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Individual, household, programme and community effects on childhood malnutrition in rural India

S. Rajaram*, **Lisa K. Zottarelli**† **and T.S. Sunil**‡

**Population Research Center, Dharwad, India, †Department of Sociology and Social Work, Texas Woman's University, Deton, Texas, USA, and ‡Department of Sociology, University of Texas at San Antonio, One UTSA Circle, San Antonio, Texas, USA*

Abstract

The children living in rural areas of India disproportionately suffer from malnutrition compared with their urban counterparts. The present article analyses the individual, household, community and programme factors on nutritional status of children in rural India. Additionally, we consider the random variances at village and state levels after introducing various observed individual-, household- and programme-level characteristics in the model. A multilevel model is conducted using data from the National Family and Health Survey 2. The results show that maternal characteristics, such as socio-economic and behavioural factors, are more influential in determining childhood nutritional status than the prevalence of programme factors. Also, it was found that individual factors show evidence of state- and village-level clustering of malnutrition.

Keywords: malnutrition, children, programme components, rural, India.

Introduction

Childhood malnutrition levels are alarmingly high around the world, particularly in developing countries. While over 97% of children survive through preschool years in developed countries, 20–25% of children in developing countries die before reaching their fifth birthday (UNICEF 2004). Underweight children are at increased risk of mortality and morbidity (Mosley & Cowley 1991; Griffiths *et al*. 2002), and the risk of mortality increases with the severity of malnutrition. Worldwide, it is estimated that approximately 55% of the deaths of children under 5 years of age are due to malnourishment (UNICEF 2004).

Even greater percentages of children survive malnutrition, the consequences of which last a lifetime. For example, children who are malnourished have a greater risk of stunting and impaired brain development, which in turn affects their ability to accrue skills

Correspondence: Lisa K. Zottarelli, Assistant Professor, Department of Sociology & Social Work, Texas Woman's University, Denton, TX 76204, USA. E-mail: lzottarelli@mail.twu.edu

critical to their life chances (UNICEF 2004). There is evidence that nutritional status is correlated with IQ level (Horton 1986), and that children who are malnourished at an early age are more likely to have reduced educational attainment (Pollit 1984). Children who suffer from malnutrition are vulnerable to retarded development, physical incapacity, emotional disturbances and, in some cases, mental defects (Lichter 1997). Further, adults who survived malnutrition as children are more vulnerable to the development of physical and intellectual impairments, and they are more likely to suffer from higher levels of chronic illness and disability (UNICEF 1998; Smith & Haddad 2000).

The quality of future human resources largely depends on children. Therefore, improving the nutritional level of children should be considered a priority area that produces social and economic returns. The importance and significance of this area of research is summarized by Dreze & Sen (1989, p. 33), who suggest that, 'though quieter than famine, it (persistent under-nutrition) kills many more people slowly in the long run than famines do'.

A recent UNICEF (2004) report has documented that over 16% of children under 5 years of age in developing countries are severely malnourished. About 90% of these children live in South Asia, with a high percentage 'anemic, weak and vulnerable to diseases and more likely to have learning problems if they ever go to school' (UNICEF 2004, p. 17). Recent statistics have shown that about 28% of the children under 5 years of age in developing countries are estimated to be underweight, with almost half of these children (about 45%) living in South Asia (UNICEF 2004). Children in India are at some of the greatest risk of all children in the region. More specifically, in India, about 30% of infants are born with low birthweight (less than 2500 g). A recent national survey reports that about 47% of the children under 5 years of age were born moderately to severely underweight, 46% of children are moderately to severely stunted, and approximately 16% are moderately to severely wasted (IIPS & ORC 2000).

