix 1 Table A1; (iv) Bootstrapped standard errors (allows for clustering at the primary sampling unit level with 500 replications) in parentheses.