Draft

Anthropometric Failure and Persistence of Poverty in Rural India

Raghav Gaiha
Faculty of Management Studies
University of Delhi

and
Veena Kulkarni
Department of Sociology and Maryland Population Research Center
University of Maryland College Park
email vkulkarni@socy.umd.edu

Abstract

Recent studies have drawn attention to the high prevalence of stunting among children in rural India. In fact, these estimates point to more pervasive deprivation than conventional measures of poverty based on income or consumption expenditure shortfalls imply. Since stunting reflects cumulative nutritional and health deprivation, it is likely to persist *despite* higher incomes. With a view to shedding some new light on this issue, an analysis of the determinants of stunting is carried out, based on a recent all-India survey of rural households. While income matters, other factors acting independently of it matter too. These include household size, whether household head is male, caste affiliation, mother's age at marriage, mother's age, age composition of children, male-female wage differences, hygiene and sanitation facilities, and prices of food items. So, while higher incomes will help mitigate stunting, careful attention must also be given to enhancing women's autonomy through more remunerative employment opportunities for them, enabling households to improve hygiene and sanitation facilities, and facilitating more competitive local markets for food.

Key words: Stunting, chronic deprivation, autonomy, hygiene and sanitation, food prices.

JEL Classification: D1, D63, H51, I12

Anthropometric Failure and Persistence of Poverty in Rural India[1]

Introduction

In recent years, there has been a growing realisation that poverty is multi-dimensional and money-metric indicators such as minimum income or expenditure cannot adequately capture all these dimensions. Attention has therefore shifted to other indicators such as health status that relate more closely to basic capabilities of individuals. An important point is that the correspondence between basic capabilities (e.g. to live a healthy and productive life) and level of income is often weak (Sen, 1985, 1999).[2]It is therefore not surprising that a wide range of indicators including income/expenditure, health and education reflect a diverse pattern in India during the 1990s. In fact, as emphasised in a recent study, while most indicators have continued to improve during the 1990s, social progress has followed diverse patterns, ranging from accelerated progress in some fields to slowdown and even regression in others.[3]

The present study focuses on a specific anthropometric indicator viz., stunting among children below 5 years, as a measure of chronic nutritional and health deprivation. The prevalence of stunting is highest in South Asia (about 63 per cent as against 42 per cent in developing countries as a whole).[4] More recent estimates confirm that this region continues to be the worst affected in this respect, with prevalence rates well above 50 per cent in India and Bangladesh, implying that one out of every two pre-school children is stunted.[5] Available projections of likely decline for the period 1995-2005 also paint a grim picture.[6]

Growth stunting in childhood is a serious concern as it is likely to result in greater mortality, poor cognitive and motor development, and other impairments. Chronic nutritional deprivation in early childhood may also lead to a later reduction in IQ of as much as 15 points, significantly affecting schooling achievement and increasing the risk of drop –out. Besides, stunting along with low birth weight (LBW) may expose them to a

[1] This has benefited from the advice of K. L. Krishna, Anil Deolalikar, P. Bardhan, A.de Janvry, Phrang Roy, G. Thapa, P. Eklund, S. Kennedy, R. Jha, F. Bresciani, and K. Imai. The views expressed here are, however, those of the authors.

[2] There is a great deal of variability between low capabilities, such as undernourishment, and low incomes, and this relationship is conditional, differing by community, families and individuals. More specifically, the contribution of income or expenditure to explaining health outcomes is limited. Sahn and Stifel (2002a), for example, report that the correlation coefficient between a wealth index derived using factor analysis and a health indicator ranges from 0.081 to 0.243 in a sample of 10 countries.

[3] Deaton and Dreze (2002) show that improvements in income poverty went hand in hand with a decline in female-male ratio among children, from 945 girls per 1000 boys (in the 0-6 age group) in 1991 to 927 girls per 1000 boys in 2000. In another but more sceptical review, Cassen (2002) also paints a mixed picture of social progress.

[4] These estimates are based on UNICEF (1993). For an assessment, see Svedberg (2001).

[5] For details, see ADB & IFPRI (2001).

[6] For details, see ADB & IFPRI (2001). Note that the regional classification used is different, as Central Asian Republics are also included.

higher risk of chronic adult disease.[7] While these links have not been conclusively established for lack of detailed panel data and matching controls for other variables, it is nevertheless arguable that chronic nutritional deprivation in childhood is likely to make it harder to live a healthy and productive life.[8] Thus nutritionally deprived children may get trapped in a vicious circle of poverty that reinforces itself.[9]

As a response to acute and pervasive malnutrition of children in India –of which stunting is one manifestation- it was envisaged in 1993 that malnutrition among children will be reduced by half in 2000 towards fulfilment of National Nutrition Goals[10]. On present evidence of slow progress it seems unlikely that this goal will be met in the near future. The present study is motivated by this concern. The main objective is to identify and assess the factors underlying stunting in rural India, based on an analysis of a nation-wide survey of rural households in 1994. In particular, an attempt is made to demonstrate that, while income matters, other factors acting independently of it have an important role too in determining the prevalence of stunting. As in an earlier contribution (Rosenzweig and Schultz, 1982), male-female wage difference has a positive effect on stunting. Other factors that matter include household size, whether household head is male, caste affiliation, access to drinking water, hygiene and sanitation facilities, mother's marriage age, age composition of children, and prices of food items. So, from a broad policy perspective, careful attention must be given to not just raising incomes and enabling households to improve their hygiene and sanitation facilities but also to enhancing women's autonomy through higher earnings relative to men's.

The scheme is as follows: Section 1 describes the salient features of the household survey on which the analysis is based; Section 2 discusses the methodology used for assessing the contribution of various household and village characteristics to stunting; Section 3 is devoted to a discussion of the results; and, in Section 4, some concluding observations are made from a broad policy perspective.

---

[7] The so- called Barker hypothesis posits that maternal dietary imbalances at critical periods of development in the womb can trigger an adaptive redistribution of fetal resources (including growth retardation). Such adaptations affect fetal structure and metabolism in ways that predispose the individual to later cardiovascular and endocrine diseases (ADB & IFPRI, 2001). For a more recent and thorough appraisal, see Osmani and Sen (2003).