The disparity in childhood nutritional levels is a result of the complex interplay of a multiplicity of factors (Mosley 1984; Bronte-Tinkew & Dejong 2004), including socio-economic and demographic factors (Rajaram *et al*. 2003). Demographic factors that appear to be important in overcoming childhood malnutrition include birth order (Horton 1988), breastfeeding practices (Victoria *et al*. 1984), and sex differentials (Sen & Sengupta 1983; Schoenbaum *et al*. 1995; Mishra *et al*. 1999; Marcoux 2002; Pande 2003; Mishra *et al*. 2004). Specifically, firstborns are the most distinctive group in birth order, receiving heavy doses of parental attention and thus having a better nutritional status than higher-order births (Behrman 1988). In fact, the adverse effects of shorter birth intervals often lead to maternal depletion, which affects fetal growth and, in turn, leads to an increased likelihood of prematurity (Miller 1989). The lack of adequate care for the child may result in a higher incidence of illness and hence affect nutritional status.

In additional to demographic and family planning factors, another approach to the issue of disparity in childhood nutrition is through socio-economic factors. In this body of literature, researchers have often emphasized social and economic factors at the individual and contextual levels which are likely to influence the normal growth of children (Griffiths *et al*. 2002; Bronte-Tinkew & Dejong 2004). Household structure has been the focus of many studies on child malnutrition (Blake 1981; Lloyd 1994; Thomson *et al*. 1996; Wu 1996; Mayer 1997; Bronte-Tinkew & Dejong 2004).

While there are numerous studies on child malnutrition in India, the majority of these studies have looked at the contributions of individual-level (socio-economic and family planning) characteristics. A growing body of literature considers the importance of understanding determinants of childhood malnutrition through an integrated analysis that considers linkages between demographic, family planning and household structures. Zottarelli *et al*. (2006) found that individual characteristics of the child, such as birth order, sex and age, as well as household factors, such as consanguinity and place of residence, helped explain the likelihood of stunting in Egypt.

Taking this one step further, it is becoming increasingly apparent that analysis of determinates of childhood malnutrition must consider incorporating contextual and programme-level characteristics in the study of childhood malnutrition. Indeed, one may argue that childhood nutritional levels are nested within the household, which in turn is nested within programme and community characteristics. For example, Fernandez *et al*. (2002) incorporated a multilevel analysis of a UNICEF model of immediate causes (measles incidents and calorie supply per capita), underlying causes (food production per capita, low birthweight, infant mortality and access to safe drinking water), and basic causes (public expenditure on education, Gross National Product per capita, adult literacy, debt service and urban population) of childhood malnutrition to identify regional variations in determinants of wasting between Asia, Africa and Latin America. More recently, Rao *et al*. (2004) discussed the nutritional status of children in the north-eastern states of India, where individual-, household- and district-level variations were considered. Despite the movement towards developing a model recognizing the contextual nature of child undernutrition, such as the UNICEF model (1990), these studies have failed to include programme-level variables within the community, such as access to healthcare facilities and programmes and availability of health professionals. Programme and community characteristics that include the healthcare supply environment have been found to be important in maternal health care in rural India (Sunil *et al*. 2006) and in children's nutritional status in rural Nepal (Hotchkiss *et al*. 2002).

Thus, in the present study we have incorporated individual-, household-, programme- and community-level factors in the outcome of childhood malnutrition in rural India. Further, we discuss the clustering of childhood malnutrition at village and state levels. A number of studies on the statistical analysis of child mortality risks identified family- and community-level clustering of child mortality (Sastry 1996, 1997). If such clustering exists for child mortality, one could reasonably expect the same for the nutritional status of children. Thus, in this study we focus on the presence of correlated outcomes among children residing in the same community and state. Multilevel modelling will allow for the presence of clustering to be examined. The estimates from such a model will provide estimates of the magnitude and importance of community- and state-level effects that are not captured by the other commonly used multivariate techniques.

Data and methods

The present study utilizes data from the National Family and Health Survey 2 (NFHS-2), the second national sample survey, conducted in India in 1998–99. The NFHS, comparable to demographic and health surveys conducted in many other countries, was undertaken by various consulting organizations in collaboration with population research centres. Details on data collection and sampling procedure followed are available in the International Institute for Population Sciences & ORC Macro (2000).

