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Determinants of child Anthropometrics in India: A quantile regression analysis

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Abstract: Reduction in child malnutrition is central to economic and social development in any country as it has dire ramifications to physical, psychological and mental development of individuals over the life course. Child malnutrition is also associated with higher morbidity and mortality incidence. Therefore, it is imperative to have knowledge of its correlates and determinants. Examination of determinants of child nutrition at different points of its distribution has better policy implications than investigating predictors on average value. Using NFHS-III (2005-06) data, this study investigates determinants of nutritional status -measured by standard anthropometric indicators- of children aged 0-59 months in India using quantile regression approach. Results show that age and birth order is negatively associated with height for age and weight for age z-scores but these are positively associated with the weight-for-height z-scores. Mothers' nutrition, educational level and better household environment are positively associated with the nutrition z-scores but these factors differential effects at different points of the conditional distribution of the anthropometric z-scores.

Introduction:

The reduction in child malnutrition is one of the most desirable components of the economic and social welfare. Child malnutrition is associated with higher mortality and morbidity (Pelletier, Frongillo, & Habicht, 1993; Pelletier, Frongillo, Schroeder, & Habicht, 1994, 1995). A large body of research on child health and nutrition argues that child malnutrition has dire implications for long term physical, cerebral and emotional development of the individual (Sen, 1999; UNICEF, 1998) The importance of child nutritional status in making of the efficient human capital makes reduction to child malnutrition central to the economic and social development agenda. To combat child malnutrition with right set of interventions, policy makers need to have better understanding of its economic, social and policy determinants.

A number of studies concerning the analysis of child malnutrition in India have focused on the estimating mean effect of different predictors like sex, socioeconomic variables and mother's education and direct supplement interventions on child malnutrition (Arnold, Nangia, & Kapil, 2004; Mishra, Roy, & Retherford, 2004; Nair, 2007; Pathak & Singh, 2011; Tarozzi & Mahajan, 2007). The previous studies focused on ascertaining the extent of child malnutrition and its determinants in India have neglected the point that socioeconomic background variables and policy interventions may affect child nutrition differently at different points of the distribution of indicator of nutritional status. For example, some of the predictors may not have significant impact on average but they may have considerable predicting capacity at the lower tail of conditional distribution of child nutritional level(Aturupane, Deolalikar, & Gunewardena, 2008; Borooah, 2005). In such situation the quantile regression has emerged as an efficient strategy to estimate effects of predictors at different points of the distribution of the dependent variable (Borooah, 2005; Koenker & Hallock, 2001).

Aims:

In the backdrop of above discussion, the main objective of this paper is to examine the determinants of child anthropometric indicators (measured in terms of z-scores using WHO reference for child growth) at different points of conditional distribution of z-scores of three anthropometric indicators of child nutritional status namely height-for-age, Weight-for-height and weight-for-age in India.

Data:

The data set required to fulfil the objectives of this study is the third round of National Family Health Survey (NFHS-III), an Indian version of DHS conducted 2005-06. NFHS-III collected information on various dimensions of child health and health care including anthropometric indicators for

children aged below five years. In NFHS-3, the height and weight (anthropometric measures) of all the children under five years of age in the household were measured to assess the nutritional status of children in India. In NFHS-III, 124385 women aged 15-49 years and 74369 men aged 15-54 are interviewed from a nationally representative sample of 109041 households. The survey collected anthropometric data on 55240 children below age 5 from the selected households. Of these, 51555 children belong to women who were interviewed in the women's questionnaire. This analysis is based on the children whose mother's information is available.

Methods:

The following standard indicators represent the nutritional status of children. Each of the following anthropometric indicators is expressed as the standard deviation units (Z-score) from the median of the reference population.

1. Height-for-age
2. Weight-for-height
3. Weight-for-age

Estimation framework for examining determinants child malnutrition:

The general estimation framework for examination of child malnutrition starts with defining the household preference model in which household maximizes utility. Households are assumed to choose child health H, leisure L, consumption of goods and services C, as if they are maximizing a household welfare function subject to the constraints pertaining to the health production function for nutritional status and budget. Preferences are assumed to be characterized by the utility function:

$$U=U(H, L, C: X_h, , \mu)$$

Where, X_h is a vector of household characteristics including the education level of the household head and his spouse, and μ unobserved heterogeneity of preferences.

The utility maximization process of the household results in a system of reduced form demand equations for child nutrition. The maximization process also leads to the derived demand equations for the food consumption. The demand equation for child nutrition is characterizes as follows:

$$Hi = F\ (Yi,Xi,Xh,Xc, i)$$

where Yi = vector of health inputs which are nutrient intake, health care practices, time spent by parents taking care of children, and disease incidence,

Xi, = vector of child characteristics which are age and gender, size at birth, birth interval etc.

Xc = vector of community characteristics that may have a direct impact on child health, which are the accessibility and quality of health services and safe water, and

i = are unobservable individual health endowments.

