# Role of individual and household level factors on stunting: A comparative study in three Indian states

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**Abstract**

*Background*: Status of growth especially in early childhood is not only the most important determinant of health of a child but also a reflection of the well-being of the entire society. The extent of malnutrition in India is very high, but the exact magnitude varies considerably depending on which indicator is used. Child health in this paper is measured through chronic malnutrition (termed as stunting). Three states were selected, namely Bihar, West Bengal and Kerala. These three states represent the three stages of development. Bihar is one of the least and Kerala is one of the most developed states in India.

*Aim*: The present paper aims to investigate the degree of chronic malnutrition in the context of socio-economic, demographic and other characteristics of the children and their households in the three selected states in India.

*Subjects and methods*: The data for this study were taken from the National Family Health Survey (NFHS-2) conducted by the International Institute for Population Sciences (IIPS), Mumbai, in 1998–1999. The NFHS-2 sample covers ever-married women in the age group 15–49 years from 26 states in India. Besides collecting information on health, the survey collects data on socio-economic and demographic characteristics at individual and household level.

*Results*: The percentage of stunting of children in Bihar, West Bengal and Kerala was found to be 54, 39 and 23%, respectively. Regression analysis showed that the major factors that significantly influenced the status of health in the children in all three states were women's education and the household condition index. Months of breastfeeding and birth interval also had some association with health status. The effect of the above-mentioned variables was most prominent in Bihar and least in Kerala in terms of statistical significance.

*Conclusion*: There is a close positive link between the nutritional status of pre-school children and the stages of development of the states. Mothers' education and household condition are important influences on children's health status irrespective of the stage of development.

**Keywords:** *Stunting, pre-school children, socio-economic variables, BMI, regression, chi-square test*

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## Introduction

Health is an instrument as well as the product of development and is therefore considered a major factor in the development process. Nutritional status is an integral component of the overall health of an individual. As the quality of future human resources depends on the present day children, improvement of the nutritional level of children of today should be given top priority. UNICEF (1994) reported that about 55% of the deaths of children below 5 years of age are due to malnutrition. Malnutrition is thus linked to mortality and also morbidity among the children in developing countries (Pelletier 1998). India has the highest occurrence of childhood malnutrition in the world (Bamji 2003).

Although child health covers areas including mortality, disease, malnutrition, child care and so on, here we restrict our study of child health to the form of chronic malnutrition, termed as stunting. Height-for-age is an indicator of stunting. It is a common manifestation of malnutrition in children in developing countries. The prevalence of malnutrition in India is extremely high even when compared to other poor countries. In the 1990s, 36% of children below the age of five in India were severely stunted, compared to 21% in Sub Saharan Africa (Svedberg 2001).

There are different opinions regarding the role of individual and household characteristics on child health. Proponents of family planning (WHO 2000) argue that malnutrition will disappear if one plans birth intervals appropriately and controls birth order and other related factors in an optimum manner (Mazumder et al. 2000); while others (Behrman and Deolalikar, 1988; Kakwani et al. 1997; Wagstaff and Watanabe 2000) emphasize the importance of improvements of individual and household characteristics (Pal 1999). The present study tries to combine both these approaches by identifying the factors influencing the nutritional level among the children in three different states of India.

Child malnutrition is one of the measures of health status recommended by World Health Organization for assessing equity in health (Braveman 1998). Anthropometry is recognized as the most useful technique in assessing the growth and nutritional status of individuals or populations (Jelliffe 1966; Rao et al. 1986; Gorstein et al. 1994; McMurray 1996; Borooah 2005). In India, a number of studies have been conducted on nutrition and health status of children. The studies of Indian Council of Medical Research (ICMR 1972) and Rao and Rao (1994) showed that the extent and type of malnutrition differ sharply due to variation of socio-economic factors, food habits, levels of literacy, climate, religion and cultural beliefs. Rajaram et al. (2003) and Rao et al. (2004) also showed the significant relationship between socio-economic variables and degree of malnutrition. Better infant feeding practices can have a substantial influence on the physical development of children (Brennan et al. 2004).

This paper analyses the health status of pre-school children in India through height-for-age using three states, namely Bihar, West Bengal and Kerala, which represent the three stages of development, Bihar being one of the least developed states and Kerala being one of the most developed states. This will be clear if we take some indices of development of these three states (Table I) such as Infant Mortality Rate, Literacy Rate, Life Expectancy at Birth and Sex Ratio. Other indices of development also show similar diversity and level of development.

