Determinants of Nutritional Outcomes of Children in India: A Quantile Regression Approach[1]

Eeshani Kandpal[2]
kandpal2@illinois.edu

Paul E. McNamara[3]
mcnamar1@illinois.edu

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[1] Draft; please do not cite without permission.
[2] Corresponding author; Agricultural and Consumer Economics, University of Illinois at Urbana-Champaign.
[3] Associate Professor, Agricultural and Consumer Economics, University of Illinois at Urbana-Champaign.

Abstract

In this paper, we use quantile regressions on data from the 2005-06 wave of the Indian National Family Health Survey to study the determinants of child body-mass-index, height-for-age, and hemoglobin at different points of the conditional distribution. Our results show that only considering the conditional mean of the entire distribution can yield misleading results. In light of compelling evidence on sex-selective abortion and infanticide, we use a Heckman correction for our quantile regression to control for the "underreporting" of female births documented by Rose (1999). We find that household maternal health and education have larger effects at the lower end of the distribution than on the upper end, for all three child nutritional indicators. Results show that iron supplements are less effective at increasing hemoglobin levels in the worst-off children. We argue that policy interventions must account for socio-economic diversity or have little hope of meeting their target.

Introduction and Motivation

The Government of India calls children one of India's "supremely important assets" and makes improving child nutrition one of its major goals (UNICEF 2007). Malnutrition in infancy or childhood impairs the development of vital organs and the cognitive ability of the afflicted child as well as reducing labor productivity in adulthood (UNICEF 1997). The government's efforts notwithstanding, child malnutrition remains persistently high in India. Data from the most recent wave of the Indian National Family Health Survey (2005-06) show that rapid economic growth appears to have had little impact in reducing the prevalence of stunting, wasting and anemia in children under the age of five.

The poor status of women in Indian society is well-documented. Amartya Sen's "missing women" hypothesis notes that there are up to fifty million women in India who should be alive, all else being equal, but aren't. Rose (1999) discovers an underreporting bias in the births of females. She argues that girls observed in data are intrinsically different from those whom we do not observe due to female feticide or infanticide. As a result, any estimates of health or educational outcomes that control for sex but not such selection bias will overestimate the effect of being female on the outcome. We implement a Heckman correction to account for such selection bias in the data. The instruments we use are state-wise feticides and infanticides as a percentage of all crimes against children (Tandon and Sharma, 2006).

In order to combat child malnutrition, policy-makers must understand its determinants—an especially difficult task in a country as geographically, economically, and culturally diverse as India. Regional dissimilarities in diet, widespread income inequality[4] and varying social norms hamper the success of "one size fits all" policies. In this paper, we use

[4] India has a Gini index value of 0.37 (WDI 2007).

quantile regressions on data from the 2005-2006 wave of the National Family Health Survey (NFHS-3) to examine the factors that influence child stunting, wasting, and anemia. We also correct our quantile regression estimates for sex selection. Our results show that factors such as income, education, and even government intervention have different coefficients across the conditional distribution of the malnutrition indicator. We thus argue that the determinants of child nutrition vary across society and thus policy interventions do not impact everyone uniformly. Indeed, unlike other previous measurement and evaluation studies, we find that the government's flagship child nutrition intervention has a significant, positive—albeit small—impact on child stunting, wasting, anemia.

In the rest of this paper, we present a brief summary of extant literature on child malnutrition in India, discuss the key characteristics and summary statistics of the dataset we use here, analyze regression results, and make some policy suggestions.

Literature Review

To the best of our knowledge, only one previous study has used quantile regressions to study child height and weight. In a 2008 study, Aturupane et al. use quantile regressions to analyze child height and weight in Sri Lanka. Their results validate the use of quantile regressions because coefficient sizes vary across quartiles of the distribution of the nutritional indicator. They find that although expenditure per capita plays a significant role in improving nutritional outcomes on average, it has little or no impact on the lower end of the distribution. The gender of the child matters significantly at the lower end, but not at the 75th and 90th quartiles, perhaps indicating intra-household gender discrimination amongst the worse-off. Parental education, on the other hand, matters more at the upper end of the distribution.

Studies monitoring child malnutrition indicators have found the mother's age and education (Kressy et al. 2007), household income, prenatal assistance, and exposure to media sources to be important independent variables (Aturupane et al. 2008). Undernourishment in children is strongly correlated with higher mortality and morbidity rates (UNICEF 1990). Evidence also suggests that childhood malnutrition stymies the growth of cognitive skills, and negatively influences productivity and increases the likelihood of developing chronic diseases (Strauss and Thomas 1998; Maluccio et al. 2006). Child malnutrition results from the interactions of several determinants (UNICEF 1990). Nutritional security is a function of health, care-giving resources, public health status, and control of and access to economic resources. Although we focus on the health aspects of nutritional security, in this paper, the other determinants are equally important. Indeed, no government scheme that focuses on isolated causes of malnutrition should hope to dramatically improve nutritional security outcomes. Dietary intake and health status are the most immediate causes of undernutrition. These two factors are in turn influenced by household-level access to food, environmental services (such as access to clean water and sanitation), and appropriate caregiver behaviors.

India's child nutrition monitoring and support chiefly occurs through the World Bank aided, 30 year old Integrated Child Development Services (ICDS), which costs approximately $1.5 billion each year (Lahariya 2008). Two studies into the efficacy of the ICDS—a major national level measurement and evaluation study conducted by the World Bank (2007) and another by Dasgupta et al. (2005)—failed to find a statistically significant correlation between underweight children and presence of a local ICDS centre. Dasgupta et al (2005) similarly find no significant relationship between underweight children and presence of ICDS centers. There is also little evidence that the ICDS has made a significant difference to decreasing Vitamin A deficiencies and inducing expectant mothers/ caregivers to adopt appropriate pre- or post-natal practices.

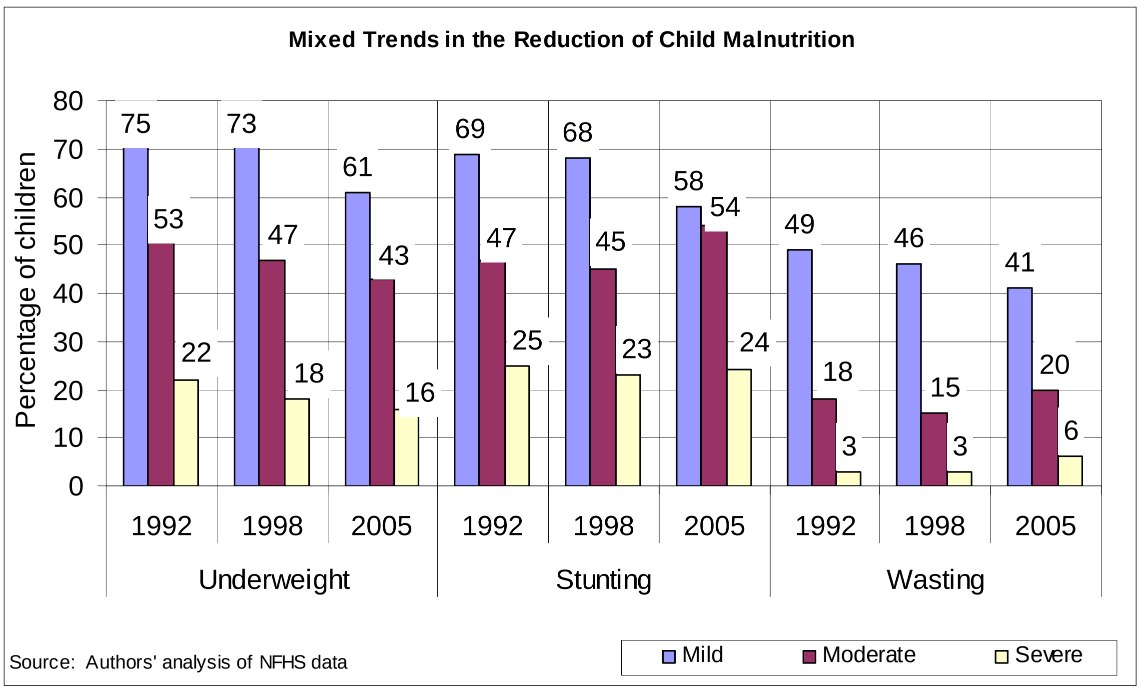
Summary Statistics

The data we use for our analysis are from the Indian National Family Health Survey (NFHS) of 2005-2006. The NFHS of 2006-06 is the third in a series of national surveys. The first NFHS survey was conducted in 1992-93 and the second in 1998-99. The third wave of the NFHS interviewed more than 230,000 women between 15 and 49 years of age from 29 states across India. The urban and rural samples within each state were drawn separately and, to the extent possible, the sample within each state was allocated proportionally to the size of the state's urban and rural populations. A uniform sample design was adopted in all the states.