[8] In a meticulous review of available evidence, Svedberg (2001) cautions against hasty generalisations. He points out, for example, that the link between chronic undernutrition in childhood, as reflected in short stature, and work capacity in adulthood is far from straightforward. Although there is some evidence linking shortness to low maximum physical work capacity, as measured by VO_2 max, this is so only among those who are considerably below the norm. Besides, tallness is an advantage only in some activities such as sugar and timber cutting, carrying heavy loads, digging or shovelling earth. In several other activities, tallness may not matter much. These activities include household tasks, and light agricultural work, in which quickness, flexibility and mobility matter more.

[9] In a stylized contribution, Dasgupta (1993,1995) reverses the causation between poverty and undernutrition, arguing that undernutrition causes poverty but not necessarily the other way round. Among those who contest the existence of such nutrition-poverty traps, see Srinivasan (1994), and Subramaniam and Deaton (1996).

[10] Other goals include substantial reductions in LBW, iron deficiency anemia in pregnant women, and iodine deficiency disorders (World Bank, 1998).

Section 1

Data

The data were collected through a multi-purpose household survey, designed and conducted by the National Council of Applied Economic Research (NCAER). This survey was spread over six months, from January to June, 1994. The data were collected using varied reference periods based on some conventional rules. For example, to estimate household income in rural agricultural households, cultivation and output figures used refer to the previous agricultural year. Similarly, to estimate short duration morbidity, occurrence of sickness during the preceding 30 days was recorded, but for major morbidity the reference period was the previous year.

A multi-stage sample design was chosen, in light of cost and time considerations, operational feasibility, and precision of the estimates.

In each of the 16 states covered, the districts were cross-classified by income from agriculture and rural female literacy rate to form homogeneous strata in terms of these two variables.[11] From each of these strata a pre-assigned number of districts, depending on the size of the stratum, were selected with probability proportional to the rural population in the district. Given the list of villages in the sample districts in Census records, a pre-assigned number of villages were then selected linear systematically after arranging the villages in a *tehsil* (an administrative block) alternately in ascending and descending order of rural female literacy. The households in the sample villages were listed along with information such as religion, caste, major sources of income, cultivable land, and other social and demographic characteristics. These attributes of the listed households were used for their stratification. Two groups of listed households were classified as Stratum 1 and Stratum 2. These were:
Stratum 1: Households with at least one pregnant woman,
Stratum 2: Households with at least one child aged less than 12 months but no pregnant woman.

The remaining households were stratified according to religion, ethnic group, and the occupation of the head of the household. Sample households from each of the strata so formed were selected linear systematically. Thus a total sample of 35,130 households spread over 1,765 villages and 195 districts in 16 states was selected. It is a rich data set covering anthropometric and other relevant data on household members and village characteristics.

[11] To be more precise, the NCAER survey covered 15 states and all north-eastern states were clubbed into one (Shariff, 1999).

Section 2

Methodology

(a) Specification

With a view to assessing the causal roles of various factors in stunting, a micro-economic framework is delineated here. It serves as the basis of the reduced- form demand relations for health outcomes, of which stunting is a special case[12] It is a one-period household model with constrained maximisation of a joint utility function without uncertainty[13]. The household is postulated to maximise a utility function (synonymous with household welfare), depending on food consumption, non-food consumption, health, time use of each household member, and number of household members, among other variables.[14] It is subject to two (sets of) constraints, given assets and prices. The first (set) consists of "production functions" broadly defined, and the second is a "full ïncome" budget constraint.

Three production functions are considered: for health, mortality and nutrients. These are delineated below.

(i) The health of the ith individual is produced by the nutrients consumed by that individual, other health related inputs (e.g. medicines, cigarettes), his or her endowments (e.g. inherent robustness), educational attainment of this individual and of the mother/wife, time use of this individual and that of the mother/wife, quality of housing (e.g. whether it has electricity, clean drinking water, drainage facilities), and village infrastructure (e.g. whether a medical facility exists in the village, and distance to it)[15].

(ii) The mortality function for the ith individual is linked closely to that person's health, with mortality resulting if health falls below some critical level. The critical level may of course vary across individuals.

(iii) The nutrient intake of the ith individual depends on the food intake of that individual, time use and capacity of the mother/wife, and the household environment.

The second constraint is on time and monetary resources (i.e. the full income constraint), where the left side gives the total value of full income: the total time of each household member valued at the appropriate wage rate/opportunity cost of time plus net income from all sources other than labour of household members; and the right side gives total resource expenditures: the sum of consumption plus the value of leisure time, time spent

[12] This framework is adapted from Behrman and Deolalikar (1988). For an application of this model to assess the effects of structural adjustment on household welfare, see Gaiha (1991).

[13] In a neoclassical model, given risk aversion, an implication of uncertainty is that individuals avoid uncertain outcomes, as compared with certain ones. While it would be interesting to explore the impact of uncertainty on decisions relating to nutrition and health, it has not been done so far.

[14] To avoid cluttering the text with too many technical details, the exposition is brief and selective. For details, see Behrman and Deolalikar (1988).

[15] See also Schiff and Valdes (1990) for some elaboration.

in schooling, and asset changes for all household members.[16] The first order conditions for constrained maximisation of the household utility function lead to reduced- form demand relations.[17] Of particular interest here is the health demand relation in which stunting of children < 5 years appears as an anthropometric measure of health outcome. Treating this as the dependent variable, the right side variables include prices, household income (or expenditure as a proxy), household endowments in terms of human and physical assets, and village endowments in terms of infrastructure. This general specification is adapted for estimation with the NCAER household survey as follows.