In addition, the choices of households are assumed to be limited by their full income constraint

$$I = PcC + WL + PY\ Y$$

where Pc and W, PY are the price vectors of consumption goods, leisure and health inputs respectively, and I is the full income including the value of the time endowment of the household and non-labor income. The reduced-form demand function for child health that results from the constrained maximization of household welfare is

$$Hi = \phi(Xi, Xh, Xc, I, Pc, P_Y, n_i)$$

Where, the particular functional form of the function ϕ(.) depends on the underlying functions characterizing household preferences and the health production function, and n_i represents unobserved heterogeneity in health outcomes.

The empirical form of above equation can be written as:

$$H_i = \alpha + X_i\beta + X_h\delta + X_c\theta + \varepsilon_i$$

Where Hi is a vector of anthropometric measures of the children under consideration, Xi , Xh, and Xc are vectors of covariates at the individual, household, and community level, respectively, and ε_i is an error term.

In this paper, we estimate the reduced-form of child nutritional equation at different points of the dependent variable's conditional distribution, using the quantile regression technique. The dependent variable will be the z-scores of the three anthropometric indicators which are height-for-age, weight-for-age and Weight-for-height.

Sample characteristics of the study population:

The study sample for this study consists of children below five years of age whose mothers have been interviewed and whose anthropometric information has been collected. Thus, total sample size for this study is 41306. The sample characteristics are given Table1. The sample has 52% male children. Eight percent children are aged below six months and 41 percent are aged 3- 5 years. 30 percent children are of first birth order, 44 percent are of 2nd or 3rd birth order and rest are of higher birth orders. Mothers of 39 percent children are underweight (mean BMI 17.1) 49 percent of children had mothers with no education. Twenty five percent children were from urban areas. Sixty three percent of the children belonged to households with no toilet facility and 79% of the children belonged to households using biomass fuel for cooking.

Results:

Prevalence of child malnutrition in India

The malnutrition among children aged 0-5years is measured in terms of stunting, underweight and wasting. The levels of stunting, underweight and wasting is ascertained through standardized anthropometric indices namely height for age, weight for age and weight for height. Each of these indicators is expressed as the standard deviation units (Z-score) from the median of the reference population (WHO reference population for child nutrition, 2006). As recommended by WHO, the

children whose height-for-age Z-score is less than -2 SD units from the median of the reference population are considered as stunted. Such children are referred as chronically malnourished. Stunting reflects under nutrition for long period of time and is also affected by recurrent and chronic illness. The children whose weight-for- height Z-score is less than -2SD units from the median of reference population are considered as Wasted. Wasting indicates the current nutritional status of the child. This also reflects the reduction in weight due to recent illness. The weight-for-age is a composite index of height-for-age and weight-for-height. It takes into account both acute and chronic malnutrition. The children whose weight-for-age Z-score is less than -2SD units from the median of reference population are classified as Underweight.

Table2 shows the prevalence of stunting, underweight and wasting among Indian children 0-5years by selected background characteristics in 2005-06. Results of the analysis indicate that about 48 percent of Indian children are stunted and 24 percent are severely stunted while around 43 percent children are underweight and 16 percent are severely underweight. Prevalence of wasting in Indian children is around 20 percent and 7 percent children are severely wasted.

The age of children appeared to be positively associated with child malnutrition as the prevalence of stunting and underweight increased with age, however, the prevalence of wasting decreased with age showing a negative relationship between age and wasting prevalence. Birth order of child depicted positive association with all the three indices of malnutrition. All the three measures of nutrition are negatively associated with child's size at birth.

The prevalence under-nutrition is negatively associated with mother' nutritional status measured in terms of body mass index (BMI) and educational status as the prevalence of all the three indicators of child malnutrition decreased with the increase in mother's nutrition and education levels.

Among household environment variables, prevalence of malnutrition varies significantly with various toilet facilities and household crowding levels. Children from those households which have flush toilet and who do not share with other households have significantly lower prevalence than those whose belongs to household with no toilet facility. Children from household where per bedroom at most two persons reside have relatively very low prevalence of malnutrition in compare to those whose household are very crowded like six or more persons per bedroom.

Determinants of nutrition in India:

In this paper, we have examined the effects of child characteristics, mother's characteristics and household environment on child nutrition in India using quantile regression analysis. The analysis reveals important differences in the role of predictors at different point of conditional distribution of z-scores. The quantile regression estimates for z-score of height-for-age, Weight-for-height and Weight-for-height are reported in table-3, 4 and 5 respectively, and we have also reported the estimates from OLS regression in the same table. The estimates of the regression models are

controlled for variables like social groups (caste and religion) of the mother, household wealth, place of residence and state.

Height-for-age:

Table3 presents OLS and quantile regression estimate for height for age z-scores of Indian children. OLS estimates show statistically significant effects of child characteristics namely age, birth order, and size at birth with z-score of height-for-age of the child. The quantile regression estimates suggest important differences in the effects of these variables at different points of the conditional distribution of z-score of height-for-age. At the bottom of the distribution (10^{th} percentile) of z-score, the effects of age are comparatively lower than that at the top of the distribution (90^{th} percentiles). As we move from the age up to six months of the children to age of 2 to 3 years or 3 to 5 years, z-score decreases by 1 point at 10^{th} quantile, more than 1.5 points at 50^{th} quantile and around 1.8 point at 90^{th} percentile. Sex of the child does not show significant effects on z-score. Another interesting finding is that there is significant negative of birth order at lower end (10^{th} quantile) and middle of the conditional distribution of z-score for height-for-age while at the upper tail of distribution (90^{th} percentile) the effect of birth order emerged to be positive. The effect of size at birth does not change over any point of the conditional distribution of height-for-age z-score but the effect is quite high e.g. in compare to small birth size, the z-score is around .30 point higher for average of high birth size.