In Bihar, rural poverty ratio is still around 40–50%. The States of Kerala and West Bengal show a visible fall in poverty proportions while states like Bihar have either shown little change or an actual rise in poverty proportions (Source: Planning Commission as quoted in the India Rural Development Report 1999). The development parameters of the state of Kerala clearly show that this state is as developed as other developed countries and is

Table I. Socio-demographic characteristics of development of the three states.

| States | Infant mortality rate, 2001 (per 1000 live birth) | | | Literacy rate, 2001 | | | Life expectancy at birth(1996–2001) | | Sex ratio, 2001 (females per1000 males) |
|---|---|---|---|---|---|---|---|---|---|
| | Rural | Urban | Total | Male | Female | Total | Male | Female | |
| Bihar | 63 | 52 | 62 | 59.68 | 33.12 | 47.00 | 61.1 | 59.3 | 921 |
| West Bengal | 54 | 37 | 51 | 77.02 | 59.61 | 68.64 | 63.2 | 64.6 | 934 |
| Kerala | 12 | 9 | 11 | 94.24 | 87.72 | 90.86 | 70.8 | 76.2 | 1058 |
| All India | 72 | 42 | 66 | 75.26 | 53.67 | 64.84 | 61.3 | 63.0 | 933 |

Source: Census of India (2001).



regarded as the model state in India. A strong class hierarchy exists in the state of Bihar. West Bengal, closer to the national average in many of the development aspects, is a state where land reforms have been undertaken and *Panchayati Raj* (a three-tier administration system at village level) has been established and is being run successfully.

Malnutrition is widespread in the country, but the exact magnitude varies considerably depending on the indicator considered. The present paper aims to explain the degree of chronic malnutrition through socio-economic and demographic factors at an individual and household level in the three states of India.

The specific objectives of the study are: (1) to see the category-wise prevalence of degree of chronic malnutrition in the above-mentioned three states in India, (2) to see the associations of both household and individual level factors with child chronic malnutrition.

## Materials and methods

### *Data source*

The data for this study are taken from the National Family Health Survey (NFHS-2, 2000) conducted by the International Institute for Population Sciences (IIPS) (2000), Mumbai, in 1998–1999. The survey is the outcome of the collaborative efforts of many organizations. The International Institute for Population Sciences (IIPS) was designated as the nodal agency for this project by the Ministry of Health and Family Welfare, Govt. of India, New Delhi. Thirteen reputed Field Organizations (FOs) in India, including five Population Research Centres, were selected to carry out the data collection phase. The survey used uniform questionnaires, sample design and field procedures to facilitate comparability of the data and to achieve a high level of data quality.

The NFHS-2 sample covers the Indian population of ever-married women in the age group 15–49 years, residing in 26 states. The survey collected data at household and individual level covering the socio-economic and demographic characteristics of the households. Health information was also collected in this study.

Mothers having at least one child of less than 3 years of age were taken as units for the survey. The survey collected data of height and weight of the children of less than 36 months. However, only height measurements were used for the present analysis.

Height-for-age is less affected by acute periods of stress at the time of measurement. Sahn and Stifel (2002) pointed out that an acute episode of diarrhoea or malaria would not affect height-for-age. Low height-for-age generally indicates long-term past nutrition and is therefore considered a good indicator of chronic malnutrition. The covariates influencing chronic child malnutrition consist of both household and individual level data. The household level factors considered are place of residence, religion, households condition index.[1] We have not taken drinking source, toilet condition and number of members in the family as determining variables separately because these variables are already considered in obtaining the household condition index. Besides household characteristics, we have taken individual characteristics of mother and children. One could have taken particulars of both the parents. But in this data set, it was seen that the father's influence was not as pronounced as the mother's influence so far as child health is concerned. So the present study does not consider the role of paternal education and occupation.

The factors considered in this study can be put in one of the three groups: Child, maternal and household related. Child-related data are age and sex of the child, height at the time of birth, preceding birth interval, breastfeeding practices before the day of survey and diarrhoea episodes within 2 weeks preceding the survey. Infant birth weight is very important for future growth. But the birth weight data are not recorded in many cases, whereas the height data at birth are available. Thus only the height of the child, as reported by the mother, at birth has been taken for the present study. Infant feeding practice is very important in the context of child growth. Too early or too late introduction of supplements is a big problem in many states of India. But in this case, there are a number of limitations regarding breastfeeding practices. Firstly, the data fail to supply the past feeding records. Only the present feeding practice at the time of survey are available. Duration of breastfeeding has been considered at the time of survey. It is not possible to know whether the babies are exclusively breastfed or not. It is also unknown when supplemented food was introduced to the babies. The present study only considers the period of breastfeeding in months regardless of whether the child is currently breastfed or not, and supplemented food is given or not.

Level of education, working status and body mass index (weight/height$^2$) of mothers are the important parameters that are assumed to affect child chronic malnutrition. It is to be noted that only non-pregnant mothers were considered in the present study.

## *Methods*

The representative numbers of the children in Kerala, West Bengal and Bihar are 596, 1033 and 2357, respectively. Indication of chronic malnutrition of health, known as stunting, are measured through height-for-age (HAZ). Generally height deficiencies become conspicuous during the first 2 years of life, when growth of the extremities is faster than that of the trunk. Height-for-age index was calculated on the basis of height for each age separately for male and female using the reference data of The World Health Organization (WHO 1995).

The present study classified the nutritional status of the children as follows: A child is termed as 'severely stunted' if the child has a *Z*-score below –3, 'moderately stunted' if the child has *Z*-scores greater than or equal to –3 and less than –2 (Mitra et al. 2001). 'Well nourished' children are those whose *Z*-scores are greater than or equal to –2. Mother's BMI (body mass index) is computed by using the formula of weight/height$^2$ (where weight

and height are measured in kilograms and metres, respectively). A BMI level less than 18.5 $kg\,m^{-2}$ indicates chronic energy deficiency or under-nutrition (WHO 1995).