The rural sample is selected in two stages: the selection of primary sampling units (PSU), with probability proportional to population size (PPS) at the first stage, followed by the random selection of households within each PSU in the second stage. In urban areas, a three-stage procedure was followed. The NFHS 3 interviewed the household head or any adult household member of each selected household for personal and household characteristics. Their cooking salt was tested for iodine content. Respondents' height, weight and hemoglobin content were also measured. These measurements were also conducted for 40, 0336 children born in or after January 2000. Since we study child nutrition indicators—child height-for-age, BMI, and hemoglobin— in our analysis, we use this sample of children.

Figure 1 shows that there is no clear trend in the prevalence of child stunting —one of the most widely used measures of child malnutrition—across the three waves of the NFHS. Although mild stunting saw steady decreases throughout this period (particularly between 1998 and 2005), the story is less encouraging for moderate and severe stunting. Despite a two percent fall in each of these measures between 1992 and 1998, both figures increased in 2005. Similarly, while mild wasting fell in each of the three NFHS survey years, moderate and severe wasting increased from 1998 to 2005. Overall, the rapid growth in income seems to have been correlated with some improvements in measures of child nutrition, but moderate and severe child malnutrition is harder to prevent or cure. Indeed, these results may be a direct result of the failure of ICDS to achieve its goals in targeting the poorest and most vulnerable of India's children.

Figure 1: Trends in Child (0-5 years) Malnutrition, from 1992 to 2005



Thirty-six percent of the sample lives in the bottom two quantiles of the income distribution. The average woman was 27 years old, was married at the age of 18, and has had at least one birth in the past five years (the sample average is 1.3 births), with the average child being two years old. The average duration of breastfeeding was 25 months. A little under half (47 percent) the children were female[5]. The average child had a BMI of 15, height-to-age ratio of 5.4, and a hemoglobin level of 10. Eighteen percent of mothers (5395 individuals) had no prenatal care, although only half a percent had completely unassisted deliveries. About 74 percent of the sample lived in areas covered by the ICDS. Only 10.5 percent of the sample was from female-headed households. Two-thirds of the sample of women did not read any newspapers or magazines on a regular basis, while 58 percent of the sample did not listen to the radio at all.

Table 1 below shows that, regardless of measure or level of child malnutrition—moderate or severe stunting, wasting, and underweight— urban areas fare significantly better than do rural areas. These figures are perhaps a result of easier access to hospitals, and better environmental services. Further, caregivers in urban areas may be exposed to more effective information dissemination, and thus adopt better pre- and post- natal behaviour.

Table 1: Child (0-5 years) Malnutrition Indicators by Residence

Location of Residence	% Moderately Stunted	% Severely Stunted
Rural	47.2	23.8
Urban	37.4	16.4
	% Moderately Wasted	% Severely Wasted
Rural	24.1	8.3
Urban	19.0	6.8
	% Moderately Underweight	% Severely Underweight
Rural	43.7	17.4
Urban	30.1	10.6

Not surprisingly, maternal education is significantly correlated with stunting in children up to five years of age. Table 2 shows that mothers with no education are nearly three times as likely to have moderately stunted children, and almost five times as likely to have severely stunted children as mothers with 12 or more years of education.

[5] Note that the biological ratio of number of female births per 100 males is 105, whereas the sample ratio is only 92, which is evidence of underreporting female births.

Table 2: Maternal Education and Stunting in Offspring (0-5 years)

Maternal Education	% Moderately Stunted	% Severely Stunted
0 years	57.2	31.6
< 5 years	50.4	24.1
5-7 years	45.6	20.3
8-9 years	40.7	15.6
10-11 years	33.0	10.9
12 or more years	21.9	7.0

Of particular concern, then, is the fact that 41 percent of all women have had no education. Only 23 percent have eight years or less of education, and as little as 14 percent complete nine years in school. A mere 22 percent complete high school. Maternal education is very influential in determining a child's nutritional and health status. The staggeringly low rates of female education do not bode well for children's nutritional status. The relation between stunting and wealth status also exhibits expected trends. Children from wealthier households are less likely to be stunted. Children from the poorest wealth quintile are more than twice as likely to be moderately stunted as are children from the wealthiest quintile, and over four times as likely to be severely stunted as children from the highest wealth quintile.

Table 3: Stunting in Children (0-5 years), by Wealth Quintile

Wealth Quintile	% Moderately Stunted	% Severely Stunted
First (lowest)	59.9	34.2
Second	54.3	27.9
Third	48.9	23.1
Fourth	40.8	16.5
Fifth (highest)	25.3	8.2

Figure 2 shows this relationship graphically. These histograms tell us that the average child in all quintiles is at least mildly stunted, while the average child in the poorest quintile is moderately stunted. The average Indian child, irrespective of family wealth, is stunted, relative to the rest of the world.

Figure 3 compares the distribution of stunting prevalence in India and the world. The average Indian child is two standard deviations below the mean of the International Reference Population, i.e. the average Indian child is moderately stunted. This result highlights serious deficiencies in the nature of Indian nutrition monitoring systems. Most stunted children never gain the corresponding body weight, and often have poor cognitive function. Severely stunted children, in particular, may suffer from lack of growth in vital organs that may lead to premature death (Berkman et al. 2002).