The effects of mother's BMI at lower end of the conditional distribution does not increases as we move from underweight mothers to normal BMI mothers but the at middle or top of the distribution i.e. 50^{th} and 90^{th} quantile, Z-score increases .13 and .19 point respectively and for overweight mother the Z-score increases more than .20 points. Mother's education level has significantly very high effects on Z–score of height-for-age of the child. As mothers education level increases i.e. from uneducated or primary to secondary or higher educated, Z-score increment is comparatively very high at 10^{th} and 50^{th} quantile but this effect is underestimated if we consider mean regression estimates. The effects of mother's decision making autonomy, freedom of mobility and sexual autonomy are very low and insignificant.

Among household environment variables, type of toilet facilities has significant effect on child height-for-age Z-score. Children from those households which use share pit toilet of no toilet facility have 0.21 and 0.16 point lower score at 10^{th} and 50 quantile respectively than those which use unshared flush toilet. Most negative effect is for those households for all the conditional distribution of Z-score i.e. 10^{th}, 50^{th} and 90^{th} quantile who use shared pit toilet. At the middle of conditional distribution of Z-score the negative effect of biomass fuel used for cooking is relatively significant high in compare to LPG/Biogas but these effect or not significant at bottom or top of the conditional distribution. Separate room used as kitchen in the household has significant effect on the z-score of the child at middle and top of the distribution and increases the score around 0.1 points. Household crowding is also a very important determinant of Z-score for height-for-age of the child. As we move

from the household with two persons per sleeping to household with 6 or more persons per sleeping room, the Z-score decreases around 0.25 point at 10^{th} quantile and around 0.20 points at 50^{th} and 90^{th} quantile.

Weight-for-age:

Table-4 shows that the determinants of z-score of weight-for-age of the Indian children are similar as that for height-for-age but their effects at different quantiles are relatively lower for some variables like age, birth order of the child, mother's education and household environment predictors. The effect of mother's BMI has relatively higher effect on weight-for-age than that on height-for-age. For example, as we move from underweight mothers to overweight mothers, the Z-score for weight-for-age increases 0.5 points which is 0.25 point higher than increment in Z-score for height-for-age. At 10^{th} quantile of the conditional distribution Z-score of weight of the child increases 0.25 points as we move from children of underweight women to that of normal BMI women. Mother's education level has significantly very high effects on Z–score of weight-for-age of the child at the lower tail of the conditional distribution of Z-score.

Weight-for-height:

Weight-for-height is thought to be a good shorter-run measure of nutritional and health status of the child. Table-5 reveals that for the bottom of the condition distribution (i.e. 10^{th} quantile) of Z-score for Weight-for-height, the score increases about 0.1 points from male child to female child with high significance. Unlike Z-scores of height and weight-for-age, Weight-for-height Z-score is positively associated with age for 10^{th} and 50^{th} quantile but at 90^{th} quantile it is negatively associated. One point is quite notable that if we go for OLS regression estimates rather than quantile regression we woudn't be able to capture this interesting contrast. With improving mother's nutritional status, the Z-score of Weight-for-height increases significantly at all the quantiles i.e. 10^{th}, 50^{th} and 90^{th} quantile. Results reveal that household environment does not have significant effects on Weight-for-height Z-score of the child. This can be justified with the fact that household environment will affects the long term malnutrition indicator: height-for-age.

Conclusions:

Using quantile regressions, this paper has explored the effects of variables such as a child's age, birth order, size at birth; mother's nutritional status and mother's schooling; and household environment and sanitation on child nutrition at different points of the conditional distributions of z-score.

The regression results reveal that child age is negatively associated with z-scores at all the quintiles except weight-for-height z-score at bottom and middle quantile where age is positively associated. Mother's education has greater role in determining nutritional status of children at the lower quantiles z-scores indicators. While mother's nutritional status is found to have greater impact at the higher quintiles. Birth order is also negatively associated with child nutrition but it has higher impact at lower tail of the z-score conditional distribution. Availability of flush toilet and less household

crowding reduce the risk of chronic malnutrition specially stunting. In fact with the help of quantile regression we have been able to identify few explanatory variables like mother's education and availability of flush toilet in household have higher impact on lower quantiles. Therefore for raising the nutritional status of children in the lower tail of the conditional height-for-age and weight-for-age distributions, it may be important to target direct nutritional interventions, providing better sanitation facility and spreading awareness among uneducated women for tackling child malnutrition.