The NFHS-2 used three types of questionnaires: Household, Woman's and Village Questionnaires. An important feature is the information available on height and weight of children in the context of utilization of maternal care services and other socio-economic characteristics of the mother. For the children born during the 3 years preceding the survey, a data file (called *kids*) combines the information from the Household and Woman's Questionnaires and was generated from the original dataset. We used this data file to examine the nutritional status of children in rural India. In addition, we merged the *kids* data file with *village* data file to obtain the selected village-level variables for further analysis. Due to missing values in the explanatory variables**,** the number of children varies in the analysis.

To assess the nutritional status of individual children, the World Health Organization (1995) recommends the use of *Z*-score indicators based on the child's sex, weight, height and age. The *Z*-score indicators of weight-for-age (WAZ), height-for-age (HAZ), and weight-for-height (WHZ) are generally used to evaluate the nutritional status of children. A *Z*-score of less than –2.00 is commonly used to indicate malnutrition and is followed in the present study as well. Following is the proposed basic multilevel logistic model to be used for identifying the malnutrition among children in rural India:

$$\log\left[\frac{\pi_{ijk}}{1-\pi_{ijk}}\right] = \beta x_{ijk} + v_{jk} + s_k$$

where, π_{ijk} is the expected probability that child '*i*' in village '*j*' in state '*k*' is malnourished; x_{ijk} is the vector of characteristics considered at individual, village and state levels, and v_{jk} and s_k represent effects of unobserved factors (error terms) at state and village levels and follows normal distribution with mean zero. The standard assumption is that the observed responses y_{ijk} ~ Bernoulli (π_{ijk}). The analysis was conducted with SAS version 8.1 (SAS Inc. 2004).

Results

Table 1 presents the distribution of anthropometric indices according to background characteristics of the children and their parents. Approximately half of the

Table 1. Percentage of children with *Z*-scores below –2 SD for various anthropometric indices in rural India, 1998–2000

Characteristics	WHZ (wasting/acute)	HAZ (stunting/chronic)	WAZ (composite)	Number of cases
Birth order				
1	15.6	43.5	43.7	4913
2	16.0	45.4	47.6	4487
3	14.9	49.3	50.1	3411
4	17.7	51.1	52.5	2066
5+	18.1	56.6	57.7	3224
Sex of the child				
Male	16.3	47.1	47.8	9500
Female	16.2	49.5	51.1	8601
Age of the child				
<6 months	9.6	16.8	12.4	3176
6–11 months	13.7	33.4	39.6	2997
12–23 months	22.7	60.6	61.5	6126
24–35 months	14.4	60.1	61.8	5802
Duration of breastfeeding				
<6 months	9.9	21.3	17.5	3660
6–11 months	14.2	36.5	41.7	3575
12–23 months	20.6	59.8	60.9	7417
24–35 months	15.8	64.1	66.4	3449
Education of mother				
Illiterate	17.4	55.2	55.5	11 475
Literate, <middle complete	16.0	41.3	45.3	3355
Middle school complete	13.6	35.6	36.7	1524
High school complete and above	11.2	27.1	27.8	1747
Height of mother				
<145 cm	17.8	62.7	61.7	2324
145–150 cm	17.1	53.3	53.3	5139
151–160 cm	15.6	44.0	46.1	9574
160+ cm	14.6	30.7	32.5	1064
Mass media exposure				
None	18.4	54.8	56.0	9370
One or two media	14.3	44.6	45.3	7036
Three or four media	12.7	27.3	29.5	1695
Smoke/chew tobacco/consume alcohol				
No	16.1	47.6	48.7	16 400
Yes	17.6	54.7	56.1	1701
Caste of the household head				
Scheduled caste	16.5	53.1	54.4	3877
Scheduled tribe	22.0	53.2	55.5	1889
Other backward caste	17.2	48.1	50.1	6080
None of them	13.4	43.9	43.6	6255