Figure 2: Stunting (Children 0-5 years) by Income Group

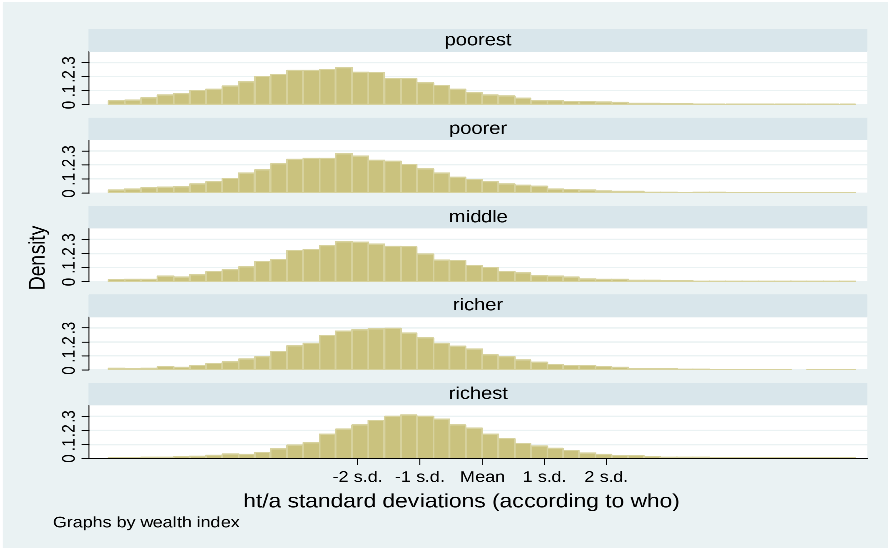


Figure 3: Child (0-5 years) Stunting in India and World Reference Population

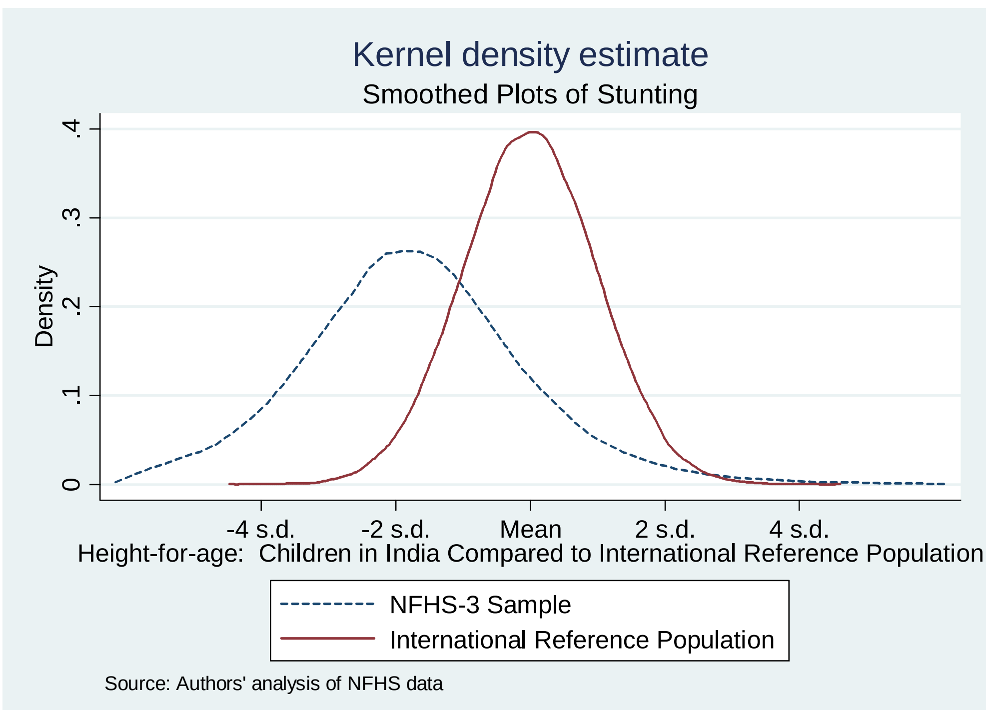


Figure 4 below tells a similarly disturbing story for the rates of wasted and underweight children in India and the world. Almost half of all Indian children under the age of five are at least moderately underweight (their BMI is two or more standard deviations below the WHO reference mean), compared with fewer than five percent in the global reference population. The causes of wasting include extremely low caloric intake, nutrient losses due to infection, or a combination of low intake and high loss (Kressy et al. 2007). Underweight status and micronutrient deficiencies cause decreases in immunity, losses in stamina, and make affected children prone to infection (Black et al. 2003). Table 4 tells us that over sixty percent of those surveyed in the NFHS-3 were anemic. Stunting, underweight status, and anemia render the child more vulnerable to disease, and may trap him/ her in a potentially lifelong, vicious cycle of ill-health and malnutrition.

Figure 4: Child (0-5 years) BMI in India and the World Reference Population

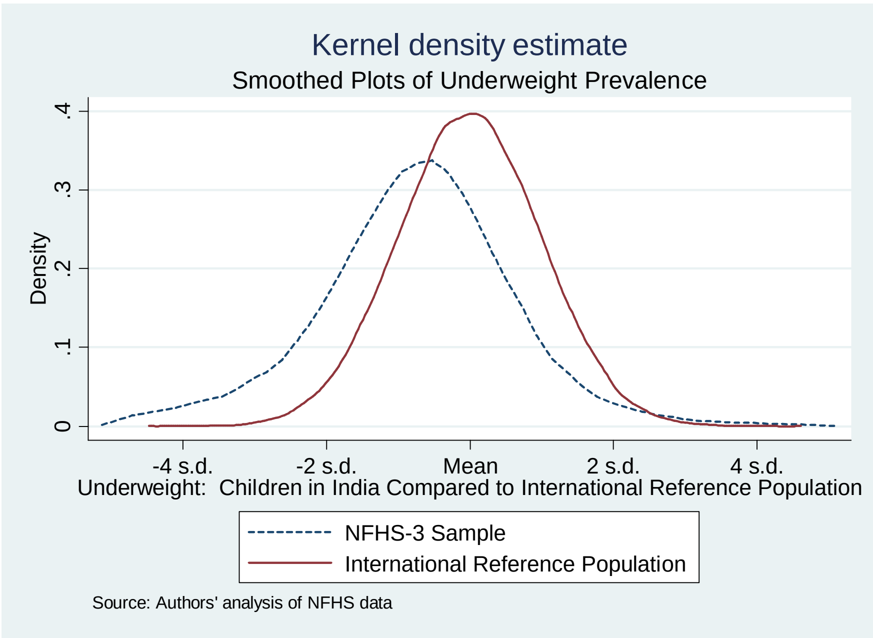
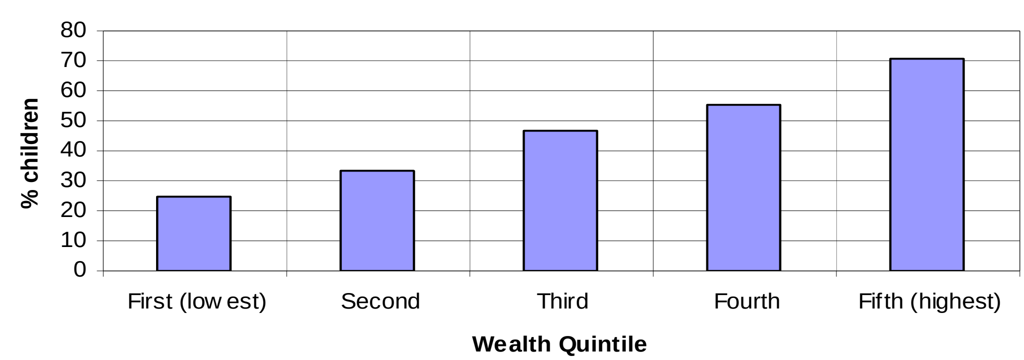


Table 4: Anemia Prevalence Among Children Younger than Five

Anemia Level	Frequency	Percent
Severe	915	2.43
Moderate	12,895	34.25
Mild	9,381	24.92
Not Anemic	12,660	33.63

In addition to high rates of child malnutrition, the rate of child immunization in India is also alarmingly low in poor and middle classes. As Figure 5 illustrates, only about a quarter of children under the age of five in the lowest wealth quintile are fully covered by all recommended vaccinations. This number increases, slightly, to just over thirty percent of all children (up to five years old) in the second wealth quintile. Even in the middle wealth quintile, the percent of children covered by all recommended vaccines is less than fifty percent. As the breakdown of prevalence of stunting by wealth quintiles shows, children from the poorest households are also most likely to be stunted, i.e., most likely suffer from chronic malnutrition. These children are thus rendered vulnerable to infection and then not covered by recommended vaccinations. Such malnutrition and lack of preventive medical cover makes these children distressingly prone to disease and infection.

Figure 5: Percent of children (0-5 years) Covered by All Recommended Vaccinations



Source: Authors' analysis of NFHS data

Access to water and sanitation services is an important component of health and nutrition status. Table 4 below shows the breakdown of time (in minutes) to the household water source. Only 53 percent of the survey sample has ready access to water, and 46 percent of the sample uses a water source that was eighteen minutes away. Further, only 42 percent of all households have access to piped drinking water—71 percent in urban areas, but only 28 percent in rural areas. 22 percent face access to risky water, such as unprotected wells, springs, lakes, rivers, streams, and canals. Unpiped water is inherently risky because it is unprotected from all types of disease and pollutants. 42 percent of all households do not have access to a toilet or latrine facility, once again increasing the risk of disease. In isolation, perhaps, the lack of access to toilets or clean, piped drinking water would have been less egregious factors. However, when combined with the wide array of factors increasing the vulnerability of these children to disease and malnutrition, the potential for harm by risky sanitation services is redoubled.