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Table No. 1: Sample characteristics of the study population

		Percentage	Mean	Standard Deviation	Sample size
Dependent variables					
	Height-for-age z-score		-1.87	1.66	
	Weight-for-age z-score		-1.78	1.23	
	Weight-for-height z-score		-1.02	1.29	
Independent variables					
Sex of the child	Male	52.3			21,462
Age of the child	Up to six months	8.4			3,346
	Seven months to one year	10.2			4,216
	One to two years	20.1			8,287
	Two to three years	20.0			8,422
	Three to five years	41.4			17,035
Birth order	1st	29.8			13,096
	2nd to 3rd	44.2			18,569
	4th to 5th	16.8			6,409
	6th & higher	9.2			3,232
Size of the child at birth	Small	20.5			8,072
	Average	55.7			23,265
	Large	23.8			9,339
Mother's BMI	Underweight (BMI<18.5)	38.9	17.09	1.03	13,398
	Normal BMI (18.5-24.9)	54.1	20.74	1.67	23,635
	Overweight (BMI>=25)	7.0	27.90	2.81	4,022
Mother's educational level	No education	49.2			16,482
	Primary	14.2			6,034
	Secondary	31.6			15,621
	Higher	5.0			3,169
Women Autonomy	Decision making index		55.2	36.8	
	Freedom of mobility index		39.4	41.7	
	Sexual autonomy index		80.8	32.0	
Place of residence	Urban	24.7			15,241
Type of Toilet Facility	Flush toilet(Not shared)	21.7			11,986
	Flush toilet (shared)	9.2			5,746
	Pit toilet (not shared)	3.7			2,833
	Pit toilet (shared)	2.0			1,608
	No facility	63.3			19,068
Source of drinking water	Improved	86.7			34,275
	Not improved	13.4			7,028
Type of fuel used	Electricity/LPG/Biogas	17.4			10,976
	biomass fuel	78.5			28,008
	kerosene/coal/charcoal	4.1			2,315
Whether separate room used as kitchen	No	47.9			12,849
	Yes	52.1			18,605
Number of persons per sleeping room	up to 2 persons	8.6			4,685
	3 to 5 persons	65.5			27,555
	More than 5 persons	25.9			9,019
Total					**41,306**

Table No. 2: Prevalence of child malnutrition according to three different anthropometric indices of nutritional status by background characteristics, India, 2005-06

Background Characteristics		Height-for- Age		Weight-for- Age		Weight-for- Height	
		Z-score < -2 S.D.	Z-score < -3 S.D.	Z-score < -2 S.D.	Z-score < -3 S.D.	Z-score < -2 S.D.	Z-score < -3 S.D.
Child Characteristics							
Age of the child	Up to 6 months	20.4	8.5	29.5	10.9	30.3	13.0
	6 to 12 months	28.6	11.8	35.5	13.8	29.0	10.4
	One to two years	52.4	26.0	43.2	16.8	22.8	7.5
	Two to three years	55.9	29.0	44.8	17.8	16.6	5.0
	Three to five years	52.5	26.1	45.4	15.9	15.5	4.3
Birth order	1st	41.0	17.9	36.0	11.9	17.8	5.4
	2nd to 3rd	47.7	22.3	41.3	14.3	19.5	6.3
	4th to 5th	54.3	30.5	49.7	21.1	21.7	7.5
	6th & higher	61.0	37.1	56.4	26.2	24.4	8.7
Size of the child at birth	Small	53.7	27.5	52.1	21.2	26.5	8.6
	Average	47.0	23.1	40.5	14.6	18.5	6.1
	Large	45.1	21.6	38.9	14.0	17.3	5.5
Mother's Characteristics							
Mother's BMI	Underweight (BMI<18.5)	53.5	27.3	51.9	20.9	25.1	7.8
	Normal BMI (18.5-24.9)	46.3	22.5	38.6	13.6	17.3	5.9
	Overweight (BMI>=25)	31.4	12.1	20.2	4.6	9.2	2.7
Mother's educational level	No education	57.2	31.6	51.9	22.1	22.7	7.9
	Primary	48.6	22.9	42.5	14.6	19.8	5.7
	Secondary	38.2	14.6	32.1	8.6	16.4	4.8
	Higher	19.4	5.5	15.8	4.3	13.0	4.3
Household Characteristics							
Place of residence	Urban	39.9	17.7	32.8	10.8	16.8	5.6
	Rural	50.7	25.7	45.7	17.5	20.8	6.7
Household assets quintile	First	60.1	34.4	56.1	24.5	23.9	8.5
	Second	55.0	29.4	51.2	20.9	23.8	7.5
	Third	49.5	23.7	42.3	14.5	19.1	6.1
	Fourth	41.9	17.1	35.1	10.7	17.5	5.1
	Fifth	26.8	8.8	20.9	4.9	12.8	4.1
Type of toilet facility	Flush toilet(Not shared)	33.0	12.5	26.7	7.4	13.8	4.4
	Flush toilet (shared)	41.7	18.1	35.3	10.1	17.5	5.4
	Pit toilet (not shared)	43.6	22.1	35.0	9.2	15.0	5.1
	Pit toilet (shared)	52.1	23.9	43.0	16.0	17.2	7.4
	No facility	54.3	28.5	49.4	20.0	22.6	7.3
Source of drinking water	Improved	47.9	23.4	41.8	15.4	19.2	6.1
	Not improved	48.8	25.7	47.0	19.0	23.7	8.5
Type of fuel used	Electricity/LPG/biogas	31.0	11.8	24.5	6.9	13.8	4.4
	Biomass fuel	52.0	26.6	46.7	18.0	21.2	6.9
	Kerosene/coal/charcoal	44.5	19.0	39.2	12.4	19.8	6.3
Separate room used as kitchen	No	54.6	29.1	49.1	19.9	22.2	7.5
	Yes	40.1	17.5	35.0	11.6	18.0	5.7
Number of persons per sleeping room	Up to 2 persons	34.3	13.7	29.3	9.5	18.1	5.5
	3 to 5 persons	46.5	21.9	41.3	14.6	19.1	6.1
	6 persons or more	56.5	31.5	50.0	21.0	22.1	7.7
Total		**48.04**	**23.71**	**42.5**	**15.83**	**19.82**	**6.43**