The first issue is the specification of stunting as the dependent variable. It is based on standardised height- for- age or z-scores of children under 5 years of age, as shown below.

$$\text{z-score} = (x_i - x_{median}) / \sigma^x, \qquad (1)$$

where x_i is height of child i, x_{median} is the median height for a healthy and well-nourished child from a reference population of the same age and gender, and σ^x is the standard deviation from the mean of the reference population.[18]The z-score for the reference population has a standard normal distribution in the limit. Thus, there is a probability distribution on the expected value of a z-score for any given child-specifically, a standard normal distribution. In other words, there is a less than 2.3 per cent probability that a healthy child will have a z-score of less than –2. Accordingly, the convention is that children whose z-scores fall below –2 are classified as stunted.[19] In addition, a cut-off point of –3z-score is used to identify the severely stunted. Those with z scores between –2 and –3 are classified as moderately stunted.

As noted earlier, stunting is an indicator of growth failure, resulting from chronic nutritional and health deprivation. Unlike other anthropometric measures, such as weight-for-age or weight-for-height, height-for-age is not affected by acute episodes of stress occurring around the time of measurement. Rather, it reflects accumulation of health and nutrition over the child's life.[20]

---

[16] Asset changes should be ignored in a one-period model, as is in fact done in Behrman and Deolalikar (1988). It is included here primarily for its importance in an extended formulation which would be more appropriate for empirical analysis.

[17] For a detailed exposition of these demand relations, see Gaiha (2003).

[18] As recommended by the World Health organisation (1995), the standard reference population is that of the United States National Centre for Health Statistics. This recommendation is based on the evidence that differences in "unconstrained growth" of children from different ethnic and racial groups are so minor up to 5 years that a common reference is appropriate.

[19] As pointed out by Sahn and Stifel (2002a), for a more accurate assessment of stunting, 2.3 per cent should be subtracted from the results when using the –2 z- score cut-off point. Since this correction is seldom applied and, in any case, not likely to affect the conclusions, the common practice is followed.

[20] As elaborated by Sahn and Stifel (2002a), an acute episode of diarrhoea or malaria will not affect the height-for-age z-score. But the long-term health environment, such as chronic inadequacy of nutrients,

The right side variables include household characteristics, prices, and regional/state dummies. At the household level, the variables used include household size, sex of household head, occupation, caste in terms of affiliation to a Scheduled Caste or Scheduled Tribe (hereafter SC/ST), number of children < 5 years, proportion of female children < 5 years, proportion of children < 24 months, mother's age at marriage, mother's education, male-female wage difference, income per capita, whether the household has a toilet and a measure of distance to drinking water. Separate price indices for cereals, pulses, *gur* and sugar, milk and milk products, edible oil, meat, fish and eggs, and vegetables were constructed at the village level.

As the number of stunted children in a household is small and discrete (with a preponderance of zeros), the Poisson regression model is preferred to the OLS.[21] This model has been widely used to analyse count data. It assumes that each observation ($Y_i = y_i$) is drawn from a Poisson distribution with parameter λ_i, which is related to the regressors, X_{ik}. The basic equation of the model is

$$\text{Prob}\ (Y_i = y_i) = \frac{e^{-\lambda_i}\lambda_i^{y_i}}{y_i!},\ y_i = 0,1,2,\ldots\ldots \qquad (2)$$

A common formulation for λ_i is

$$\ln \lambda_i = \Sigma_K \beta_K X_{ik}\ . \qquad (3)$$

The expected number of "events" (in this case, the number of stunted children) for the ith household is $E\left[y_i \,/\, X_i\right] = \lambda = e^{\sum_K \beta_K X_{iK}}$. Consequently, the expected number of events will increase with the value of the kth explanatory variable if $\beta_K > 0$ and will decrease if $\beta_k < 0$.[22]

(b) Estimation

Two variables on the right side, income per capita and male-female wage differencel, are endogenous. So an IV estimation procedure is used, with land owned, proportion of adult males, proportion of adult females, highest educational level of a male household member, highest educational level of a female household member, and age of household head and its square as the instruments. For male-female wage difference, a specific instrument is a measure of off-farm income opportunities in a village. As several of these activities (e.g. pottery, petty trading, cattle tending) are female intensive, a higher share is likely to be associated with a lower male-female wage difference. Estimated values of these two variables are then used in the Poisson regressions.

---

neglect by care-givers or mothers, frequent parasitic infection and long-term chronic diseases (e.g. AIDS), will.

[21] See, for example, Borooah (2001) for an application of the Poisson model to assess the determinants of child mortality.

[22] For an exposition of the Poisson regression model, see Greene (1993).

Section 3

Results

First, a few key correlates of stunting at all-India level are given, followed by a discussion of the Poisson regression results. The cross-classifications, designed to identify a few key correlates of stunting, refer to 1993-94. The correlates are essentially indicative, since in a two-way classification there are no other controls. So causality should not be inferred. These cross-classifications are supplemented by Poisson regressions, as the latter yield insights into causal relationships.

(a) Cross- Classifications

In Table 1, the prevalence of stunting by gender is given. Two categories of stunting are considered viz. moderate and severe stunting. Close to 60 per cent of the under 5 boys and about 57 per cent of the girls are stunted, implying the absence of a gender bias. Majority of the stunted boys and girls are severely stunted (about 73 and 74 per cent, respectively). Combining boys and girls, the prevalence of stunting is over 58 per cent.

Table 1

Prevalence of Stunting by Gender, Rural India [1]

Category	Boys	Girls	Combined
Severely Stunted	43.44	42.39	42.94
Moderately Stunted	16.39	14.79	15.62
Not stunted	40.17	42.82	41.44

1. All figures are in percentages

In Table 2, prevalence of stunting among Scheduled Caste/Scheduled Tribe (hereafter SC/ST) households and others is given. This cross-classification examines whether prevalence of stunting is high among a subset of households considered most deprived in terms of both physical and human capital (e.g. land and education, respectively). Their deprivation is often aggravated by their physical isolation and social exclusion. These households account for about one-third of stunted children in rural India. A little over one- third of the severely stunted children (33.4 per cent) belong to these households while the share among the moderately stunted is slightly lower (29.66 per cent). The shares of girls who are severely and moderately stunted are lower than corresponding shares of boys among SC/ST households. The overall prevalence of stunting among SC/ST children is higher than the All-India estimate (over 63 per cent as against about 58 per cent), implying greater vulnerability of the former. In fact, the prevalence of severe stunting among both SC/ST boys and girls is much higher than among other households while moderate stunting is about the same or slightly lower among the former.