Table 5: Time to Water Source (in minutes)

Time to Water Source	Frequency	Cumulative Percentage	Mean	Standard Deviation
Less than 100 minutes	22143	46.03%	18.39	15.58
More than 100 minutes	314	0.07%	134.52	31.86
On Premises	25463	53.1%	--	--

We instrument for the selection bias described by Rose using Tandon and Sharma's estimates of female feticide and infanticide as percentages of crimes against children, by state in the year 2000. Madhya Pradesh (and Chattisgarh), and Maharashtra perform the worst by these measures of child safety and health. Rates of incidence vary widely, with feticides comprising 45.1 percent of all crimes against children in Maharastra, but only one percent in Bihar, Karnataka, and Jharkand.[6]

Table 6: Feticide and Infanticide as percentages of crimes against children, by state in 2000 (Tandon and Sharma, 2006)

State	Feticide	Infanticide
Jammu and Kashmir	0	1
Himachal Pradesh	0	0
Punjab	0	5.8
Uttaranchal	0	0
Haryana	14.3	1

[6] Since the states of Uttarakhand, Jharkand, and Chattisgarh were all created at the end of 2000 but Tandon and Sharma do not provide estimates of feticide and infanticide for these states, we apply the values of these variables for the parent states (Uttar Pradesh, Bihar, and Madhya Pradesh) to these three new states.

Delhi	2.2	1.9
Rajasthan	9.9	4.8
Uttar Pradesh	0	0
Bihar	1.1	3.8
Sikkim	0	2.9
Arunachal Pradesh	0	0
Nagaland	0	0
Manipur	0	0
Mizoram	0	0
Tripura	0	0
Meghalaya	0	0
Assam	0	3.8
West Bengal	0	1.9
Jharkhand	1.1	3.8
Orissa	1.1	0
Chhattisgarh	15.4	29.8
Madhya Pradesh	15.4	29.8
Gujarat	0	3.8
Maharashtra	45.1	19.2
Andhra Pradesh	8.8	7.7
Karnataka	1.1	1.9
Goa	0	0
Kerala	0	1.9

Results:

In this section, we present results from OLS regression analysis, followed by those from selection-corrected quantile regressions. We highlight key differences in the results and their differing policy implications. Since heteroscedasticity and non-independence of errors may be a concern, we bootstrap standard errors. The t-statistics presented in Tables 8 through 10 are based on these bootstrapped standard errors. Table 7 below presents the results from initial OLS regression analysis. The columns present coefficient estimates for the three dependent variables: child height-to-age (the basis for child stunting), body-mass-index (BMI), and hemoglobin. These results show that the Inverse Mills' Ratio is only significant for child hemoglobin and suggests that females have higher hemoglobin levels than males. Mother's height-for-age and hemoglobin are significantly (at the one percent level) and positively correlated with child height-to-age. Mother's hemoglobin is also a significant determinant of child hemoglobin, but not of the child's BMI. Household wealth index, mother's age and education are only significant (and positive) for child hemoglobin, suggesting that these variables do not determine child height-for-age or BMI. The mother's age, number of births ever as well as in the last five years, and current pregnancy is significant determinants of child health, although it appears as though an increase in the mother's age decreases child BMI. Parenting habits such as duration of breastfeeding are also significantly correlated with child health.

Tables 8, 9 and 10 present quantile regression results for child height-for-age, BMI, and hemoglobin.[7] Since the coefficient estimates and levels of significance are different for various quantiles, quantile regression appears to provide us information omitted by OLS. The results tell us that mother's height-to age is a significant determinant of child height-to-age, and the impact size increases as we move up the distribution, toward healthier children (Table 8). Other indicators of maternal health are also significant determinants of some (but not all) indicators. For instance, the mother's hemoglobin level and BMI have significant positive impacts on the child's BMI and hemoglobin, but not on height-for-age. On the other hand, the coefficient of mother's height-to-age on child BMI, while positive and significant, decreases as we move up the distribution of the dependent variable (Table 7). In contrast to OLS results, mother's age is significantly and positively correlated with child health as measured by all three indicators. The number of children ever born to a woman and current pregnancy both significantly decrease child height-for-age at the lower end of the distribution, but has an insignificant impact at the higher end, variation which we would have missed out on had we relied solely on OLS results. Figure 6 highlights the difference between quantile regression and OLS results. We see that OLS overestimates the effect of

[7] Quantile regressions were estimated for each decile, but we only provide results for three deciles (lowest, middle, and highest) in the tables below. Full tables are available upon request from the corresponding author.

the number of children ever born on child stunting at the lower end of the distribution, but underestimates it at the upper end. The OLS estimate is particularly misleading for duration of breastfeeding and the mother's height-for-age. The effect of breastfeeding duration on child stunting in the lowest deciles is significantly underestimated by OLS, which could lead to incorrect policy initiatives. Similarly, we see that quantile estimates provide a wealth of information for mother's height-for-age, current pregnancy and current age, as well as the inverse Mills' ratio which OLS estimates mask.

Figure 7 and table 9 present results for child BMI expressed as standard deviations from the WHO reference population mean. Once again, we find that quantile regression results yield different estimates for the effect of covariates by decile. The mother's BMI is once again a significant determinant of child BMI, although the magnitude increases as we move up the distribution toward healthier children. The child's BMI also increases in the mother's age and in duration of breastfeeding. Women with fewer births in the last five years also have significantly healthier children. Figure 7 highlights the poor quality of the OLS estimates in general and for the effect of mother's BMI and duration of breastfeeding in particular. We also find evidence that the Indian Integrated Child Development Services—the government's primary child nutrition intervention—has a significant effect on both stunting and BMI in some of the lower deciles. These results contradict the consensus in the literature as well as our OLS estimates, and suggest that this endogeneously placed program may be having an effect at the lower end of the distribution of child health outcomes.

Figure 8 and table 10 tell a similar story for hemoglobin. The Inverse Mills' Ratio is positive for all deciles, but is significant only for the fiftieth and higher deciles indicating the presence of positive selection bias in the upper end of the distribution of child hemoglobin.

Figure 8 shows that OLS significantly underestimates of the effect of the mother's hemoglobin on child hemoglobin for the lower half of the distribution, but overestimates it for the upper half. Any policy based on such an estimate would be regressive by focusing less-than-ideal resources on increasing the mother's hemoglobin among the worst-off. Girls in the lower end of the hemoglobin distribution are better off than suggested by OLS, while they are worse off at the upper end than indicated by OLS. OLS also overestimates the effect of iron supplements on the lower end of the hemoglobin distribution. Policy based on this OLS estimate would lead to an over-dependence and expenditure on iron supplements.

Conclusion

This paper uses quantile regressions to examine the determinants of Indian child nutrition. We find that OLS estimates of variables such as the mother's health and education can be misleading because such variables have differing impacts across the distribution of nutritional outcomes. The sign and size of the effect of gender also seem to vary across the distribution, so there is no conclusive evidence on the correlation between gender and nutrition—a fact obscured by OLS estimates. We also find evidence of selection bias at some—but not all—parts of the distributions of child stunting, BMI, and hemoglobin.

Our results suggest that maternal education and health positively influence the health of the child, and that iron supplements and drugs for intestinal worms may not be as effective as expected in the worst-off households. In order to make its health interventions more effective, the government should look beyond narrowly defined interventions to the overall food and nutritional status of children.