In the second step of the analysis, the risk of $z$-scores of value −2 or less (i.e. malnourished) is estimated. The logistic regression technique is used in this paper[2] for estimation of the odds of being malnourished of the groups that have a higher or lower risk of under-nutrition in the study population. To create the dependent variable, children whose $z$-scores are below −2 are coded 1 and those with $z$-scores of −2 or higher are coded 0. The predictor variables are entered into the regression equation, thus the results obtained are compared with the reference category. In this context it should be mentioned that the set of regressors taken for the regression analysis has been tested for multicollinearity. It is found that there is a strong correlation between child normal age and the period of breastfeeding (not shown in this table). For this reason we considered one of these two variables in the regression analysis. One can also see that the design of the survey is nested, i.e. children are nested within household and households are nested within states. This could be controlled by using a multi-level model as described by Griffiths et al. (2004). Griffiths et al. investigated the determinants of weight-for-age Z-score (WAZ) in four Indian States using statistical modelling of the NFHS data. Multi-level modelling is more useful in finding intra-class correlations and variation within a given level. Since the aim of the present study was to estimate the regression coefficients and these coefficients do not differ much even if a multi-level model is taken, we have not used a multi-level model. Regression analysis is carried out separately for each of the three states also.

Statistical analysis has been carried out using the statistical software package SPSS (11.0 version) for Windows and the significance levels of $p < 0.01$, 0.05 and 0.1 were considered.



## Results

The comparisons of the three states through some of the development parameters are given in Table I. It is evident from the table that Bihar lags far behind Kerala. West Bengal is in-between Bihar and Kerala. In other words, these three states represent the three states of development.

Percentage of stunted children in the age of <36 months in three states in India are shown in Table II. The results reveal that an overall 36% of children of below 3 years in Bihar, 9% in Kerala, and 17% in West Bengal, are severely stunted[3]. The corresponding percentages of moderately stunted children are 18%, 14% and 21%. The prevalence of severely stunted children in Bihar is very high (more than double) compared to West Bengal. Almost the reverse trend has been observed in case of moderately stunted children.

Table II. Percentage distribution of child chronic malnutrition in the three states of India.

| | | Stunted | | |
|---|---|---|---|---|
| State | Normal | Moderate | Severe | Total |
| Bihar | 45.6 (1073) | 18.3 (432) | 36.1 (852) | 2357 |
| West Bengal | 61.2 (632) | 21.4 (221) | 17.4 (180) | 1033 |
| Kerala | 77.1 (460) | 14.3 (85) | 08.6 (51) | 596 |

Figures in parentheses represent the number of children.

The overall percentages of stunted children (a condition reflecting chronic malnutrition) in Bihar, Kerala and West Bengal are about 54%, 23% and 39%, respectively. Thus Kerala, West Bengal and Bihar belong to three distinct groups representing three stages of development in regard to the status of health of children.

Table III presents the age-wise distribution of stunted children. An increasing trend in the percentages of severely stunted children in Bihar is observed up to the age of 24 months and thereafter it has an oscillating behaviour. The same trend is found in the case of moderately stunted children but the percentages are less than those of severely stunted children. In Kerala, the percentage of severely stunted children shows a decreasing trend at first and then oscillates. The prevalence of moderately stunted children also shows a vacillating feature. Since these percentages are quite small in Kerala, the features are not so conspicuous as in Bihar and West Bengal and one should not draw any conclusion from these percentages in Kerala. Apart from a spurious percentage in the age group 6–8 months, the general trends of severely and moderately stunted children in West Bengal are almost same as in Bihar.

Differentials of malnutrition among the pre-school children in three states have been investigated by taking some selected factors relating to child, mother and household levels. The correlations among these factors give us an idea about the degree of multi-collinearity. This is not presented here, because most of these factors are categorical and may not be meaningful in some cases, especially when there are more than two categories. However, it is to be noted that only the background characteristics, which come under the subset of best predictors, was included in the final model. Instead of interrelations among these variables, it is more appealing to see the relations of these variables with height-for-age of the children. Table IV shows the percentage distribution of 3986 children of less than 36 months by selected child, mother and household level characteristics. Bivariate tables showing relations between the status of health and each of the selected categories along with the result of $\chi^2$ test of significance are summarized in this table (Table IV).