Table 3: Results from ordinary least square regression and quantile regression analysis for height-for-age Z-score for the Indian children of age up to five years, 2005-06

Background Characteristics	Height-for-age							
	OLS		Q10		Q50		Q90	
	Coeff.	95% CI	Coeff.	95% CI	Coeff.	95% CI	Coeff.	95% CI
Child characteristics								
***Sex of the child* (ref=Male)**								
Female	0.03*	(0 - 0.07)	0.04**	(0 - 0.07)	0.04**	(0 - 0.08)	0	(-0.07 - 0.07)
***Age of the child* (ref=Up to six months)**								
6 to 12 months	-0.46***	(-0.54 - -0.37)	-0.31***	(-0.49 - -0.14)	-0.55***	(-0.7 - -0.41)	-0.57***	(-0.78 - -0.37)
One to two years	-1.38***	(-1.45 - -1.31)	-1***	(-1.16 - -0.85)	-1.51***	(-1.61 - -1.4)	-1.66***	(-1.8 - -1.51)
Two to three years	-1.5***	(-1.57 - -1.43)	-1.09***	(-1.23 - -0.95)	-1.61***	(-1.72 - -1.49)	-1.82***	(-1.98 - -1.66)
Three to five years	-1.44***	(-1.5 - -1.37)	-0.9***	(-1 - -0.79)	-1.51***	(-1.61 - -1.4)	-1.88***	(-2.03 - -1.73)
***Birth order* (ref=1st order)**								
2nd to 3rd	-0.08***	(-0.12 - -0.04)	-0.13***	(-0.19 - -0.07)	-0.1***	(-0.14 - -0.07)	0.01	(-0.05 - 0.07)
4th to 5th	-0.09**	(-0.15 - -0.03)	-0.25***	(-0.37 - -0.13)	-0.12**	(-0.19 - -0.04)	0.12**	(0 - 0.25)
6th & higher	-0.18***	(-0.26 - -0.1)	-0.29***	(-0.4 - -0.19)	-0.28***	(-0.38 - -0.18)	0.12	(-0.05 - 0.3)
***Size of the child at birth* (ref=Small)**								
Average	0.26***	(0.21 - 0.31)	0.29***	(0.2 - 0.38)	0.26***	(0.21 - 0.31)	0.28***	(0.18 - 0.37)
Large	0.32***	(0.27 - 0.37)	0.35***	(0.23 - 0.47)	0.32***	(0.26 - 0.38)	0.31***	(0.2 - 0.43)
Mother's Characteristics								
***Mother's BMI* (ref=Underweight (BMI<18.5))**								
Normal BMI (18.5-24.9)	0.13***	(0.09 - 0.17)	0.08**	(0.01 - 0.15)	0.13***	(0.08 - 0.17)	0.19***	(0.13 - 0.26)
Overweight (BMI>=25)	0.25***	(0.19 - 0.32)	0.22***	(0.09 - 0.35)	0.27***	(0.21 - 0.34)	0.24***	(0.12 - 0.35)
Mother's education (ref=No education)								
Primary	0.04	(-0.02 - 0.09)	0.14**	(0.01 - 0.27)	0.04	(-0.03 - 0.11)	-0.04	(-0.14 - 0.07)
Secondary	0.13***	(0.08 - 0.18)	0.29***	(0.17 - 0.4)	0.13***	(0.09 - 0.16)	0.05	(-0.08 - 0.17)
Higher	0.42***	(0.33 - 0.5)	0.58***	(0.44 - 0.72)	0.44***	(0.35 - 0.53)	0.41***	(0.26 - 0.56)
Women Autonomy								
Decision making	0.01**	(0 - 0.02)	0.02	(-0.01 - 0.05)	0.01	(0 - 0.03)	0.02	(-0.02 - 0.05)
Freedom of mobility	0.01**	(0 - 0.03)	-0.01	(-0.03 - 0.02)	0.02**	(0 - 0.04)	0.01	(-0.01 - 0.04)
Sexual autonomy	0	(-0.01 - 0.01)	0	(-0.02 - 0.03)	0	(-0.01 - 0.02)	0.01	(-0.02 - 0.03)
Household Characteristics								
Toilet Facility (ref=Unshared flush toilet)								
Shared Flush toilet	-0.11***	(-0.17 - -0.05)	-0.15**	(-0.26 - -0.03)	-0.16***	(-0.23 - -0.09)	-0.08	(-0.2 - 0.05)
Unshared pit toilet	-0.03	(-0.11 - 0.06)	-0.16**	(-0.32 - 0)	-0.05	(-0.13 - 0.03)	0.08	(-0.11 - 0.28)
Shared pit toilet	-0.18***	(-0.29 - -0.07)	-0.22**	(-0.37 - -0.07)	-0.16**	(-0.26 - -0.05)	-0.27**	(-0.49 - -0.05)
No facility	-0.15***	(-0.22 - -0.09)	-0.21***	(-0.3 - -0.12)	-0.15***	(-0.22 - -0.08)	-0.07	(-0.17 - 0.03)
Source of Drinking water (ref=Improved)								
Not improved	0.04	(-0.01 - 0.09)	-0.05	(-0.13 - 0.03)	0.03	(-0.02 - 0.09)	0.06	(-0.04 - 0.15)
type of fuel used (ref=Electricity/LPG/Biogas)								
Biomass fuel	-0.07**	(-0.13 - -0.01)	-0.07	(-0.22 - 0.07)	-0.11***	(-0.15 - -0.07)	-0.01	(-0.12 - 0.1)
Kerosene/coal/charcoal	-0.02	(-0.1 - 0.06)	-0.01	(-0.18 - 0.16)	0.02	(-0.04 - 0.08)	-0.09	(-0.22 - 0.04)
Separate room used as kitchen (ref=No)								
Yes	0.1***	(0.06 - 0.14)	0.05	(-0.04 - 0.15)	0.1***	(0.05 - 0.15)	0.08**	(0.01 - 0.15)
Persons per sleeping room (ref=Up to 2 persons)								
3 to 5 persons	-0.15***	(-0.21 - -0.09)	-0.16***	(-0.25 - -0.06)	-0.12***	(-0.16 - -0.08)	-0.2***	(-0.28 - -0.11)
6 persons or more	-0.21***	(-0.29 - -0.14)	-0.25***	(-0.36 - -0.15)	-0.2***	(-0.26 - -0.13)	-0.2***	(-0.31 - -0.09)