Table 2

Stunting among Scheduled Caste/ Scheduled Tribe, and Other Households, Rural India

	Severely Stunted			Moderately Stunted			Not Stunted		
Ethinc Group	Boys	Girls	Combined	Boys	Girls	Combined	Boys	Girls	Combined
SC/ST	47.31	44.86	46.13	16.06	13.64	14.89	36.63	41.50	39.98
Others	41.70	41.26	41.50	16.55	15.32	15.94	41.75	43.42	42.56

A third cross-classification of stunted children by landholding in Table 3 is also revealing. It points to high prevalence rates even among large landholders, suggesting that these rates are not strongly correlated with amount of land held or operated. In general, prevalence rates of moderate or severe stunting for both boys and girls vary little by landholding group. An exception is medium landholders among whom severe stunting of girls is lower than among other groups. So ownership of/access to land does not appear to make a significant difference.

Table 3

Stunting by Landholding Group, Rural India

	Severely Stunted			Moderately Stunted			Not Stunted		
Landholding Group	Boys	Girls	Combined	Boys	Girls	Combined	Boys	Girls	Combined
Landless	43.46	42.54	43.04	15.82	14.83	15.32	40.72	42.63	41.64
Marginal	43.65	43.88	43.73	17.03	15.70	16.40	39.41	40.42	39.87
Small	43.03	44.80	43.87	16.59	14.55	15.69	40.38	40.85	40.50
Medium	41.13	36.28	38.79	17.74	15.25	16.53	41.13	48.47	44.68
Large	44.27	41.40	42.75	16.64	13.72	15.22	39.09	44.87	41.91

What must, however, be emphasised is that the landless households account for about 47 per cent of the stunted children. Also, their shares of severely and moderately stunted children are about the same (about 47 per cent).

In the NCAER survey, households are classified into 4 groups on the basis of their per capita incomes.[23] Renaming these groups as the poorest, moderately poor, moderately affluent and affluent, prevalence rates of stunting are computed for each group, as shown below in Table 4.

Table 4

Stunting by Income Group, Rural India

	Severely Stunted			Moderately Stunted			Not Stunted		
Group	Boys	Girls	Combined	Boys	Girls	Combined	Boys	Girls	Combined
Poorest	45.36	44.85	45.09	17.34	13.83	15.61	37.30	41.32	39.30
Moderately Poor	44.83	42.50	43.73	17.16	15.29	16.27	38.01	42.21	40.00
Moderately Affluent	41.99	41.67	41.83	15.46	15.46	15.46	42.55	42.87	42.71
Affluent	42.42	40.41	41.49	16.25	13.47	14.96	41.33	46.12	43.55

These rates vary little among the four groups except that the prevalence of severe stunting among both boys and girls in the poorest households is highest. The poorest account for about 23 per cent of the severely stunted. With children from moderately poor households included, the share rises to 46 per cent. Thus nearly half of the severely stunted children belong to the poor households. The fact that a little more than half of severely stunted children live in (relatively) affluent households suggests that prevalence of stunting and income deprivation are not so closely linked.

Prevalence of stunting- whether moderate or severe- is much higher among male headed households. This holds equally for both boys and girls. Although these findings are consistent with the view that incomes in the hands of women are associated with better nutritional/health outcomes for children, it is not clear why the prevalence of severe stunting is so much higher among girls than among boys in female- headed households.[24] As noted earlier, a difficulty is the failure to control for other intervening variables. If, for example, female-headed households comprise higher proportions of older female children (> 24 months), the number of stunted female children is likely to be higher.

[23] The poorest consisted of those whose per capita incomes were less than the average income of the poor; the moderately poor were those with incomes exceeding the average income of the poor; the moderately affluent comprised non-poor households whose incomes were less than the average income of the non-poor; and the affluent included those whose incomes were greater than the average income of the non-poor. The average incomes of these groups were Rs. 1095, 2026, 3931, and 11396 (at current prices), respectively (Shariff, 1999).

[24] For details, see Gaiha (1993).

Table 5

Stunting by Gender of Household Head, Rural India

	Severely Stunted			Moderately Stunted			Not Stunted		
Group	Boys	Girls	Combined	Boys	Girls	Combined	Boys	Girls	Combined
Male-Headed	42.94	42.52	42.80	15.61	14.89	15.39	41.44	42.56	41.79
Female-Headed	33.46	38.52	35.84	13.42	10.89	12.23	53.02	51.15	52.14

That mother's education –as a proxy for home care, environment, and time devoted to child care – is linked to a child's health in general, and to reducing the prevalence of stunting in particular, is illustrated in Table 6.

Table 6

Stunting by Mother's Education, Rural India

	Severely Stunted			Moderately Stunted			Not Stunted		
Mother's Education	Boys	Girls	Combined	Boys	Girls	Combined	Boys	Girls	Combined
Below Primary	44.46	43.46	43.98	16.83	15.12	16.01	38.71	41.42	40.01
Between Primary and Matriculation	42.82	41.93	42.74	15.51	14.87	15.46	41.67	43.20	41.80
Matriculation and Above	39.37	34.26	36.95	15.16	11.84	13.59	45.47	53.90	49.46

The prevalence of severe stunting, as also of moderate stunting, among both boys and girls, fall with the mother's educational attainment,. However, as shown later, with matching controls, mother's education does not have a significant role.[25]

Table 7

[25] This of course requires a more detailed investigation than attempted here. For elaboration, see Behrman and Deolalikar (1988), and Strauss and Thomas (1998).

Stunting by Mother's Age Group, Rural India

	Severely Stunted			Moderately Stunted			Not Stunted		
Mother's Marriage Age	Boys	Girls	Combined	Boys	Girls	Combined	Boys	Girls	Combined
<20 years	44.35	43.25	43.82	16.60	14.81	15.73	39.05	41.94	40.45
21-25 years	40.38	38.61	39.58	13.46	14.29	13.84	46.16	47.10	46.58
26-35 years	26.23	31.86	29.05	8.02	16.77	12.36	65.75	51.26	58.59
>35 years	20.39	11.52	16.59	6.27	5.75	6.05	73.34	82.73	27.36

Table 7 suggests that the prevalence of stunting – both severe and moderate- falls with the mother's marriage age, with the highest in the youngest age group. In particular, severe stunting falls somewhat rapidly across different age groups.