Table IV clearly shows that the percentages of severely as well as moderately stunted children decrease with increasing levels of mother's education, household condition index and mother's nutritional status. Percentages of stunted children in Bihar, Kerala and West Bengal among illiterate or primary level educated mothers are 57%, 25% and 49%, respectively. These percentages drop drastically (17% in Bihar, 12% in Kerala and 10%

Table III. Age-group-wise percentage distribution of stunted children in the three states of India.

| | Bihar | | | West Bengal | | | Kerala | | |
|---|---|---|---|---|---|---|---|---|---|
| Child age (months) | Severely malnourished | Moderately malnourished | $n$* | Severely malnourished | Moderately malnourished | $n$* | Severely malnourished | Moderately malnourished | $n$* |
| 0–<3 | 9.6 | 6.1 | 228 | 9.2 | 9.2 | 65 | 7.9 | 5.3 | 38 |
| 3–<6 | 12.2 | 15.1 | 271 | 9.2 | 8.3 | 109 | 6.5 | 17.4 | 46 |
| 6–<9 | 21.0 | 16.4 | 219 | 12.0 | 15.2 | 99 | 4.9 | 8.2 | 61 |
| 9–<12 | 27.0 | 19.9 | 141 | 11.8 | 16.2 | 68 | 6.7 | 11.1 | 45 |
| 12–<18 | 36.0 | 24.8 | 464 | 21.5 | 28.3 | 205 | 8.1 | 15.2 | 99 |
| 18–<24 | 60.6 | 16.7 | 287 | 21.3 | 32.7 | 150 | 7.8 | 22.4 | 116 |
| 24–<30 | 42.3 | 23.8 | 357 | 20.4 | 24.1 | 191 | 9.5 | 14.7 | 116 |
| ≥30 | 56.7 | 16.7 | 390 | 26.7 | 18.5 | 146 | 14.7 | 9.3 | 75 |
| Total | 36.1 | 18.3 | 2357 | 17.4 | 21.4 | 1033 | 8.6 | 14.3 | [illegible] |

*$n$ denotes the total number of children, including normal children.

Table IV. Percentage distribution of children less than 36 months by background and family characteristics in three states in India.

| | Bihar | | | | West Bengal | | | | Kerala | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Stunting | | | | Stunting | | | | Stunting | | |
| Characteristics | *n* | Severe | Moderate | $\chi^2$ | *n* | Severe | Moderate | $\chi^2$ | *n* | Severe | Moderate | $\chi^2$ |
| Sex of baby | | | | | | | | | | | | |
| Male | 1217 | 36.2 | 18.2 | 0.048 (0.976) | 537 | 13.8 | 21.4 | 10.93 (0.004) | 308 | 10.1 | 13.6 | 1.93 (0.380) |
| Female | 1140 | 36.1 | 18.5 | | 496 | 21.4 | 21.4 | | 288 | 6.9 | 14.9 | |
| Residence | | | | | | | | | | | | |
| Urban | 201 | 27.9 | 14.4 | 13.17 (0.001) | 351 | 9.7 | 17.4 | 34.28 (0.000) | 144 | 6.9 | 15.3 | 0.723 (0.697) |
| Rural | 2156 | 36.9 | 18.7 | | 682 | 21.4 | 23.5 | | 452 | 9.1 | 13.9 | |
| Ethnicity | | | | | | | | | | | | |
| Scheduled Castes/Scheduled Tribes | 665 | 39.4 | 19.4 | 14.89 (0.005) | 315 | 22.2 | 23.5 | 11.95 (0.018) | 53 | 20.8 | 20.8 | 6.90 (0.002) |
| Other Backward Classes | 1263 | 36.4 | 18.3 | | 41 | 12.2 | 14.6 | | 267 | 9.0 | 14.6 | |
| Others | 429 | 30.3 | 16.8 | | 677 | 15.5 | 20.8 | | 276 | 5.8 | 12.7 | |
| Breastfeeding | | | | | | | | | | | | |
| More than 6 months | 1744 | 43.9 | 20.5 | 273.75 (0.000) | 781 | 20.0 | 24.6 | 44.40 (0.000) | 470 | 8.5 | 14.3 | 0.006 (0.997) |
| Up to 6 months | 613 | 14.0 | 12.2 | | 252 | 9.5 | 11.5 | | 126 | 8.7 | 14.3 | |
| Breastfeeding | | | | | | | | | | | | |
| Currently breastfeeding & age >12 | 1284 | 50.1 | 20.9 | 373.09 (0.000) | 577 | 23.6 | 26.7 | 81.06 (0.000) | 251 | 10.0 | 17.5 | 7.31 (0.293) |
| Not breastfeeding & age >12 | 175 | 35.4 | 21.1 | | 86 | 15.1 | 20.9 | | 135 | 9.6 | 12.6 | |
| Currently breastfeeding & age ≤12 | 879 | 16.4 | 14.4 | | 355 | 8.7 | 13.5 | | 204 | 6.4 | 11.3 | |
| Not breastfeeding & age ≤12 | 19 | 15.8 | – | | 15 | – | 6.7 | | 6 | – | 16.7 | |
| Size at birth | | | | | | | | | | | | |
| Average or larger | 1942 | 35.2 | 18.4 | 4.99 (0.082) | 811 | 15.0 | 20.7 | 18.88 (0.000) | 458 | 8.1 | 14.2 | 0.613 (0.736) |
| Smaller | 415 | 40.2 | 18.1 | | 222 | 26.1 | 23.9 | | 138 | 10.1 | 14.5 | |
| Had diarrhoea | | | | | | | | | | | | |
| No | 1937 | 35.8 | 17.6 | 6.73 (0.035) | 958 | 17.2 | 21.3 | 5.65 (0.754) | 526 | 8.2 | 13.7 | 2.33 (0.312) |
| Yes | 420 | 37.6 | 21.9 | | 75 | 20.0 | 22.7 | | 70 | 11.4 | 18.6 | |
| Birth interval (months) | | | | | | | | | | | | |
| ≥24 | 1506 | 36.8 | 16.5 | 22.10 (0.000) | 538 | 16.7 | 24.0 | 11.98 (0.018) | 295 | 6.8 | 13.6 | 35.03 (0.000) |
| <24 | 312 | 42.6 | 19.2 | | 119 | 26.1 | 19.3 | | 65 | 27.7 | 10.8 | |
| First birth | 539 | 30.6 | 23.0 | | 376 | 15.7 | 18.4 | | 236 | 5.5 | 16.1 | |
| Mother's BMI | | | | | | | | | | | | |
| Malnourished | 901 | 39.1 | 20.0 | 15.03 (0.005) | 492 | 21.1 | 23.8 | 19.35 (0.001) | 141 | 13.5 | 16.3 | 7.54 (0.110) |
| Normal | 1411 | 34.5 | 17.5 | | 493 | 14.8 | 19.7 | | 381 | 7.1 | 14.2 | |
| Overweight | 45 | 28.9 | 11.1 | | 48 | 6.3 | 14.6 | | 74 | 6.8 | 10.8 | |