Notes: *** refers p-value < .001; ** refers .001 < p-value < 0.05; * refers 0.5 < p-value <= 0.1; OLS- ordinary least square; CI-confidence interval; caste, religion, place of residence, household wealth and state are used as controls in the regression models.

Table 4: Results from ordinary least square regression and quantile regression analysis for weight-for-age Z-score for the Indian children of age up to five years, 2005-06

Background Characteristics	Weight-for-age							
	OLS		Q10		Q50		Q90	
	Coeff.	95% CI	Coeff.	95% CI	Coeff.	95% CI	Coeff.	95% CI
Child characteristics								
***Sex of the child* (ref=Male)**								
Female	-0.02	(-0.04 - 0.01)	-0.03	(-0.08 - 0.01)	-0.01	(-0.04 - 0.02)	-0.02	(-0.06 - 0.02)
***Age of the child* (ref=Up to six months)**								
6 to 12 months	-0.16***	(-0.23 - -0.1)	-0.05	(-0.23 - 0.12)	-0.15***	(-0.23 - -0.07)	-0.26***	(-0.4 - -0.12)
One to two years	-0.38***	(-0.43 - -0.32)	-0.2**	(-0.36 - -0.04)	-0.36***	(-0.41 - -0.31)	-0.54***	(-0.64 - -0.45)
Two to three years	-0.51***	(-0.56 - -0.46)	-0.29***	(-0.44 - -0.13)	-0.53***	(-0.58 - -0.47)	-0.71***	(-0.81 - -0.61)
Three to five years	-0.56***	(-0.61 - -0.51)	-0.24***	(-0.39 - -0.1)	-0.56***	(-0.6 - -0.52)	-0.86***	(-0.96 - -0.77)
***Birth order* (ref=1st order)**								
2nd to 3rd	-0.08***	(-0.12 - -0.05)	-0.07**	(-0.14 - 0)	-0.1***	(-0.13 - -0.06)	-0.07**	(-0.13 - -0.01)
4th to 5th	-0.09***	(-0.14 - -0.05)	-0.13**	(-0.23 - -0.03)	-0.12***	(-0.17 - -0.06)	0	(-0.08 - 0.08)
6th & higher	-0.2***	(-0.25 - -0.14)	-0.23***	(-0.35 - -0.11)	-0.26***	(-0.34 - -0.19)	-0.1	(-0.22 - 0.03)
***Size of the child at birth* (ref=Small)**								
Average	0.3***	(0.27 - 0.34)	0.33***	(0.29 - 0.38)	0.31***	(0.28 - 0.34)	0.28***	(0.19 - 0.36)
Large	0.4***	(0.36 - 0.44)	0.43***	(0.35 - 0.5)	0.41***	(0.37 - 0.45)	0.38***	(0.29 - 0.47)
Mother's Characteristics								
***Mother's BMI* (ref=Underweight (BMI<18.5))**								
Normal BMI (18.5-24.9)	0.29***	(0.26 - 0.32)	0.25***	(0.2 - 0.3)	0.29***	(0.25 - 0.33)	0.35***	(0.3 - 0.4)
Overweight (BMI>=25)	0.51***	(0.46 - 0.55)	0.5***	(0.43 - 0.57)	0.5***	(0.45 - 0.55)	0.55***	(0.47 - 0.64)
Mother's education (ref=No education)								
Primary	0.05**	(0.01 - 0.1)	0.11**	(0.03 - 0.19)	0.05*	(0 - 0.1)	0.01	(-0.06 - 0.08)