Table 8

Stunting by Birth Order, Rural India

	Severely Stunted			Moderately Stunted			Not Stunted		
Birth Order	Boys	Girls	Combined	Boys	Girls	Combined	Boys	Girls	Combined
1	41.64	39.58	40.68	16.64	15.78	16.24	41.72	44.64	43.07
2	43.07	39.98	40.78	17.82	15.30	16.62	40.67	44.71	42.60
3	45.64	44.94	45.20	15.50	14.00	14.76	39.08	40.83	39.94

Table 8 points to the prevalence of a birth order effect on stunting. Severe stunting rises with the birth order- both among boys and girls-especially for the birth order 3 or higher children. This suggests greater neglect of higher birth order children.

To sum up, these cross-classifications indicate that stunting does not vary by gender. But, perhaps more importantly, what is also indicated is that, while stunting and poverty overlap to some extent, these are also *distinct* forms of deprivation.

(b) Poisson Regression Results

Three sets of results are presented, one focusing on the determinants of stunting (i.e. children with z scores < -2) and the remaining two on the determinants of severe stunting (i.e.children with z scores < -3). For the latter, two alternative specifications are employed i.e. with and without regional/ state dummies. The results confirm that the determinants vary by degree of stunting, as also with the specification used.

.

Table 9

Determinants of Stunting, Rural India

Variable	Coefficient	z-value	P >| z |
Constant	-1.477	-10.32	0.0
Household Size	-0.006	-2.71	0.0
Whether Household Head Male?[1]	0.171	4.71	0.0
Scheduled Caste/Scheduled Tribe [2]	0.007	0.55	0.582
Mother's Education (Primary or Below)[3]	-0.007	-0.44	0.663
Father's Education (Primary or Below)[3]	0.008	0.56	0.573
Mother's Marriage Age (< 20 years)[4]	0.087	4.79	0.0
Mother's Age	0.050	5.78	0.0
Square of Mother's Age	-0.0008	-5.75	0.0
Proportion of Children <24 months	-0.237	-11.10	0.0
Proportion of Female Children	-0.012	-0.76	0.45
Number of Children <5 years	0.322	56.96	0.0
Distance to Drinking Water [5]	0.096	3.04	0.0
Whether a Toilet in the House?[6]	0.122	6.23	0.0
Whether Cooking Place Ventilated?[7]	-0.074	-5.35	0.0
Per Capita Income (IV estimate) x 1000	-0.0083	-2.07	0.039
Male-Female Wage Difference (IV estimate)	0.005	0.16	0.872
Price of Cereals	-0.019	-5.18	0.00
Price of Pulses	-0.004	-2.51	0.012
Price of *Gur* and Sugar	-0.005	-1.30	0.195
Price of Milk and Milk Products	0.006	8.17	0.00
Price of Edible oils	-0.001	-1.61	0.108
Price of Meat, Fish and Eggs	0.002	6.97	0.0
Price of Vegetables	-0.0002	-1.40	0.162
No. of Observations	26854		
Log Likelihood	-34087.59		
Likelihood ratio $\chi^2(23)$	7049.22		
Prob > χ^2	0.0		
Pseudo R^2	0.094		

1. This variable is specified as a dummy that takes the value 1 if the head is male and 0 otherwise.
2. If the household belongs to a Scheduled Caste/ Tribe, the dummy takes the value 1 and 0 otherwise.
3. This variable is specified as a dummy that takes the value 1 if mother's/father's education is primary or below and 0 otherwise.
4. The dummy takes the value 1 if mother's age at marriage was < 20 and 0 otherwise.
5. Distance is measured in terms of walking time in minutes. The dummy variable takes the value 1 if walking time is more than 30 minutes.
6. If there is no toilet in the house, the dummy takes the value 1 and 0 otherwise.
7. The dummy variable takes the value 1 if the cooking place is ventilated.

For convenience of discussion, the right side variables are grouped into: (a subset of) household-specific variables, educational and other variables, age and composition of children, water, sanitation and hygiene, income related variables, and prices.

(i) Household-Specific Variables

Household size is associated with a reduction in the number of stunted children presumably because of economies of scale in consumption and child care practices. Male-headed households have higher numbers of stunted children (than female headed households). As expected, the coefficient of SC/ST households is positive but not significant.

(ii) Educational and Other Variables

Somewhat surprisingly, neither mother's nor father's educational attainments have significant effects. Considering that mothers have a crucial role in child care and education induces better quality child care through, for example, better hygiene and sanitation, it is not obvious why the coefficient of their educational attainments is not significant[26]. Alternative specifications of educational attainments yielded similar results.[27]

Early marriages of women are associated with frequent pregnancies, low-birth-weight of children, and lesser attention to them, resulting in greater stunting. The positive and significant coefficient of mother's marriage age is consistent with this view. Besides, mother's age has a positive effect on stunting that weakens with her advancing age. This implies that older mothers become less efficient in child care but at a diminishing rate..

[26] For a review of corroborative evidence, see Behrman and Deolalikar (1988), and Strauss and Thomas (1998).

[27] Clearly, the dummy variable specification is not appealing. A better specification would have been in terms of number of years of schooling. The NCAER survey, however, does not give these details.

(iii) Age and Sex Composition of Children

The number of stunted children is inversely associated with the proportion of children < 24 months. This suggests that the cumulative effect of periods of nutritional and health stress is greater as children get older.[28] However, the proportion of female children < 5 years has no effect on stunting. The number of stunted children is positively related to the number of children < 5 years in a household, mainly because of a birth order effect.