(*Continued*)

Table IV. Continued.

| | Bihar | | | | West Bengal | | | | Kerala | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Stunting | | | | Stunting | | | | Stunting | | |
| Characteristics | *n* | Severe | Moderate | $\chi^2$ | *n* | Severe | Moderate | $\chi^2$ | *n* | Severe | Moderate | $\chi^2$ |
| Mother's education | | | | | | | | | | | | |
| ≤Primary | 1926 | 37.9 | 18.8 | 46.96 (0.000) | 660 | 22.9 | 25.6 | 79.69 (0.000) | 72 | 9.7 | 15.3 | 19.14 (0.001) |
| Secondary | 361 | 31.9 | 18.0 | | 301 | 9.0 | 15.6 | | 345 | 11.6 | 16.2 | |
| Higher | 70 | 10.0 | 7.1 | | 72 | 2.8 | 6.9 | | 179 | 2.2 | 10.1 | |
| Mother's working status | | | | | | | | | | | | |
| Not working | 1856 | 34.2 | 18.5 | 19.35 (0.001) | 838 | 15.9 | 20.5 | 14.66 (0.005) | 517 | 9.1 | 14.9 | 3.46 (0.483) |
| Non-manual | 34 | 29.4 | 23.5 | | 18 | 22.2 | 11.1 | | 33 | 3.0 | 9.1 | |
| Manual | 467 | 44.5 | 17.3 | | 177 | 24.3 | 26.6 | | 46 | 6.5 | 10.9 | |
| HCI | | | | | | | | | | | | |
| Low | 681 | 39.2 | 18.8 | 21.72 (0.000) | 164 | 24.4 | 26.2 | 36.93 (0.000) | 119 | 13.4 | 11.8 | 9.35 (0.053) |
| Medium | 1528 | 35.9 | 18.7 | | 638 | 18.7 | 22.9 | | 418 | 7.7 | 16.0 | |
| High | 148 | 34.3 | 12.8 | | 231 | 9.1 | 13.9 | | 59 | 5.1 | 6.8 | |
| Religion | | | | | | | | | | | | |
| Hindu | 1910 | 36.3 | 18.5 | 7.77 (0.256) | 741 | 16.3 | 19.6 | 14.76 (0.022) | 275 | 8.0 | 13.8 | 3.64 (0.456) |
| Muslim | 421 | 35.6 | 17.6 | | 275 | 21.1 | 26.2 | | 246 | 9.8 | 16.3 | |
| Christian | 13 | 46.2 | – | | 4 | – | – | | 75 | 6.7 | 9.3 | |
| Others | 13 | 15.4 | 38.5 | | 13 | 7.7 | 30.8 | | – | – | – | |

Values in parentheses are the levels of significance.

in West Bengal) among the higher educated mothers. Child's age has a significant association with height for age. In Kerala and West Bengal, the proportion of severely stunted children is lower in the higher age group compared to the moderately stunted children. On the other hand, the proportion of moderately stunted children in Bihar is less than that of severely stunted children. Scheduled Castes (SC) and Scheduled Tribes (ST) are the most affected ethnic groups. Next comes Other Backward Classes (OBC). The general castes are the most privileged group. The effect of diarrhoea is found to be significant only in Bihar. Breast feeding is very important for child growth[4]. It is found from the table that the children breastfed more than 6 months have a significant association with stunting except for Kerala. The picture is quite alarming in Bihar.

Table V shows the results of the logistic regression of height-for-age on the socio-economic and demographic characteristics of the children aged less than 36 months combining data of all the three states considered in the paper. The stunted children, according to height for age, are given a value 1 and the normal children are given the value 0, i.e. the normal children are treated as the reference category. The table gives standard errors, odds ratio and the level of significance along with the coefficients. The coefficients of the most of the variables have been found to be significant at 5% level. The results of logistic regression separately for each state are also given in Table VI. The effects of the variables have been found to be similar in all the cases and the coefficients, if significant, have signs as expected.