Secondary	0.16***	(0.12 - 0.19)	0.24***	(0.17 - 0.3)	0.14***	(0.1 - 0.19)	0.1***	(0.05 - 0.15)
Higher	0.39***	(0.33 - 0.45)	0.44***	(0.34 - 0.54)	0.38***	(0.29 - 0.46)	0.41***	(0.3 - 0.51)
Women Autonomy								
Decision making	0	(-0.01 - 0.01)	0.01	(-0.01 - 0.02)	0	(-0.01 - 0.01)	-0.01	(-0.02 - 0.01)
Freedom of mobility	0.01	(0 - 0.02)	0.01	(-0.01 - 0.03)	0.01**	(0 - 0.02)	0.01	(-0.01 - 0.03)
Sexual autonomy	0.01	(0 - 0.02)	0.02*	(0 - 0.04)	0.01**	(0 - 0.02)	0	(-0.01 - 0.01)
Household Characteristics								
Toilet Facility (ref=Unshared flush toilet)								
Shared Flush toilet	-0.09***	(-0.13 - -0.04)	-0.08*	(-0.16 - 0.01)	-0.1**	(-0.16 - -0.04)	-0.1**	(-0.18 - -0.02)
Unshared pit toilet	0.02	(-0.04 - 0.09)	0.01	(-0.1 - 0.13)	0	(-0.07 - 0.07)	0.05	(-0.11 - 0.2)
Shared pit toilet	-0.1**	(-0.18 - -0.02)	-0.13**	(-0.26 - 0)	-0.04	(-0.13 - 0.06)	-0.17**	(-0.31 - -0.04)
No facility	-0.08***	(-0.13 - -0.04)	-0.12***	(-0.19 - -0.05)	-0.07**	(-0.14 - -0.01)	-0.07	(-0.15 - 0.01)
Source of Drinking water (ref=Improved)								
Not improved	-0.01	(-0.04 - 0.03)	-0.03	(-0.09 - 0.03)	-0.02	(-0.07 - 0.02)	0.07*	(-0.01 - 0.15)
type of fuel used (ref=Electricity/LPG/biogas)								
Biomass fuel	-0.06**	(-0.1 - -0.01)	-0.01	(-0.08 - 0.07)	-0.06*	(-0.13 - 0)	-0.03	(-0.12 - 0.06)
Kerosene/coal/charcoal	-0.02	(-0.08 - 0.04)	-0.02	(-0.11 - 0.07)	0	(-0.09 - 0.08)	0.01	(-0.1 - 0.13)
Separate room used as kitchen (ref=No)								
Yes	0.05**	(0.02 - 0.08)	0.05**	(0 - 0.09)	0.04**	(0.01 - 0.08)	0.05*	(-0.01 - 0.11)
Persons per sleeping room (ref=Up to 2 persons)								
3 to 5 persons	-0.09***	(-0.13 - -0.04)	-0.07*	(-0.15 - 0.01)	-0.09**	(-0.16 - -0.03)	-0.08**	(-0.15 - -0.02)
6 persons or more	-0.1***	(-0.15 - -0.05)	-0.1**	(-0.19 - -0.01)	-0.1**	(-0.18 - -0.02)	-0.13**	(-0.23 - -0.04)

Notes: *** refers p-value < .001; ** refers .001 < p-value < 0.05; * refers 0.5 < p-value <= 0.1; OLS- ordinary least square; CI- confidence interval; caste, religion, place of residence, household wealth and state are used as controls in the regression models.

Table 5: Results from ordinary least square regression and quantile regression analysis for Weight-for-height Z-score for the Indian children of age up to five years, 2005-06