Table 7: OLS Regression Results

	Child Stunting (S.D. from WHO Mean)		Child BMI (S.D. from WHO Mean)		Child Hemoglobin (grams/dl)	
Variables	Coefficient	t-stat	Coefficient	t-stat	Coefficient	t-stat
Inverse Mills' Ratio	0.10	0.14	-0.23	-0.52	17.82	2.60
Mother's Hemoglobin level (g/dl)*100	0.18	2.78	0.00	0.99	16.26	19.17
Mother's Height-to-Age	0.26	16.54	0.00	0.44	-0.04	-0.29
Mother's BMI(*100)	0.02	3.70	0.02	6.21	0.08	1.83
Lowest Quintile of Wealth	-0.25	-0.91	0.15	0.89	-2.11	-0.84
Second Quintile of Wealth	-0.10	-0.37	0.13	0.78	-1.36	-0.54
Third Quintile of Wealth	0.05	0.18	0.13	0.81	-0.99	-0.40
Fourth Quintile of Wealth	0.09	0.34	0.17	1.05	-0.47	-0.19
Mother's Age	0.02	4.38	-0.01	-2.86	0.24	4.97
Mother's Education	0.01	0.85	0.02	1.88	-0.08	-0.52
Sex of Household head	-0.02	-0.46	0.04	1.33	-0.78	-1.56
Age of Household head*100	0.07	0.59	0.04	0.60	-0.44	-0.42
Total children ever born	-0.07	-3.19	0.00	0.29	-0.57	-2.70
Births in last five years	-0.08	-3.11	0.05	2.93	1.07	4.19
Mother currently pregnant	-0.30	-5.84	0.09	2.99	1.39	2.99
Number of living children	-0.01	-0.53	0.02	1.51	0.37	1.63
No Education	-0.11	-0.41	0.23	1.38	-1.82	-0.70
Primary Education	-0.18	-0.79	0.17	1.24	-0.76	-0.35
Secondary Education	-0.12	-0.68	0.09	0.79	-0.35	-0.20
Age at first marriage	-0.02	-2.91	0.00	1.05	-0.16	-2.63
No prenatal assistance	-0.15	-1.15	0.05	0.64	-1.78	-1.49
Months of Breastfeeding	-0.06	-23.77	0.01	6.60	0.19	7.47

Months of Breastfeeding (squared)	0.00	19.08	0.00	-4.50	0.00	-5.45
Child's sex	0.05	1.70	-0.07	-3.84	0.25	0.89
Mother has money for own use?	-0.03	-0.85	0.02	0.99	0.50	1.62
ICDS?	0.03	0.63	0.01	0.26	-0.54	-1.27
Risky water source	0.08	2.32	-0.03	-1.43	0.10	0.31
Risky sanitation	0.03	0.61	-0.04	-1.29	0.16	0.33
Wasted	0.47	13.04	-2.20	-100.66	-0.65	-1.90
Rural area	0.10	1.80	-0.03	-0.96	1.13	2.10
Slum	0.27	1.59	-0.25	-2.36	-0.16	-0.10
Almost Never Reads Newspaper	-0.22	-1.69	-0.06	-0.78	-1.71	-1.39
Reads Newspaper Less Than Once a Week	-0.30	-2.30	-0.01	-0.13	-1.35	-1.09
Reads Newspaper Atleast Once a Week	-0.25	-1.80	-0.04	-0.44	-0.89	-0.68
Almost Never Listens to Radio	-0.01	-0.19	0.04	1.35	-0.46	-0.97
Listens to Radio Less Than Once a Week	-0.03	-0.47	0.04	1.27	-0.39	-0.73
Listens to Radio Atleast Once a Week	0.04	0.59	-0.01	-0.23	0.54	0.93
Fully immunized	-0.09	-2.54	0.04	1.71	0.37	1.16
Hindu	0.31	2.77	-0.12	-1.70	1.51	1.42
Muslim	0.18	1.54	-0.04	-0.52	1.87	1.68
Sikh	0.12	0.99	0.15	2.11	3.49	3.08
Buddhist	0.73	2.01	-0.01	-0.02	9.26	2.69
Jain	0.96	4.81	-0.10	-0.85	-4.66	-2.51
Jewish	0.02	0.01	-0.68	-0.72	-14.68	-1.05
Donyi/Polo	-0.13	-0.29	0.32	1.16	-7.98	-1.98
Other	0.06	0.24	0.49	2.93	3.79	1.46

Caste1	-0.10	-1.19	0.04	0.76	-0.47	-0.60
Caste2	-0.10	-1.14	0.02	0.39	-2.11	-2.44
Village Sex Ratio	0.41	0.32	-0.48	-0.62	31.44	2.61
Village Population	-0.06	-1.64	-0.06	-2.45	0.09	0.24
Average Wealth of Village	0.00	0.71	0.00	1.51	0.00	-0.07
Share of Mothers with Secondary Education	0.30	3.06	-0.07	-1.13	1.31	1.43
Share of Mothers with Primary Education	0.26	2.25	0.05	0.77	1.61	1.47
Lack of Improved Sanitation	0.03	0.41	-0.01	-0.19	-0.17	-0.22
Electrification	0.02	0.51	-0.02	-0.60	-0.31	-0.76
Taking iron pills, sprinkles for syrup	-0.01	-0.22	0.02	1.48	-0.48	-1.84
Taken drugs for intestinal worms in last 6 months	-0.03	-1.09	0.00	6.21	0.65	2.84
Constant	-1.14	-0.85	-0.44	-0.54	46.99	3.72
Observations	11696		11696		10408	
R-squared	0.15		0.51		0.99	
State Dummies	Yes		Yes		Yes	

Table 8: Quantile Regression Results for Child Stunting in Standard Deviations from WHO Reference Mean

	Coefficient	t-test	Coefficient	t-test	Coefficient	t-test
	Tenth Decile		Fiftieth Decile		Ninetieth Decile	
Inverse Mills' Ratio	1.55	1.57	0.39	0.44	-0.45	-0.28
Mother's Hemoglobin level (g/dl)*100	0.18	1.45	0.21	1.83	0.31	2.56
Mother's Height-to-Age	0.22	8.23	0.30	17.71	0.32	9.56
Taking iron pills, sprinkles for syrup	-0.05	-1.74	-0.02	-0.45	-0.02	-0.22
Taken drugs for intestinal worms in last 6 months	-0.02	-0.47	-0.03	-0.99	-0.01	-0.29
Mother's BMI(*1000)	0.09	0.93	0.30	3.22	0.47	4.09
Lowest Quintile of Wealth	-0.31	-1.21	-0.11	-0.45	0.05	0.12
Second Quintile of Wealth	-0.23	-0.94	0.04	0.19	0.16	0.37
Third Quintile of Wealth	0.01	0.06	0.14	0.63	0.18	0.48
Fourth Quintile of Wealth	0.06	0.39	0.17	0.77	0.15	0.38
Mother's Age	0.03	3.44	0.02	2.97	0.04	2.65
Mother's Education	0.04	1.51	0.02	1.64	-0.01	-0.44
Sex of Household head	-0.17	-1.52	-0.04	-0.58	0.08	0.72
Age of Household head*100	0.00	0.03	0.00	0.76	0.00	0.14
Total children ever born	-0.08	-2.53	-0.06	-1.73	-0.05	-0.84
Births in last five years	-0.05	-1.06	-0.09	-4.00	-0.09	-1.94
Mother currently pregnant	-0.24	-2.45	-0.44	-7.98	-0.06	-0.53
Number of living children	-0.04	-1.21	-0.03	-0.81	-0.02	-0.34
Age at first marriage	-0.01	-1.47	-0.02	-2.71	-0.03	-2.08
No prenatal assistance	-0.24	-1.09	-0.16	-1.04	0.05	0.21
Months of Breastfeeding	-0.03	-13.35	-0.06	-22.17	-0.07	-11.96
Months of Breastfeeding (squared)	0.08	1.80	0.06	1.75	-0.04	-0.67