Comparison of the coefficients of the overall regression and the state-wise regressions leads to the conclusion that the child's age and mother's education have significant association with stunting in all the cases. Here it should be noted that, being a developed state, the inter-group differences for many of the variables in Kerala are not conspicuous and do not show any significant contribution towards determination of chronic malnutrition of children. Thus, looking at the results of regression of West Bengal and Bihar, we get some more variables such as height of the baby at birth and housing condition index, which have significant influence on stunting of children. Sex, diarrhoeal episode, mother's BMI and religion do not have much association for any of the states. Other variables such as status of breastfeeding[5], preceding birth interval, mother's working status, and place of residence show mixed results. In conclusion, it can be stated that age of children has a positive and preceding birth interval, mother's education level, household condition index and height of the baby at birth have strong negative relations with the stunting of the children.



## Discussion

The importance of the nutritional status of children in the developing countries should be emphasized, not only for the improvement of health of children in the coming generation, but also for the overall development of the concerned region in near future. There are significant differences of nutritional status between states and between regions of the states. It is seen that, in Bihar, the risk of chronic malnutrition increases with age and attains its peak value at some point during the second year of life and then goes downward as also found by Mitra et al. (2001). West Bengal also has almost the same pattern, but Kerala gives somewhat spurious results, possibly due to smallness of number of malnourished children. Thus, the association of socio-economic, demographic and health factors with the health status of the children can be studied more effectively for regions, which are comparatively

Table V. Logistic regression of height-for-age *Z*-scores of children aged less than 36 months on socio-demographic characteristics for all three states.

| Characteristics | Coefficient | SE | Odds | *p* |
|---|---|---|---|---|
| Age | | | | |
| ≥1 years * | | | | |
| <1 years | −1.162 | 0.102 | 0.313 | 0.000 |
| Sex | | | | |
| Female* | | | | |
| Male | −0.070 | 0.070 | 0.932 | 0.317 |
| Breastfeeding | | | | |
| More than 6 months* | | | | |
| Up to 6 month | −0.440 | 0.114 | 0.644 | 0.000 |
| Height of the baby at birth | | | | |
| Smaller* | | | | |
| Average or larger | −0.225 | 0.089 | 0.799 | 0.012 |
| Diarrhoea | | | | |
| Yes* | | | | |
| No | −0.250 | 0.100 | 0.779 | 0.012 |
| Preceding birth interval: | | | | |
| ≥24 months* | | | | |
| <24 months | 0.322 | 0.110 | 1.380 | 0.003 |
| First birth | 0.089 | 0.083 | 1.093 | 0.285 |
| Mother's BMI | | | | |
| Malnourished* | | | | |
| Normal and overweight | −0.117 | 0.073 | 0.889 | 0.107 |
| Mother's education | | | | |
| ≤Primary* | | | | |
| Middle completed | −0.679 | 0.088 | 0.507 | 0.000 |
| Higher | −1.687 | 0.192 | 0.185 | 0.000 |
| Mother's working status | | | | |
| Not working* | | | | |
| Working, non-manual | 0.098 | 0.276 | 1.113 | 0.723 |
| Working, manual | 0.118 | 0.097 | 1.125 | 0.223 |
| Household condition index | | | | |
| Low* | | | | |
| Medium | −0.133 | 0.083 | 0.875 | 0.107 |
| High | −0.534 | 0.147 | 0.587 | 0.000 |
| Residence | | | | |
| Rural* | | | | |
| Urban | −0.336 | 0.105 | 0.714 | 0.001 |
| Religion | | | | |
| Hindu* | | | | |
| Muslim | −0.085 | 0.091 | 0.918 | 0.348 |
| Christian | −0.522 | 0.294 | 0.593 | 0.075 |
| Others | −0.183 | 0.429 | 0.832 | 0.669 |
| Ethnicity | | | | |
| Scheduled Castes/Scheduled Tribes* | | | | |
| Other Backward Classes | −0.045 | 0.091 | 0.957 | 0.623 |
| Others | −0.319 | 0.105 | 0.727 | 0.002 |

*Reference category.

less developed. Specifically, the nutritional status of child decreases as age of child increases, and it increases with the height of the baby at birth, preceding birth interval and level of mother's education. The present study thus corroborates with the study of Griffiths et al. (2004).

Table VI. Logistic regression of height-for-age *Z*-scores of children aged less than 36 months on socio-demographic characteristics.