(iv) Water, Sanitation and Hygiene

Lack of easy access to drinking water has a positive effect on stunting presumably for two reasons: one is loss of time in fetching water that women would otherwise devote to household chores (e.g. preparation of meal), and the second is use of polluted water for cooking and the high risk of water-borne diseases among children. Absence of a toilet in the house has a positive effect on stunting too, as also lack of ventilation in the cooking place.

(v) Income Related Variables

Two IV estimates of income are used: one is income per capita and the other is male-female wage difference. The latter has been emphasized in some recent studies as a significant determinant of child-nutrition and well-being- especially of female children.[29] The results confirm a small but significant negative effect of income on stunting. The male-female wage difference, on the other hand, does not have a significant effect. In another specification, however, this variable does have a significant effect, as shown below.

(vi) Prices

We have used seven price indices at the village level. These were constructed from household data. Price indices of pulses, and of cereals have negative and significant coefficients, implying that higher prices of these commodities lower stunting. By contrast, prices of milk and milk products, edible oils, and of meat, fish and eggs have positive effects. It is not obvious why some prices have negative effects on stunting. Whether higher prices of some food items induce substitution of cheaper sources of nutrients can only be confirmed after a detailed investigation that we have not been able to carry out.

The overall specification is validated by the likelihood ratio χ^2- test.

[28] In a recent contribution, Sahn and Stifel (2002b) present evidence on catch-up growth after the weaning age.

[29] See, for example, Rosenzweig and Schultz (1982).

(vii) Comparisons

Two comparisons are carried out here: one focuses on the differences in the determinants of stunting and severe stunting using the same specification, and the second on differences in the determinants of severe stunting with alternative specifications.

A brief comparison of the results in Tables 9 and 10 illustrates some differences in the determinants of stunting and severe stunting. [30] Among household –specific variables, there are two differences. While household size has a negative coefficient, it is weakly significant; and the coefficient of SC/ST dummy is positive and significant. Among educational and other variables, there are no major differences. Neither mother's nor father's educational attainments reduce severe stunting. All other variables (e.g. mother's age at marriage, mother's present age and its square) also have similar effects on severe stunting. Among age and sex composition of children variables, the only difference is that the coefficient of the proportion of female children <5 years is negative and weakly significant. All water, sanitation and hygiene-related variables have similar effects. In contrast to the result in Table 9, per capita income does not have a significant negative effect on severe stunting. The male-female wage difference, however, does not have a significant effect in either case. The price effects also vary- while price of pulses ceases to have a significant negative effect, that of Gur and Sugar has a significant negative effect. Among the prices with a significant positive effect in Table 9, that of edible oils ceases to have a significant effect.

The overall specification is validated by the likelihood ratio χ^2- test.

Let us now compare selectively the results in Tables 10 and 11.

As noted earlier, the results on the determinants of severe stunting in these two tables are based on two alternative specifications. While the specification used in Table 10 omits state dummies, that in Table 11 groups states into four regions (viz. BIMARU, South, East and North, with the last as the default case for the dummy variable specification). That such a regional classification is an appropriate one for anthropometric and other nutritional outcomes is corroborated by earlier studies.[31] As elaborated below, with the introduction of state dummies, some of the results change significantly.

Since the default case is North, the results suggest that the prevalence of severe stunting is higher in BIMARU states and lower in the South relative to that in the North. The coefficient for the East is statistically not significant.

[30] Since there is a well-known positive relationship between the sample size and the probability of rejecting the null-hypothesis for a fixed size of a test, sometimes a Bayesian procedure is adopted for adjusting the critical values. Deaton (1997) recommends a cautious use of such adjustments. We have accordingly relied on standard criteria but a cautious interpretation of the results.

[31] See, for example, Borooah (2001), and, for a case for a South-North divide in the context of gender disparity in well-being, see Bardhan (2003).

Among the (subset of) of household- specific variables, a notable difference is that household size has a significant negative coefficient. Among the educational variables an important difference is the positive and significant coefficient of father's educational dummy, implying higher prevalence of severe stunting among children whose fathers are either illiterate or possess no more than primary education. Another important difference is that mother's age at marriage does not have a significant coefficient. Also, while the coefficient of the proportion of female children <5 years is negative, its significance is weaker. The water, sanitation and hygiene-related variables have similar effects in Tables 10 and 11. Among the income related variables, an important difference is that the male-female wage difference has a significant positive effect on severe stunting without a negative role of per capita income. There are some notable differences in the price effects. The price of cereals has a positive and significant effect, as also the price of edible oils. On the other hand, the price of meat, fish and eggs ceases to have a significant positive coefficient.

The overall specification is validated by the likelihood ratio χ^2 test.

(viii) Simulations

Simulation results based on Poisson regression results in Tables 9 and 11 are summarized below.

What is indeed striking is that per capita income possesses a significant negative coefficient only in one specification (Table 9)[32]. On the other hand, several other variables such as caste affiliation (implying social exclusion) and lack of easy access to drinking water, sanitation and hygiene facilities that manifest more pervasive forms of chronic deprivation are significant determinants of stunting. But, more importantly, as illustrated by the simulations below, mitigation of some of these forms of deprivation has a potentially more decisive role in reducing stunting.[33] A related issue is that allocation mechanisms of food, health care and other resources within a household matter too, given income and other indicators of household well-being (e.g access to drinking water). Finally, high prices of some food items (e.g. milk and milk products) are also causally linked to stunting, signifying failure to substitute cheaper sources of nutrients.

.

Let us first consider the simulation results based on Table 9. Most of the counterfactual scenarios delineated here are plausible over a period of 7-10 years.

A doubling of income per capita is associated with a reduction of barely 2.61 per cent in stunting. Lack of women's autonomy, as reflected in early marriages, and other forms of deprivation matter a great deal more. If women do not marry before they are twenty years old, stunting will reduce by 6.58 per cent. If *all* households have easy access to

[32] Note that per capita income has significant coefficients in two alternative specifications of stunting and severe stunting with individual state dummies as well. In fact, in these specifications, the (absolute) values of the coefficients are larger. Details will be furnished on request.