Child's sex	0.00	8.19	0.00	18.99	0.00	8.26
Mother has money for own use?	0.04	0.99	-0.04	-1.03	-0.02	-0.25
ICDS?	0.02	0.22	0.01	0.15	0.02	0.45
Risky water source	0.20	2.87	0.36	4.89	0.95	12.71
Risky sanitation	0.03	0.60	0.06	1.72	0.15	3.12
Wasted	0.01	0.14	0.04	0.62	0.03	0.25
Rural area	0.05	0.69	0.07	1.18	0.28	2.98
Slum	0.03	0.09	0.16	0.87	0.42	1.05
Almost Never Reads Newspaper	-0.12	-0.78	-0.29	-2.11	-0.26	-1.26
Reads Newspaper Less Than Once a Week	-0.24	-1.51	-0.36	-3.01	-0.29	-1.51
Reads Newspaper Atleast Once a Week	-0.02	-0.13	-0.33	-2.71	-0.31	-1.21
Almost Never Listens to Radio	-0.11	-1.14	-0.02	-0.34	0.04	0.49
Listens to Radio Less Than Once a Week	-0.03	-0.32	-0.02	-0.30	-0.02	-0.15
Listens to Radio Atleast Once a Week	-0.06	-0.65	0.05	0.95	0.18	1.83
Fully immunized	0.03	0.69	-0.08	-2.25	-0.26	-3.36
No Education	-0.10	-0.28	0.23	1.05	-0.16	-0.50
Primary Education	-0.19	-0.72	0.15	0.81	-0.12	-0.47
Secondary Education	-0.19	-0.98	0.14	0.92	-0.04	-0.14
Hindu	0.19	0.96	0.22	1.69	0.42	1.81
Muslim	0.06	0.34	0.19	1.51	0.23	0.88
Sikh	0.03	0.14	0.05	0.30	0.23	0.80
Buddhist	0.34	0.49	0.37	0.67	1.66	1.91
Jain	0.48	1.51	0.83	3.40	0.79	1.39
Jewish	2.10	2.30	-0.01	-0.14	-1.72	-2.19
Donyi/Polo	0.19	0.32	-0.28	-0.46	-0.18	-0.37
Other	-0.26	-0.43	0.03	0.06	0.23	0.31
Caste1	0.11	0.86	-0.05	-0.62	-0.27	-2.41

Caste2	0.10	0.73	-0.08	-0.69	-0.23	-1.30
Village Sex Ratio	2.84	1.71	0.86	0.56	-0.18	-0.06
Village Population	-0.05	-0.81	-0.10	-2.48	0.00	0.04
Average Wealth of Village	0.00	0.58	0.00	1.21	0.00	1.54
Share of Mothers with Secondary Education	0.47	4.13	0.23	1.87	0.21	1.18
Share of Mothers with Primary Education	0.76	3.83	0.26	2.37	0.04	0.15
Lack of Improved Sanitation	-0.12	-0.79	0.12	1.38	-0.08	-0.44
Electrification	0.06	0.60	0.02	0.28	0.08	0.80
Constant	-5.63	-3.06	-2.00	-1.21	0.39	0.14
Observations	11696		11696		11696	
R-squared	0.083		0.0814		0.108	
State Dummies	Yes		Yes		Yes	

Table 9: Quantile Regression Results for Child BMI in Standard Deviations from the WHO Reference Mean

	Coefficient	t-test	Coefficient	t-test	Coefficient	t-test
	Tenth Decile		Fiftieth Decile		Ninetieth Decile	
Inverse Mills' Ratio	0.01	0.01	0.13	0.32	-1.27	-1.72
Mother's Hemoglobin level (g/dl)	0.00	-0.79	0.00	1.43	0.00	0.12
Mother's Height-to-Age	-0.01	-0.90	0.00	0.08	0.04	2.52
Taking iron pills, sprinkles for syrup	0.01	0.42	-0.03	-1.22	-0.04	-0.67
Taken drugs for intestinal worms in last 6 months	0.02	1.26	0.01	0.49	0.03	0.51
Mother's BMI(*1000)	0.10	2.65	0.20	4.61	0.40	5.58
Lowest Quintile of Wealth	-0.06	-0.33	0.09	0.74	0.58	1.19
Second Quintile of Wealth	-0.06	-0.34	0.08	0.66	0.54	1.15
Third Quintile of Wealth	-0.06	-0.37	0.09	0.69	0.52	1.09
Fourth Quintile of Wealth	-0.06	-0.42	0.14	1.12	0.53	1.11
Mother's Age	0.00	-0.73	-0.01	-3.75	-0.02	-2.30
Mother's Education	0.00	-0.14	0.01	1.19	0.02	1.07
Sex of Household head	0.02	0.57	0.05	1.54	0.02	0.45
Age of Household head*100	0.00	-1.14	0.00	0.10	0.00	1.82
Total children ever born	0.00	-0.24	0.01	0.65	0.02	0.75
Births in last five years	0.05	1.85	0.06	3.25	0.00	-0.07
Mother currently pregnant	0.07	2.24	0.05	1.20	0.10	1.56
Number of living children	0.01	0.82	0.02	1.17	0.03	1.15
Age at first marriage	0.01	0.91	0.01	2.12	0.00	0.48
No prenatal assistance	0.05	0.34	0.04	0.45	-0.09	-0.54
Months of Breastfeeding	0.02	7.84	0.01	7.11	0.00	-0.19
Months of Breastfeeding (squared)	-0.10	-5.76	-0.07	-3.36	-0.09	-2.28

Child's sex	0.00	-6.60	0.00	-5.53	0.00	0.73
Mother has money for own use?	0.02	0.50	0.01	0.28	0.00	0.05
ICDS?	0.04	1.09	0.01	0.34	0.04	0.73
Risky water source	-2.29	-63.72	-1.89	-85.03	-2.42	-75.52
Risky sanitation	-0.05	-1.86	-0.05	-2.20	-0.01	-0.22
Wasted	0.03	0.59	-0.06	-1.79	-0.07	-1.25
Rural area	0.00	0.07	-0.05	-1.71	-0.05	-0.92
Slum	-0.08	-0.74	-0.23	-1.69	-0.32	-1.77
Almost Never Reads Newspaper	0.00	-0.03	-0.04	-0.42	-0.19	-1.24
Reads Newspaper Less Than Once a Week	0.05	0.39	0.00	0.00	-0.09	-0.60
Reads Newspaper Atleast Once a Week	0.14	1.08	-0.02	-0.18	-0.17	-1.21
Almost Never Listens to Radio	0.01	0.26	0.04	1.67	0.04	0.69
Listens to Radio Less Than Once a Week	-0.02	-0.61	0.06	1.47	0.03	0.35
Listens to Radio Atleast Once a Week	-0.06	-1.32	0.00	-0.13	-0.02	-0.25
Fully immunized	0.08	2.64	0.04	1.68	0.00	0.04
No Education	-0.19	-0.82	0.07	0.45	0.36	1.13
Primary Education	-0.14	-0.79	0.03	0.21	0.32	1.25
Secondary Education	-0.14	-1.02	-0.02	-0.17	0.22	1.22
Hindu	-0.04	-0.51	-0.01	-0.14	-0.09	-0.76
Muslim	-0.02	-0.22	0.05	0.68	0.04	0.31
Sikh	0.05	0.55	0.25	2.74	0.25	1.46
Buddhist	0.23	1.01	-0.11	-0.44	-0.12	-0.35
Jain	0.07	0.67	-0.06	-0.39	0.01	0.06
Jewish	0.25	1.54	-0.45	-1.75	-1.60	-1.97
Donyi/Polo	0.45	0.80	0.53	1.14	0.36	0.70
Other	0.44	1.58	0.44	1.81	0.68	1.55
Caste1	-0.01	-0.18	0.02	0.22	0.11	1.30
Caste2	-0.03	-0.47	-0.01	-0.12	0.12	1.22

Village Sex Ratio	0.15	0.15	0.22	0.31	-2.30	-1.80
Village Population	0.00	0.05	-0.06	-2.21	-0.12	-2.21
Average Wealth of Village	0.00	0.88	0.00	0.85	0.00	1.50
Share of Mothers with Secondary Education	-0.08	-0.95	-0.06	-1.07	-0.28	-2.34
Share of Mothers with Primary Education	0.07	0.59	0.12	1.30	-0.07	-0.48
Lack of Improved Sanitation	-0.07	-0.96	-0.03	-0.48	-0.14	-2.29
Electrification	-0.02	-0.41	-0.04	-1.24	0.01	0.31
Constant	-1.71	-1.89	-1.35	-1.90	2.47	1.77
Observations	11696		11696		11696	
R-squared	0.43		0.31		0.25	
State Dummies	Yes		Yes		Yes	