Table 1. *Continued*

Characteristics	WHZ (wasting/acute)	HAZ (stunting/chronic)	WAZ (composite)	Number of cases
Standard of living index				
Low	19.9	53.9	56.8	7437
Medium	14.4	47.2	48.0	8545
High	11.0	32.7	28.9	2119
Received IFA tablets/syrups for three or more months and consumed all of them				
Not received	16.4	53.2	52.9	9737
Received, but not consumed all	16.4	46.4	49.7	1521
Received and consumed all	15.9	41.7	44.3	6843
Received two or more TT injections during pregnancy				
No	17.2	55.5	55.4	5992
Yes	15.8	44.7	46.4	12 108
Any IEC activity organized in the village				
No	15.5	51.4	51.1	11 096
Yes	17.4	43.3	46.6	7005
Availability of health professional in the village				
No	17.4	49.5	52.0	8310
Visiting health professional	16.8	48.1	49.1	2317
Within the village	14.7	46.9	46.5	7474
Distance to nearest government health facility				
Within the village	15.4	43.9	45.9	4651
1–4 km	15.2	50.4	50.0	5247
5–9 km	16.4	49.1	49.9	4639
10+ km	18.6	49.7	52.3	3564
Distance to nearest private health facility				
Within the village	14.8	45.0	45.0	5290
1–4 km	14.8	49.8	50.8	4687
5–9 km	16.5	51.2	51.6	3156
10+ km	19.0	48.4	51.3	4968
Availability of *anganwadi* centre in the village				
No	16.1	51.5	51.1	6617
Yes	16.3	46.4	49.4	11 484
Total	16.2	48.3	49.4	18 101

HAZ, height-for-age *Z*-score; IEC, information, education and communication; IFA, iron and folic acid; TT, tetanus; WAZ, weight-for-age *Z*-score; WHZ, weight-for-height *Z*-score.

children (48.3%) born in the rural areas in India suffer from stunting or chronic malnutrition, and 16.2% of children suffer from wasting or acute malnutrition. A long list of variables are used in the present study, and several need specific mention in describing the differentials in stunting (HAZ), wasting (WHZ) and underweight (WAZ). The composite index, WAZ, shows that about half of the children (49.4%) in rural India suffer from being underweight.

Four variables related to individual child characteristics are considered in the analysis and are presented in Table 1. These characteristics include birth order, sex, age and duration of breastfeeding. The prevalence of acute, chronic and composite malnutrition was greater when the birth order was higher. Female children had a greater prevalence of being stunted and underweight than did male children, and an approximately equal incidence of wasting. There was a greater prevalence of malnutrition in older children compared with younger children. Finally, children who were breastfed longer had a greater frequency of malnutrition on all three indices.

In addition to the characteristics of the child, several variables related to the child's mother are found to be important in describing differentials in nutritional levels. As expected, the prevalences of stunting, wasting and underweight were greater for children of mothers who are illiterate, and lowest among children of mothers with high school or more education. A similar trend is found in the other maternal characteristics, such as mother's height and mother's mass media exposure. Another behavioural variable used is the mother's smoking/chewing of tobacco and/or consuming alcohol. Specifically, children of mothers who consume tobacco and/or alcohol have a greater prevalence of being malnourished, compared with children of mothers who refrain from tobacco and alcohol consumption.

Two characteristics of the household, the standard of living index and caste/tribe of the household head, were used to examine the differentials in the nutritional status of the children in rural India. The standard of living index shows a negative inverse trend on the malnutrition indicators. In other words, children in households with a low standard of living have a higher prevalence of malnourishment than children living in households with medium and high standards of living. Further, the prevalence of malnutrition is found to be greater among children belonging to scheduled tribes and scheduled castes.

The next set of variables presents the differentials in malnutrition levels according to selected programme- and community-level variables. Acute, chronic and composite measures of malnutrition have a lower occurrence among children whose mothers' consumed iron and folic acid (IFA) tablets, as compared with the prevalence of malnutrition in children born to mothers who had not received and/or had not consumed IFA tablets during pregnancy. Likewise, the prevalence of malnutrition was lower for children born to women who received tetanus (TT) shots during pregnancy. Communities with IEC (information, education and communication) activities organized within the village had lower incidences of stunting and underweight but a slightly higher prevalence of wasting. The availability of a healthcare professional in the village decreased the prevalence of malnutrition in children. The percentage of children experiencing malnutrition is lower among children born in villages where there is a private or public healthcare facility. Also, the prevalences of stunting and wasting are lower among children born in villages where there are *mahila mandal*[1] or *anganwadi* centres,[2] compared with the prevalence among children born in villages where no such organizations are present.