Background Characteristics	Weight-for-height							
	OLS		Q10		Q50		Q90	
	Coeff.	95% CI	Coeff.	95% CI	Coeff.	95% CI	Coeff.	95% CI
Child characteristics								
***Sex of the child* (ref=Male)**								
Female	0.03**	(0 - 0.06)	0.1***	(0.06 - 0.15)	0.02*	(0 - 0.05)	-0.03	(-0.07 - 0.02)
***Age of the child* (ref=Up to six months)**								
6 to 12 months	0.09**	(0.02 - 0.15)	0.39***	(0.25 - 0.53)	0.11**	(0.01 - 0.22)	-0.28**	(-0.47 - -0.1)
One to two years	0.22***	(0.16 - 0.28)	0.78***	(0.64 - 0.92)	0.32***	(0.25 - 0.39)	-0.42***	(-0.57 - -0.28)
Two to three years	0.23***	(0.17 - 0.29)	0.93***	(0.82 - 1.05)	0.33***	(0.26 - 0.41)	-0.56***	(-0.71 - -0.42)
Three to five years	0.19***	(0.13 - 0.24)	0.97***	(0.87 - 1.08)	0.28***	(0.22 - 0.33)	-0.67***	(-0.81 - -0.54)
***Birth order* (ref=1st order)**								
2nd to 3rd	-0.05**	(-0.08 - -0.01)	-0.04	(-0.12 - 0.05)	-0.05**	(-0.08 - -0.02)	-0.03	(-0.1 - 0.04)
4th to 5th	-0.06**	(-0.11 - 0)	-0.03	(-0.1 - 0.04)	-0.08**	(-0.13 - -0.03)	-0.06	(-0.17 - 0.05)
6th & higher	-0.13***	(-0.2 - -0.06)	-0.1	(-0.26 - 0.05)	-0.12***	(-0.18 - -0.06)	-0.09*	(-0.19 - 0.01)
***Size of the child at birth* (ref=Small)**								
Average	0.22***	(0.18 - 0.25)	0.22***	(0.16 - 0.28)	0.24***	(0.21 - 0.27)	0.18***	(0.11 - 0.25)
Large	0.3***	(0.26 - 0.35)	0.32***	(0.25 - 0.39)	0.34***	(0.29 - 0.38)	0.24***	(0.15 - 0.34)
Mother's Characteristics								
***Mother's BMI* (ref=Underweight (BMI<18.5))**								
Normal BMI (18.5-24.9)	0.31***	(0.27 - 0.34)	0.29***	(0.23 - 0.35)	0.33***	(0.29 - 0.36)	0.34***	(0.29 - 0.39)
Overweight (BMI>=25)	0.52***	(0.46 - 0.57)	0.56***	(0.45 - 0.67)	0.53***	(0.48 - 0.58)	0.58***	(0.48 - 0.67)
Mother's education (ref=No education)								
Primary	0.04	(-0.01 - 0.09)	0.12**	(0.04 - 0.2)	0.03	(-0.03 - 0.09)	-0.06	(-0.14 - 0.03)
Secondary	0.11***	(0.07 - 0.15)	0.16***	(0.09 - 0.24)	0.1***	(0.05 - 0.15)	0.06	(-0.02 - 0.15)
Higher	0.21***	(0.14 - 0.28)	0.19**	(0.06 - 0.33)	0.22***	(0.15 - 0.29)	0.15**	(0.01 - 0.29)
Women Autonomy								
Decision making	-0.01*	(-0.02 - 0)	-0.01	(-0.03 - 0.01)	-0.01	(-0.02 - 0.01)	-0.02**	(-0.04 - 0)
Freedom of mobility	0	(-0.01 - 0.01)	0	(-0.02 - 0.02)	0	(-0.02 - 0.01)	0.01	(-0.01 - 0.03)
Sexual autonomy	0.01*	(0 - 0.02)	0.02	(0 - 0.04)	0.01	(-0.01 - 0.02)	0	(-0.02 - 0.02)
Household Characteristics								
Toilet Facility (ref=Unshared flush toilet)								
Shared Flush toilet	-0.03	(-0.08 - 0.02)	-0.01	(-0.1 - 0.08)	-0.01	(-0.06 - 0.05)	-0.1*	(-0.2 - 0)
Unshared pit toilet	0.05	(-0.02 - 0.13)	0.06	(-0.06 - 0.18)	0.03	(-0.04 - 0.09)	0.14*	(-0.01 - 0.29)
Shared pit toilet	0.02	(-0.08 - 0.11)	-0.02	(-0.22 - 0.19)	0.06	(-0.05 - 0.16)	0.02	(-0.13 - 0.18)
No facility	0.01	(-0.05 - 0.06)	0	(-0.07 - 0.07)	0	(-0.04 - 0.05)	0.04	(-0.09 - 0.17)
Source of Drinking water (ref=Improved)								
Not improved	-0.04*	(-0.08 - 0.01)	-0.07	(-0.16 - 0.02)	-0.03	(-0.08 - 0.02)	-0.01	(-0.08 - 0.06)
type of fuel used (ref=Electricity/LPG/Biogas)								
Biomass fuel	-0.02	(-0.07 - 0.03)	0.01	(-0.09 - 0.11)	-0.01	(-0.06 - 0.04)	-0.03	(-0.14 - 0.08)
Kerosene/coal/charcoal	-0.01	(-0.08 - 0.06)	0.01	(-0.12 - 0.13)	0	(-0.08 - 0.08)	0	(-0.19 - 0.18)
Separate room used as kitchen (ref=No)								
Yes	-0.01	(-0.05 - 0.02)	-0.02	(-0.08 - 0.03)	-0.02	(-0.05 - 0.01)	0.01	(-0.04 - 0.06)
Persons per sleeping room (ref=Up to 2 persons)								
3 to 5 persons	0	(-0.04 - 0.05)	0.04	(-0.07 - 0.14)	-0.01	(-0.06 - 0.04)	0.01	(-0.09 - 0.12)
6 persons or more	0.03	(-0.03 - 0.09)	0.04	(-0.09 - 0.17)	0.02	(-0.04 - 0.09)	0.05	(-0.06 - 0.16)

Notes: *** refers p-value < .001; ** refers .001 < p-value < 0.05; * refers 0.5 < p-value <= 0.1; OLS- ordinary least square; CI-confidence interval; Coefficient are controlled for caste, religion, place of residence, household wealth and states.