Table 10: Quantile Regression Results for Child Hemoglobin

	Coefficient	t-test	Coefficient	t-test	Coefficient	t-test
		Tenth Decile	Fiftieth Decile		Ninetieth Decile	
Inverse Mills' Ratio	6.76	0.85	13.96	2.12	12.95	1.69
Mother's Hemoglobin level (g/dl)	0.20	11.48	0.16	12.27	0.14	7.53
Mother's Height-to-Age	0.09	0.27	-0.03	-0.25	-0.01	-0.07
Taking iron pills, sprinkles for syrup	-0.96	-1.81	-0.67	-1.47	-0.07	-0.26
Taken drugs for intestinal worms in last 6 months	0.71	3.53	0.40	2.31	-0.19	-0.43
Mother's BMI(*1000)	0.00	-0.01	0.00	1.48	0.00	0.26
Lowest Quintile of Wealth	1.14	0.27	-1.09	-0.29	-6.17	-1.19
Second Quintile of Wealth	1.58	0.38	-0.53	-0.14	-5.46	-1.04
Third Quintile of Wealth	2.10	0.55	-0.57	-0.16	-6.07	-1.17
Fourth Quintile of Wealth	2.65	0.71	-0.41	-0.11	-5.29	-1.05
Mother's Age	0.07	1.03	0.23	5.81	0.24	4.53
Mother's Education	-0.09	-0.60	-0.03	-0.21	0.31	2.43
Sex of Household head	-0.31	-0.33	-0.38	-0.99	-0.18	-0.30
Age of Household head*100	-0.01	-0.29	0.00	0.43	0.00	-0.11
Total children ever born	-0.26	-0.58	-0.49	-3.18	-0.40	-1.94
Births in last five years	0.72	2.02	0.92	4.84	0.86	4.10
Mother currently pregnant	1.15	1.58	0.62	1.92	0.99	1.80
Number of living children	0.37	0.81	0.21	1.12	-0.05	-0.24
Age at first marriage	-0.02	-0.18	-0.20	-5.88	-0.22	-4.01
No prenatal assistance	-2.16	-1.72	-0.03	-0.05	0.03	0.04
Months of Breastfeeding	0.17	3.48	0.17	5.35	0.12	4.43
Months of Breastfeeding (squared)	0.65	1.63	0.15	0.92	-0.11	-0.51

Child's sex	0.00	-2.89	0.00	-4.13	0.00	-2.30
Mother has money for own use?	0.72	1.74	0.59	2.49	-0.19	-0.59
ICDS?	0.37	0.35	-0.57	-1.34	-0.66	-1.20
Risky water source	-0.14	-0.25	-0.57	-1.54	-0.43	-1.27
Risky sanitation	-0.02	-0.03	0.07	0.24	0.21	0.59
Wasted	-0.01	-0.02	0.15	0.40	0.08	0.20
Rural area	1.62	2.56	0.06	0.20	0.42	0.91
Slum	2.21	0.90	1.39	0.98	-1.50	-0.55
Almost Never Reads Newspaper	-0.97	-0.80	-0.91	-1.41	-0.51	-0.40
Reads Newspaper Less Than Once a Week	-1.26	-0.99	-0.34	-0.57	-0.20	-0.14
Reads Newspaper Atleast Once a Week	-0.85	-0.70	-0.52	-0.96	1.04	0.62
Almost Never Listens to Radio	0.17	0.17	-0.17	-0.38	-0.96	-1.52
Listens to Radio Less Than Once a Week	0.13	0.15	-0.19	-0.39	-0.94	-1.57
Listens to Radio Atleast Once a Week	0.33	0.28	0.60	0.84	0.12	0.15
Fully immunized	0.14	0.21	0.75	2.10	0.04	0.12
No Education	-1.87	-0.67	-0.83	-0.43	5.50	3.12
Primary Education	-0.89	-0.41	-0.22	-0.16	4.71	2.59
Secondary Education	-0.15	-0.08	-0.39	-0.33	2.97	1.79
Hindu	2.19	0.81	0.45	0.39	-1.68	-1.30
Muslim	2.05	0.79	0.93	0.73	-0.52	-0.45
Sikh	2.41	0.89	2.32	1.90	1.14	1.07
Buddhist	11.69	1.44	4.42	1.02	6.77	1.36
Jain	-6.16	-1.20	-7.23	-2.52	-5.04	-1.45
Jewish	6.55	1.46	-17.24	-2.05	-34.07	-2.01
Donyi/Polo	-14.83	-1.30	-12.01	-1.84	-1.26	-0.22
Other	4.50	0.85	0.43	0.14	2.56	1.00
Caste1	1.71	1.28	-0.25	-0.44	0.02	0.03
Caste2	0.03	0.03	-2.08	-3.12	-2.46	-3.46

Village Sex Ratio	12.05	0.89	23.60	2.06	23.34	1.80
Village Population	0.13	0.41	0.32	1.45	0.36	1.17
Average Wealth of Village	0.00	-0.35	0.00	-0.57	0.00	0.86
Share of Mothers with Secondary Education	0.73	0.58	0.49	1.01	1.00	1.66
Share of Mothers with Primary Education	1.28	1.11	0.25	0.33	1.37	1.55
Lack of Improved Sanitation	0.43	0.47	0.47	0.75	-1.26	-1.25
Electrification	-0.56	-0.75	0.12	0.30	0.09	0.30
Constant	39.64	2.38	55.38	4.05	80.09	4.71
Observations	10408		10408		10408	
R-squared	0.6519		0.8117		0.9483	
State Dummies	Yes		Yes		Yes	