The overall distribution of the prevalence of malnutrition in rural areas of India is provided in Table 2. The percentage of children in rural areas experiencing acute malnutrition (wasting) ranges from 5.0% in the states of Haryana and Sikkim to 28.7% in rural New Delhi. Additionally, approximately one-quarter of the children born in rural areas of Maharashtra and Orissa suffer from acute malnutrition. The percentage of children in each state experiencing chronic malnutrition or stunting ranges from 18.8% in Goa to 56.6% in Uttar Pradesh. Further, in six of the states (Bihar, Haryana, Madhya Pradesh, Rajasthan, Uttar Pradesh and New Delhi), more than half of the children living in rural areas can be classified as chronically undernourished. Considering the composite index of malnutrition, the lowest percentage of children in rural areas calculated as underweight is found in Sikkim at 21.1%. Madhya Pradesh had the highest percentage of underweight children, with 58.4%. Seven other states (Bihar, Maharashtra, Orissa, Rajasthan, West Bengal, Uttar Pradesh and New Delhi) had more than half of the children living in rural areas classified as both chronically and acutely malnourished.

The first panel in Table 3 shows the odds ratios of individual-, household-, programme- and community-level factors on acute malnutrition (wasting). Although the odds ratios are found to be statistically significant at $P < 0.05$, it may not be reflected in the calculation of the confidence interval. Compared with the next two analyses, only a few variables are statistically significant. At the individual level, the age of the child and the duration of breastfeeding are found to be significant. A number of maternal and

[1]Women's community group in rural areas.

[2]An early childhood development centre in the rural areas and *anganwadi* worker provide integrated child development services and also engaged in promoting of various maternal and child health services.

Table 2. Percentage of children with *Z*-scores below −2 SD for various anthropometric indices in rural India, 1998–2000, by state

State	WHZ (wasting/acute)	HAZ (stunting/chronic)	WAZ (composite)
Andhra Pradesh	9.2	41.8	40.6
Assam	13.7	49.7	35.2
Bihar	21.4	54.9	54.9
Goa	12.2	18.8	30.2
Gujarat	19.5	46.3	49.2
Haryana	5.0	52.8	35.5
Himachal Pradesh	17.6	42.4	44.8
Jammu & Kashmir	12.7	40.9	37.1
Karnataka	21.8	39.6	46.6
Kerala	11.4	22.4	26.9
Madhya Pradesh	20.4	54.6	58.4
Maharashtra	24.9	43.9	52.9
Manipur	8.0	32.5	27.5
Meghalaya	13.3	45.6	37.2
Mizoram	15.5	35.5	33.1
Nagaland	11.7	34.5	26.4
Orissa	24.6	44.8	55.4
Punjab	7.0	42.1	31.7
Rajasthan	12.4	54.6	52.2
Sikkim	5.0	32.9	21.1
Tamil Nadu	20.2	30.8	38.6
West Bengal	14.7	44.8	52.6
Uttar Pradesh	11.2	56.6	53.1
New Delhi	28.7	50.5	50.8
Arunachal Pradesh	8.4	27.3	25.5
Tripura	12.9	36.8	40.1

Based on state weights.

Table 3. Results of multilevel model for children with height-for-age *Z*-score below −2 SD in rural India, 1998–2000

	WHZ		HAZ		WAZ	
	Exp(B)	95% CI	Exp(B)	97% CI	Exp(B)	95% CI
Individual characteristic						
Birth order						
1	0.91	0.79, 1.04	0.92	0.82, 1.03	0.81	0.72, 0.91
2	0.90	0.78, 1.03	0.95	0.85, 1.06	0.89	0.80, 1.00
3	0.81	0.70, 0.94	0.98	0.87, 1.10	0.89	0.79, 1.00
4	0.88	0.75, 1.03	0.97	0.85, 1.10	0.88	0.78, 1.01
Sex of the child						
Male	1.03	0.95, 1.13	0.97	0.90, 1.04	0.90	0.84, 0.96
Age of the child						
<6 months	0.97	0.70, 1.35	0.11	0.09, 0.14	0.08	0.06, 0.10
6–11 months	1.14	1.48, 0.87	0.37	0.31, 0.45	0.44	0.37, 0.53
12–23 months	1.97	2.30, 1.69	1.15	1.03, 1.28	1.12	1.00, 1.25
Duration of breastfeeding						
<6 months	0.62	0.45, 0.86	0.79	0.64, 0.98	0.77	0.62, 0.95
6–11 months	0.77	0.59, 1.00	0.75	0.62, 0.91	0.73	0.61, 0.88
12–23 months	0.82	0.69, 0.98	0.83	0.73, 0.94	0.78	0.69, 0.88