| Characteristics | Coefficient | SE | Odds | *p* |
|---|---|---|---|---|
| ***Bihar*** | | | | |
| Age | | | | |
| ≥1 years* | | | | |
| <1 years | −1.209 | 0.129 | 0.298 | 0.000 |
| Sex | | | | |
| Female* | | | | |
| Male | 0.011 | 0.092 | 1.011 | 0.903 |
| Breastfeeding | | | | |
| More than 6 months* | | | | |
| Up to 6 month | −0.742 | 0.145 | 0.476 | 0.000 |
| Height of the baby at birth | | | | |
| Smaller* | | | | |
| Average or larger | −0.321 | 0.123 | 0.726 | 0.009 |
| Diarrhoea | | | | |
| Yes* | | | | |
| No | −0.191 | 0.121 | 0.826 | 0.115 |
| Preceding birth interval | | | | |
| ≥24 months* | | | | |
| <24 months | 0.213 | 0.141 | 1.238 | 0.129 |
| First birth | 0.103 | 0.114 | 1.109 | 0.362 |
| Mother's BMI | | | | |
| Malnourished* | | | | |
| Normal & over | −0.098 | 0.095 | 0.907 | 0.305 |
| Mother's education | | | | |
| ≤Primary* | | | | |
| Middle completed | −0.183 | 0.138 | 0.832 | 0.183 |
| Higher | −1.486 | 0.351 | 0.226 | 0.000 |
| Mother's working status | | | | |
| Not working* | | | | |
| Working, non-manual | −0.107 | 0.386 | 0.899 | 0.782 |
| Working, manual | 0.212 | 0.122 | 1.237 | 0.081 |
| Household condition index | | | | |
| Low* | | | | |
| Medium | −0.133 | 0.103 | 0.875 | 0.194 |
| High | −0.510 | 0.223 | 0.601 | 0.022 |
| Residence | | | | |
| Rural* | | | | |
| Urban | −0.312 | 0.174 | 0.732 | 0.074 |
| Religion | | | | |
| Hindu* | | | | |
| Muslim | −0.024 | 0.131 | 1.024 | 0.855 |
| Christian | −0.573 | 0.620 | 0.564 | 0.355 |
| Others | 0.048 | 0.613 | 0.953 | 0.937 |
| Ethnicity | | | | |
| Scheduled Castes/Scheduled Tribes* | | | | |
| Other Backward Classes | −0.093 | 0.112 | 0.911 | 0.404 |
| Others | −0.313 | 0.156 | 0.728 | 0.043 |
| ***West Bengal*** | | | | |
| Age | | | | |
| ≥1 years* | | | | |
| <1 years | −1.354 | 0.212 | 0.258 | 0.000 |

(*Continued*)

Table VI. Continued.

| Characteristics | Coefficient | SE | Odds | *p* |
|---|---|---|---|---|
| Sex | | | | |
| Female* | | | | |
| Male | −0.266 | 0.144 | 0.766 | 0.064 |
| Breastfeeding | | | | |
| More than 6 months* | | | | |
| Up to 6 month | −0.154 | 0.234 | 0.857 | 0.510 |
| Height of the baby at birth | | | | |
| Smaller* | | | | |
| Average or larger | −0.536 | 0.172 | 0.585 | 0.002 |
| Diarrhoea | | | | |
| Yes* | | | | |
| No | −0.067 | 0.266 | 0.935 | 0.801 |
| Preceding birth interval | | | | |
| ≥24 months* | | | | |
| <24 months | 0.074 | 0.226 | 1.076 | 0.745 |
| First birth | 0.160 | 0.163 | 1.173 | 0.325 |
| Mother's BMI | | | | |
| Malnourished* | | | | |
| Normal & over | −0.214 | 0.147 | 0.807 | 0.145 |
| Mother's education | | | | |
| ≤Primary* | | | | |
| Middle completed | −0.807 | 0.182 | 0.446 | 0.000 |
| Higher | −1.725 | 0.461 | 0.176 | 0.000 |
| Mother's working status | | | | |
| Not working* | | | | |
| Working, non-manual | 0.375 | 0.584 | 1.456 | 0.521 |
| Working, manual | 0.251 | 0.193 | 1.285 | 0.195 |
| Household condition index | | | | |
| Low* | | | | |
| Medium | −0.238 | 0.195 | 0.788 | 0.221 |
| High | −0.513 | 0.262 | 0.599 | 0.050 |
| Residence | | | | |
| Rural* | | | | |
| Urban | −0.233 | 0.177 | 0.792 | 0.188 |
| Religion | | | | |
| Hindu* | | | | |
| Muslim | 0.320 | 0.194 | 1.376 | 0.099 |
| Christian | −4.572 | 5.825 | 0.012 | 0.432 |
| Others | −0.167 | 0.642 | 0.846 | 0.795 |
| Ethnicity | | | | |
| Scheduled Castes/Scheduled Tribes* | | | | |
| Other Backward Classes | −0.379 | 0.404 | 0.685 | 0.349 |
| Others | −0.149 | 0.184 | 0.861 | 0.415 |
| ***Kerala*** | | | | |
| Age | | | | |
| ≥1 years * | | | | |
| <1 years | −0.795 | 0.311 | 0.452 | 0.010 |
| Sex | | | | |
| Female* | | | | |
| Male | 0.134 | 0.211 | 1.143 | 0.527 |
| Breastfeeding | | | | |
| More than 6 months* | | | | |
| Up to 6 month | 0.611 | 0.338 | 1.843 | 0.071 |

(*Continued*)

Table VI. Continued.