Figure 6: OLS and Quantile Estimates for Stunting

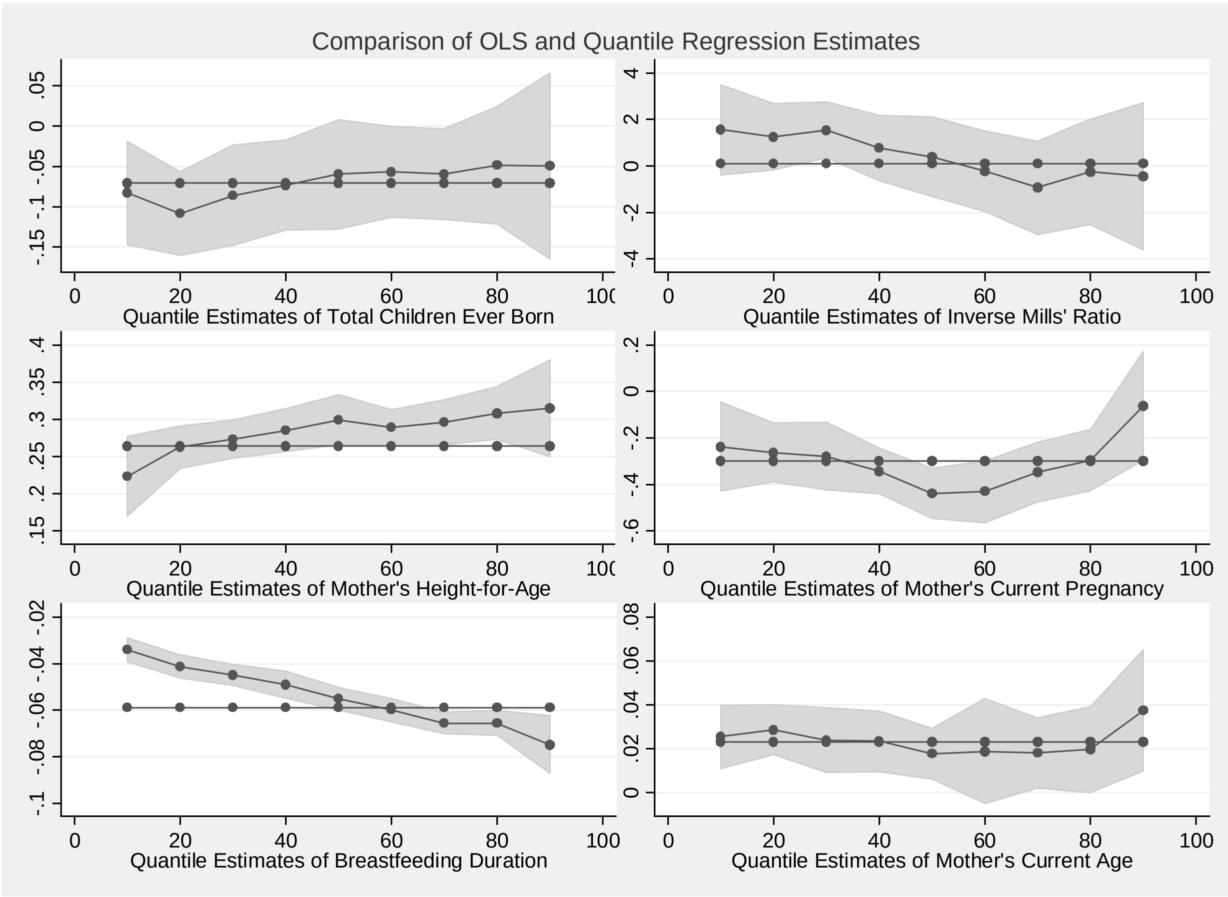


Figure 7: OLS and Quantile Estimates for BMI

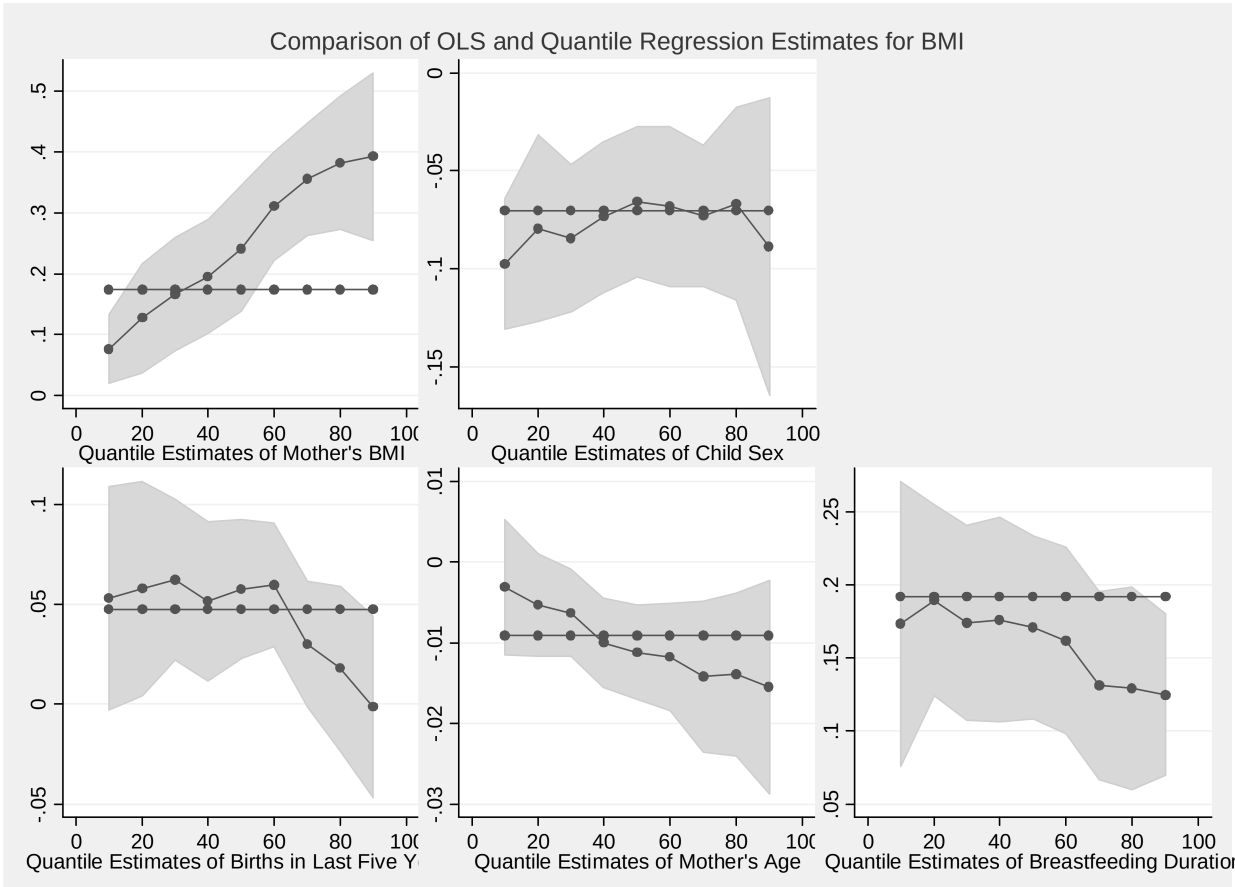
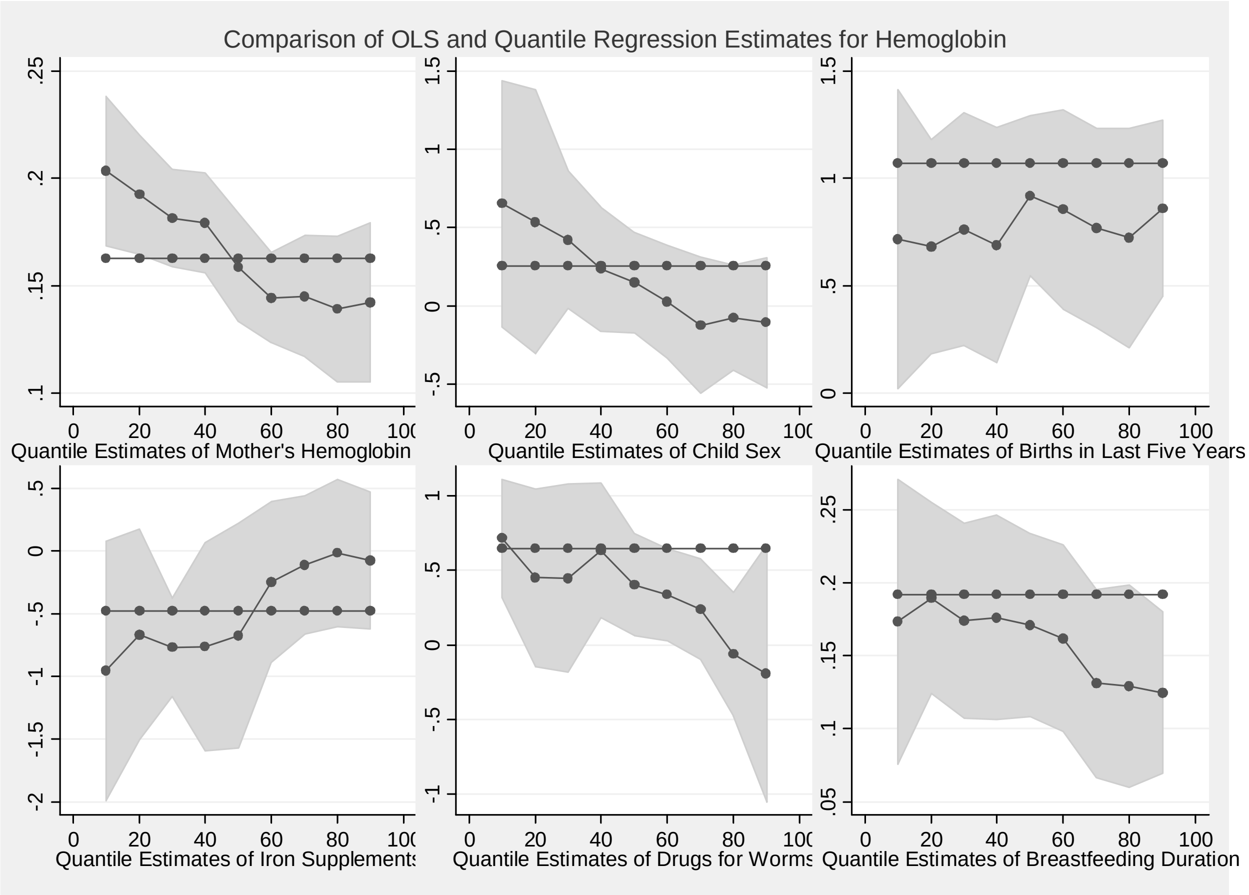


Figure 8: OLS and Quantile Estimates for Hemoglobin



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