[33] Cost-effectiveness of various interventions is not assessed here.

drinking water, stunting will decline by 8.29 per cent. Toilet facilities *within* all households will result in a more substantial reduction of about 9.50 per cent. The larger the number of 5 year old children, the stronger will be the birth order effect. So a halving of the number of 5 year old children implies a reduction in stunting of 28.38 per cent. Finally, a halving of the price of milk will reduce stunting by 2.25 per cent.

Table 10
Determinants of Severe Stunting, Rural India

Variable	Coefficient	z-value	P >| z |
Constant	-1.802	-10.79	0.0
Household Size	-0.040	-1.53	0.125
Whether Household Head Male?[1]	0.231	5.30	0.0
Scheduled Caste/Scheduled Tribe [2]	0.047	3.16	0.00
Mother's Education (Primary or Below)[3]	-0.007	-0.35	0.726
Father's Education (Primary or Below)[3]	0.026	1.58	0.113
Mother's Marriage Age (< 20 years)[4]	0. 073	3.43	0.00
Mother' Age	0.054	5.37	0.0
Square of Mother's Age	-0.0009	-5.27	0.0
Proportion of Children <24 months	-0.136	-5.48	0.0
Proportion of Female Children	-0.030	-1.62	0.106
Number of Children <5 years	0.326	49.47	0.0
Distance to Drinking Water [5]	0.068	1.86	0.063
Whether a Toilet in House?[6]	0.116	5.07	0.0
Whether Cooking Place Ventilated?[7]	-0.097	-5.97	0.0
Per Capita Income (IV estimate) x1000	-0.0063	-1.34	0.181
Male- Female Wage Difference (IV estimate)	0.039	1.05	0.296
Price of Cereals	-0.022	-4.98	0.00
Price of Pulses	-0.002	-1.12	0.264
Price of *Gur* and Sugar	-0.018	-3.76	0.00
Price of Milk and Milk Products	0.009	10.25	0.0
Price of Edible Oils	0.001	1.29	0.20
Price of Meat, Fish and Eggs	0.001	3.72	0.0
Price of Vegetables	-0.0005	-3.04	0.0
No. of Observations	26854		
Log Likelihood	-31234.61		
Likelihood Ratio χ^2 (23)	5318.31		
Prob > χ^2	0.0		
Pseudo R^2	0.08		

1. This variable is specified as a dummy that takes the value 1 if the head is male and 0 otherwise.
2. If the household belongs to a Scheduled Caste/ Tribe, the dummy takes the value 1 and 0 otherwise.
3. This variable is specified as a dummy that takes the value 1 if mother's/father's education is primary or below and 0 otherwise.

4. The dummy takes the value 1 if mother's age at marriage was < 20 and 0 otherwise.
5. Distance is measured in terms of walking time in minutes. The dummy takes the value 1 if walking time is more than 30 minutes.
6. If there is no toilet in the house, the dummy takes the value 1 and 0 otherwise.
7. If the cooking place is ventilated, the dummy takes the value 1 and 0 otherwise.

Table 11

Determinants of Severe Stunting, Rural India
(With Regional/State Dummies)

Variable	Coefficient	z-value	P >| z |
Constant	-1.577	-9.15	0.0
BIMARU[1]	0.081	3.23	0.0
South	-0.380	-13.18	0.0
East	-0.034	-0.66	0.510
Household Size	-0.007	-2.47	0.013
Whether Household Head Male?[2]	0.142	3.29	0.0
Scheduled Caste/Scheduled Tribe [3]	0.037	2.58	0.010
Mother's Education (Primary or Below)[4]	0.018	0.98	0.326
Father's Education (Primary or Below)[4]	0.027	1.72	0.085
Mother's Marriage Age (< 20 years)[5]	0. 013	0.65	0.516
Mother' Age	0.048	4.82	0.0
Square of Mother's Age	-0.0008	-4.94	0.0
Proportion of Children <24 months	-0.155	-6.25	0.0
Proportion of Female Children	-0.028	-1.51	0.131
Number of Children <5 years	0.335	50.12	0.0
Distance to Drinking Water [6]	0.072	2.0	0.045
Whether a Toilet in House?[7]	0.102	4.66	0.0
Whether Cooking Place Ventilated?[8]	-0.038	-2.52	0.012
Per Capita Income (IV estimate) x1000	-0.0015	-0.35	0.729
Male- Female Wage Difference (IV estimate)	0.072	2.25	0.025
Price of Cereals	-0.011	-2.27	0.023
Price of Pulses	-0.003	2.01	0.045
Price of *Gur* and Sugar	-0.014	-3.17	0.0
Price of Milk and Milk Products	0.005	5.63	0.0
Price of Edible Oils	0.002	1.97	0.048
Price of Meat, Fish and Eggs	0.0001	0.22	0.823
Price of Vegetables	-0.001	-7.45	0.0
No. of Observations	26854		
Log Likelihood	-30847.29		
Likelihood Ratio χ^2 (23)	6092.95		
Prob > χ^2	0.0		
Pseudo R^2	0.09		

1. The dummy takes the value 1 if the household belongs to Bihar, Madhya Pradesh, Rajasthan or Uttar Pradesh (BIMARU) and 0 otherwise; the dummy takes the value 1 if the household belongs to Andhra Pradesh, Karnataka, Kerala, Tamil Nadu, Maharashtra or Gujarat (South) and 0 otherwise; the dummy takes the value 1 if the household belongs to Assam, West Bengal, or Orissa (East) and 0 otherwise. The default case is North comprising Punjab, Haryana or Himachal Pradesh.
2. This variable is specified as a dummy that takes the value 1 if the head is male and 0 otherwise.
3. If the household belongs to a Scheduled Caste/ Tribe, the dummy takes the value 1 and 0 otherwise.
4. This variable is specified as a dummy that takes the value 1 if mother's/father's education is primary or below and 0 otherwise.
5. The dummy takes the value 1 if mother's age at marriage was < 20 and 0 otherwise.
6. Distance is measured in terms of walking time in minutes. The dummy takes the value 1 if walking time is more than 30 minutes.
7. If there is no toilet in the house, the dummy takes the value 1 and 0 otherwise.
8. If the cooking place is ventilated, the dummy takes the value 1 and 0 otherwise.