Table 3. *Continued*

	WHZ		HAZ		WAZ	
	Exp(B)	95% CI	Exp(B)	97% CI	Exp(B)	95% CI
Education of mother						
Literate, <middle complete	0.91	0.79, 1.03	0.78	0.71, 0.86	0.83	0.75, 0.92
Middle school complete	0.77	0.64, 0.93	0.68	0.59, 0.78	0.70	0.61, 0.80
High school complete and above	0.63	0.51, 0.78	0.52	0.45, 0.61	0.54	0.46, 0.63
Height of mother						
145–150 cm	0.98	0.85, 1.14	0.70	0.62, 0.79	0.74	0.65, 0.84
151–160 cm	0.88	0.77, 1.02	0.46	0.41, 0.52	0.54	0.48, 0.61
160+ cm	0.87	0.69, 1.09	0.24	0.20, 0.29	0.30	0.25, 0.36
Mass media exposure						
One or two media	0.90	0.81, 1.01	0.95	0.87, 1.03	0.91	0.84, 0.99
Three or four media	0.89	0.72, 1.10	0.80	0.68, 0.94	0.74	0.63, 0.87
Smoke/chew tobacco/consume alcohol						
Yes	0.85	0.73, 0.99	1.16	1.03, 1.30	1.04	0.92, 1.17
Household characteristics						
Caste of the household head						
Scheduled tribe	1.15	0.98, 1.36	0.93	0.81, 1.07	0.85	0.74, 0.98
Other backward caste	1.03	0.90, 1.17	0.94	0.85, 1.05	0.99	0.89, 1.10
None of them	0.91	0.79, 1.04	0.85	0.76, 0.95	0.76	0.68, 0.85
Standard of living index						
Medium	0.81	0.73, 0.90	0.90	0.83, 0.98	0.84	0.77, 0.91
High	0.85	0.70, 1.03	0.63	0.55, 0.73	0.55	0.48, 0.63
Programme and community characteristics						
Received IFA tablets/syrup for three or more months and consumed all tablets/syrup						
Received and consumed all	1.00	0.90, 1.13	0.95	0.87, 1.03	0.99	0.90, 1.08
Received, but not consumed all	0.97	0.82, 1.16	0.98	0.85, 1.12	1.08	0.94, 1.24
Received two or more TT injections during the pregnancy						
Yes	0.93	0.84, 1.04	0.90	0.83, 0.98	0.89	0.82, 0.97
Any IEC activity organized in the village						
Yes	1.18	1.05, 1.33	0.91	0.83, 1.00	1.07	0.97, 1.17
Availability of health professional in the village						
Within the village	0.98	0.86, 1.13	1.04	0.93, 1.16	0.98	0.88, 1.09
Visiting health professional	1.03	0.88, 1.20	1.01	0.89, 1.15	0.95	0.84, 1.07
Distance to nearest government health facility						
Within the village	0.87	0.74, 1.02	0.95	0.83, 1.08	0.85	0.75, 0.97
1–4 km	0.89	0.75, 1.04	0.97	0.85, 1.10	0.87	0.77, 0.99
5–9 km	0.95	0.80, 1.11	0.96	0.84, 1.09	0.88	0.77, 1.00
Distance to nearest private health facility						
Within the village	0.98	0.83, 1.16	1.02	0.89, 1.16	1.01	0.89, 1.15
1–4 km	0.91	0.77, 1.06	1.03	0.90, 1.16	1.06	0.94, 1.20
5–9 km	0.94	0.80, 1.10	1.10	0.97, 1.26	1.07	0.94, 1.22
Availability of *anganwadi* centre in the village						
Yes	0.97	0.86, 1.09	1.01	0.92, 1.11	1.04	0.95, 1.14
Constant	0.24	0.18, 0.34	4.09	3.08, 5.43	4.70	3.49, 6.32
Number of cases (unweighted)	17 466		17 466		17 466	