| Characteristics | Coefficient | SE | Odds | p |
|---|---|---|---|---|
| Height of the baby at birth | | | | |
| Smaller* | | | | |
| Average or larger | 0.098 | 0.242 | 1.103 | 0.686 |
| Diarrhoea | | | | |
| Yes* | | | | |
| No | −0.306 | 0.299 | 0.736 | 0.306 |
| Preceding birth interval | | | | |
| ≥24 months* | | | | |
| <24 months | 0.839 | 0.313 | 2.315 | 0.007 |
| First birth | 0.180 | 0.231 | 1.197 | 0.436 |
| Mother's BMI | | | | |
| Malnourished* | | | | |
| Normal & over | −0.335 | 0.238 | 0.715 | 0.159 |
| Mother's education | | | | |
| ≤Primary* | | | | |
| Middle completed | 0.002 | 0.329 | 1.002 | 0.995 |
| Higher | −0.736 | 0.427 | 0.479 | 0.085 |
| Mother's working status | | | | |
| Not working* | | | | |
| Working, non-manual | −0.023 | 0.600 | 0.977 | 0.969 |
| Working, manual | −0.697 | 0.457 | 0.498 | 0.127 |
| Household condition index | | | | |
| Low* | | | | |
| Medium | 0.054 | 0.260 | 1.055 | 0.835 |
| High | −0.807 | 0.499 | 0.446 | 0.106 |
| Residence | | | | |
| Rural* | | | | |
| Urban | 0.256 | 0.251 | 1.292 | 0.308 |
| Religion | | | | |
| Hindu* | | | | |
| Muslim | 0.348 | 0.257 | 1.417 | 0.175 |
| Christian | −0.102 | 0.392 | 1.107 | 0.795 |
| Others | – | – | – | – |
| Ethnicity | | | | |
| Scheduled Castes/Scheduled Tribes* | | | | |
| Other Backward Classes | −1.045 | 0.358 | 0.352 | 0.004 |
| Others | −1.249 | 0.376 | 0.287 | 0.001 |

*Refernce category.



Mother's education is a vital factor in determining the health of a child. In the present study, children of uneducated or primary educated mothers had a high risk of severe stunting. This finding is consistent with those of Roy (2000), Smith and Haddad (2000), Brennan et al. (2004) and many others. The results of Smith and Haddad (2000) are based on the data of 63 developing countries over the period of 25 years. Results from the present study do not show much association of mother's nutritional status with the status of chronic malnutrition of children. When seen state-wise, many of the factors, except for mother's education, and child age, fail to significantly explain the health status of children for all the states, whereas breastfeeding is not an important factor in the other two states. Similarly, a birth interval less than 24 months is an important factor in Kerala, but does not have much effect in West Bengal. No sex difference is found in any of the states, except in West Bengal where there is a slight positive advantage for male children.

The paper calls for raising awareness of mothers about the positive association of preceding birth interval and for raising awareness of heads of families as well as of mothers about the positive influence of household condition on the chronic health status of children. Needless to say, education of mothers possesses the key role in this context.

**Acknowledgements**

The authors gratefully acknowledge the two unknown referees who have critically reviewed the paper and made valuable suggestions, which have helped greatly in the improvement of the quality of the paper. However any errors lie with us.



## Notes

[1] Household condition index (HCI) is measured by an index that reflects the household condition in terms of sanitation, drinking source and family size. Each of these variables are given scores according to the degree of facility available or the amount of the variable as follows. *Toilet facility*: 0 for no facility, 1 for shared or public pit toilet, 2 for public or shared flush or own pit toilet and 4 for own flush toilet. *Source of drinking water*: 0 for source other than pipe, hand pump, public tap or well, 1 for public tap, hand pump or well, and 2 for private pipe lines, hand pump or well in residence/yard/plot. *Family size*: 0 for 11 or more members in the family, 1 for 8–10 members in the family, 2 for five to seven members in the family and 4 for less than five members in the family. The HCI can then be defined as the total score divided by the maximum possible score. In this paper we defined the HCI to be low if the total score is in the interval [0–2]; medium if the total score is in the interval [3–6]; and high if it is in the interval [7 and above].

[2] Since height-for-weight data are continuous it may be thought that the usual multiple linear regression model would be a more appropriate model. The usual linear regression model gives the expected change in the value of the response variable due to one unit change in the explanatory variable regardless of whether the child is malnourished or not. We have, in this paper, tried to find the probability of a child being chronic malnourished given the explanatory variable. Thus the logistic regression is more appropriate in this case.

[3] The NFHS data as shown in the all India report show slightly different figures (Bihar: 34%, Kerala: 7% and West Bengal: 14%). The first reason behind this discrepancy is that the data size has been greatly reduced in the present study. The reduction was necessary because some values were missing or there were outlying observations. One missing or erroneous observation forced the entire unit to be discarded, i.e. other observations of the unit are also deleted. The second reason is that only non-pregnant mothers were considered.

[4] There is a widespread belief that exclusive breastfeeding for the first few months of an infant's life ensures good physical growth. The actual age of supplementary food varies with respect to other factors. But the nature of our data prevents us from doing any fruitful analysis on this relation. We have only the present status of breastfeeding, and the effect of this should be different at different age groups. We do not have enough data to do this analysis. We should not give much weight to the results of statistical tests of feeding practices given in Table IV.

[5] The status of breastfeeding should be taken along with other inputs like supplemented food and age of the child. The interacting nature of these variables can not be analysed in this type of model. For this, one must resort to the Cox regression model.

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