Let us now consider briefly the simulation results for severe stunting based on Table 11.

A narrowing down of the male-female wage difference has a significant effect on severe stunting. If the difference is completely eliminated through more remunerative employment opportunities for women, this will imply a reduction in severe stunting of 11.27 per cent. A halving of number of 5-year old children is associated with a reduction of over 29 per cent. Easier access of all households to drinking water, toilet facilities and ventilated kitchens will together reduce severe stunting by about 15.50 per cent. A halving of prices of pulses, milk and milk products and edible oils results in a smaller but a more than moderate reduction of about 7.70 per cent.

Section 4

Concluding Observations

Some observations are made from a broad policy perspective.

It was argued that stunting as a manifestation of cumulative nutritional and health deprivation persists even among (relatively) affluent households in rural India. There is of course some overlap between stunting and income deprivation but some other factors influence stunting independently of income. The evidence in fact confirms that income has a weaker role in reducing stunting than, say, easier access to drinking water, and sanitation and hygiene facilities.

Of particular importance is women's autonomy in fertility decisions and allocation of household resources. Early marriages result in frequent pregnancies, low birth weight babies, lesser attention to them, and greater stunting. Raising marriage age may require greater awareness of these risks, changes in attitudes, higher literacy rates, and better employment options. Some of these changes may also imply a more decisive role for women in allocation of household resources even among male-headed households.

Improvements in village and home infrastructure in terms of easy access to drinking water, and sanitation and hygiene facilities are also likely to have a significant impact on stunting. Awareness building must be combined with mobilization of community resources to ensure that such improvements occur quickly and are sustainable.

Inter-village variation in prices of food items is considerable, as a result of remoteness of location, limited transport facilities and local market imperfections (e.g. commitment to sell milk at a low price to a few large buyers against advance payment who then sell it at considerably higher prices). So there is a strong case for strengthening road and transportation network, and for promoting more competitive local markets through, for example, producers' cooperatives.

In conclusion, while income matters in reducing stunting, a more autonomous role for women, improvements in hygiene and sanitation facilities, and more competitive local markets for food items deserve higher priority.

References

ADB/IFPRI (2001) *Attacking the Double Burden of Malnutrition in Asia and the Pacific*, Manila, ADB.

Bardhan, P. (2003) " On Life and Death Questions", in *Poverty, Agrarian Structure & Political Economy in India*, New delhi: Oxford University Press.

Behrman, J. and A. Deolalikar (1988) "Health and Nutrition", Chapter 14, in H. Chenery and T.N. Srinivasan (ed.) *Handbook of Development Economics*, Volume 1, Amsterdam: Elsevier Science Publishers, B.V.

Borooah, V. K. (2001) " Do Children in India Benefit from Having Mothers Who are Literate?", Working Paper Series 77, Delhi: National Council of Applied Economic Research.

Cassen, R. (2002) "Well-Being in the 1990s",*Economic and Political Weekly*, May 6.

Dasgupta, P. (1993) *An Inquiry into Well-Being and Destitution*, Oxford: Clarendon Press.

Dasgupta, P. (1995) "Nutritional Status, the Capacity for Work, and Poverty Traps", London: STICERD, London School of Economics, mimeo.

Deaton, A. (1997) *The Analysis of Household Surveys, A Microeconometric Approach to Development Policy*, Baltimore: Johns Hopkins University Press.

Deaton, A. and J. Dreze (2002) "Poverty and Inequality in India", Research Programme in Development Studies, Princeton University, mimeo.

Gaiha, R. (1991) *Structural Adjustment and Household Welfare- A Micro Economic Perspective*, Rome: FAO.

Gaiha, R. (1993) *Design of Poverty Alleviation Strategy in Rural Areas*, Rome: FAO.

Gaiha, R. (2003) "Household Food Security- A Methodological Note," Rome: Role of Agriculture Project, FAO, mimeo.

Greene, W.H. (1993) *Econometric Analysis*, Second Edition, New York: Macmillan.

Osmani, S. and Amartya Sen (2003) " The Hidden Penalties of Gender Inequality: Fetal Origins of Ill Health", *Economics and Human Biology*, January 2003.

Rosenzweig, M. and T. P. Schultz (1982) "Market Opportunities, Genetic Endowments, and Intrafamily Resource Distribution: Child Survival in Rural India", *American Economic Review*, vol. 72.

Sahn, D. and D. C. Stifel (2002a) " Robust Comparisons of Malnutrition in Developing Countries", *American Journal of Agricultural Economics*, vol. 84, no. 3.

Sahn, D. and D. C. Stifel (2002b) " Parental Preferences for Nutrition of Boys and Girls: Evidence from Africa", *Journal of Development Studies*, vol. 39.

Schiff, M. and A. Valdes (1990) " Poverty, Food Intake, and Malnutrition: Implications for Food security in Developing Countries", *American Journal of Agricultural Economics.*

Sen, Amartya (1985) *Commodities and Capabilities*, Amsterdam: North Holland.

Sen, Amartya (1999) *Development as Freedom*, New York: Knopf.

Shariff, A. (1999) *India: Human Development Report*, New Delhi: Oxford University Press.

Srinivasan, T. N. (1994) "Destitution: A Discourse", *Journal of Economic Literature*, vol. 32.

Strauss, J.and D. Thomas (1998) " Health, Nutrition and Economic Development", *Journal of Economic Literature*, vol. xxxxvi.

Subramaniam, S. and A. Deaton (1996) "The Demand for Food and Calories", *Journal of Political Economy*, vol. 104.

Svedberg, P. (2000) *Poverty and Undernutrition- Theory, Measurement, and Policy*, UNU/WIDER Studies in Development Economics, Oxford: Oxford University Press.

UNICEF (1993) *Child Malnutrition Progress Towards the World Summit for Children Goal*, New York, UNICEF**.**

WHO (1995) " Physical Status: The Use and Interpretation of Anthropometry Report of a WHO Expert Committee", WHO Technical Report 854, Geneva.

World Bank, (1998) *India: Wasting Away*, Washington DC.