HAZ, height-for-age *Z*-score; IEC, information, education and communication; IFA, iron and folic acid; TT, tetanus; WAZ, weight-for-age *Z*-score; WHZ, weight-for-height *Z*-score.

household characteristics are found to be important. Specifically, mother's education, and her consumption of tobacco and/or alcohol, as well as the household standard of living, have significant odds on acute malnutrition of children. The only variable of statistical significance at the programme/community level is the presence of IEC activities in the village.

The indicator of chronic malnutrition (stunting) is shown in the second panel in Table 3. At the individual level, the odds of chronic malnutrition among rural children increase with the age of the child, and decrease with mother's educational level and with the height of the mother. Mothers who smoke cigarettes, chew tobacco and/or consume alcohol during pregnancy have 1.16 times higher odds of having chronically malnourished children, compared with women who do not use these products. Duration of breastfeeding is also found to have a significant influence on rural malnutrition in India. At the household level, the odds of chronic malnutrition decline with increases in the standard of living. Two variables show statistical significance at the programme and community levels. First, women who received two or more TT injections during pregnancy have lower odds of having chronically malnourished children, compared with women who did not receive these shots during their pregnancy. Second, children who are living in villages with organized IEC programmes are likely to have lower chronic malnutrition compared with children living in villages where no such programmes exist.

The third panel of Table 3 shows the effects of individual and programme factors on the composite index of malnutrition – a combination of both chronic and acute malnutrition – in rural India. All individual factors are found to be statistically significant. The odds of being underweight decrease with higher birth orders and increase with the age of the child. Individual-level variables, such as mother's educational level, height of the mother, and mass media exposure, and the household variable of standard of living, show a monotonic decline of odds of being underweight. Two variables at the programme and community level are found to be significant. The women who have received two or more TT injections during pregnancy are 0.89 times less likely to have underweight children compared with women who did not receive TT injections. The odds of being underweight also increase with the increased distance to nearest government health facility. That is, for women who live in a village with a government health facility, the odds are 0.89 times less for having an underweight child, compared with women who live at least 10 km away from the nearest government health facility.

The final analysis examines how far the random variances at various levels change after introducing the observed characteristics of individual, household, programme and community variables into the model. These random variances at village and state levels are presented in Table 4 . First, we introduced individual and household characteristics into the model. Then

Table 4. The effects of individual-, programme- and community-level variables on the state- and village-level variances

Variables included	WHZ		HAZ		WAZ	
	Coefficient	SE	Coefficient	SE	Coefficient	SE
Only individual variables						
Between-state variation	0.2534	0.0782	0.2455	0.0727	0.2842	0.0834
Between-village variation	0.2896	0.0397	0.2029	0.0253	0.1666	0.0244
Individual + programme variables (like IFA, TT, BF)						
Between-state variation	0.2596	0.0807	0.2459	0.0732	0.2928	0.0859
Between-village variation	0.2999	0.0404	0.2023	0.0254	0.1656	0.0244
Individual + programme + community variables						
Between-state variation	0.2668	0.0826	0.2378	0.0709	0.2872	0.0844
Between-village variation	0.2974	0.0404	0.2042	0.0254	0.1678	0.0245

BF, breastfeeding; HAZ, height-for-age *Z*-score; IFA, iron and folic acid; TT, tetanus; WAZ, weight-for-age *Z*-score; WHZ, weight-for-height *Z*-score.

building the model, we included individual, household and programme characteristics. Finally, all the characteristics were included and considered in the analysis in order to examine how random variances changes.

The results suggest that the introduction of programme- and community-level variables does not produce much change in the random variances at state and village. This is consistent for the three nutritional measures considered in the analysis. The results clearly indicate that the programme and community variables considered in the analysis are not important in explaining the nutritional status of rural children in India. In other words, individual and household characteristics explain the nutritional status among rural children better than programme- and community-level variables.

Conclusion

Without doubt it can be argued that children born in rural areas of India are at great risk for undernourishment, and the prevalence of chronic undernutrition is higher than that of acute undernutrition. Further, the rural areas of the northern states (namely Bihar, Madhya Pradesh, Rajasthan, Uttar Pradesh and New Delhi) have a higher prevalence of chronic malnutrition compared with other regions of the country collectively. These states, including Orissa, also have higher concentrations of underweight children born in rural areas. Over half of the children born in rural areas of these states suffer from chronic and underweight malnutrition.

The vulnerability of rural children is linked to individual background characteristics and maternal behaviours. Surprisingly, a longer duration of breastfeeding, which is often found to have a protective influence on child health, was found to be statistically significant. It is unclear from the way the data were collected whether the longer duration of breastfeeding is prolonged exclusive breastfeeding, or whether the mothers supplement breastmilk with other foods as the child ages and has changing nutritional demands. More research is needed on this material behaviour to understand its influence on child malnutrition. In this study, maternal behaviour (tobacco and/or alcohol consumption, and mass media exposure) and characteristics of the mother (height and education) were other important determinants of childhood malnutrition. Further, household characteristics (standard of living) were also found to be of significance to the child's vulnerability to malnutrition. These findings lend support to previous studies on childhood malnutrition in India (e.g. Pal 1999; Arnold *et al*. 2004; Radhakrishna & Ravi 2004) and extend research to focus on the malnutrition across the rural areas of India.

Additionally, the models examined consider the context in which the children and households exist by considering programme- and community-level factors. This would be expected as the child is nested within the household, while the household is nested within the community. However, while a few variables at the programme and community levels were found to be significant, none of these variables seemed to have a greater impact on nutritional indicators than the individual and household characteristics. Therefore, the relationship between the child and the community may be more complex than is captured in this model. Further, despite these findings, it should be noted that household-level variables, such as standard of living, education levels and access to media, are all influenced by factors beyond the household.

While the present study results resemble other nutritional studies conducted in this region, differences do exist. One of the reasons for this difference is attributed to the variations in the analytical models used in previous studies. For example, Rao *et al.* (2004) showed that IEC programmes have significant effect on nutritional status of children in selected north-eastern states in India. In the present study, we found that, although the presence of IEC programmes in rural villages showed 0.91 times decline in stunting or chronic malnutrition, a reverse effect was observed for acute malnutrition and underweight. Similarly, Roy *et al*. (2004) emphasized the importance of antenatal care services and location of health facility in nutrition inequalities in selected states in India. Their study results showed a strong correlation between these variables and nutritional indicators. In the present study, after controlling for variations at different levels (such as programme and community), the variables such as presence of health facility, availability of health professional in the village, and distance to nearest government/private health facility were not statistically significant in determining the nutritional status of children in rural areas. This lack of consistency in research findings, especially as multilevel models are used, suggests that there may be a more complex interaction of various levels influencing the nutritional status of children. Clearly, more research is needed that would address the complex relationships between programme and community factors and the households and children within the communities.

Even after controlling for the observable characteristics at various levels, unexplained variations in the nutritional status among children at the state and village levels remain significant. In particular, the state-level variances are marginally higher for all the nutritional measures, except for weight-for-height. In other words, there appears to be a clustering in the prevalence of undernutrition at various levels, such as village and state. The evidence of a state-level clustering effect, as well as the clustering of village level, suggests that unexplained factors should be sought at state level as well as at the lower levels in future analysis.

There is a complex interplay between factors inside and outside of the household. As noted, and consistent with other findings, individual and household characteristics are important in understanding the presence of malnutrition. While some of these factors originate within the household (duration of breastfeeding), they are linked, directly or indirectly, to community resources outside of the household. Future research is needed to examine the nature of the household–community relationship in a manner that allows for comparisons between state and region.

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