PREDICTORS OF STUNTING IN STATES OF INDIA WITH HIGHEST AND LOWEST PREVALENCE OF UNDER-FIVE STUNTED CHILDREN

Master of Public Health Integrating Experience Project

Professional Publication Framework

By: Shivam Kumar Soni

Advising team:

Vahe Khachadourian, MD, MPH, PhD(c)

Anahit Demirchyan, MD, MPH

Gerald and Patricia Turpanjian School of Public Health

American University of Armenia

Yerevan, Armenia

2017-18

Acknowledgements

I would like to express my sincere gratitude to my advisors; Vahe Khachadourian and Anahit Demirchyan for their continuous support, patience, encouragement and constructive feedbacks.

I would like to thank Varduhi Petrosyan, Dean of the School of Public Health, American University of Armenia (AUA) for her feedbacks on the presentation slides, her constant push and motivation which helped me to complete my thesis within the given time.

Finally, I am thankful to my parents for always trusting in me and being supportive in every aspect of my life. I am thankful to my sister Dr. Anuradha Rani for encouraging me to join AUA and for being my motivator throughout my life. My sincere thanks to my peers especially Lusine Aslanayan and Sathiyaseelan Bhaskaran for their help, friendship, love and comfort.

Contents

Abstract

Background: According to 2017 data, globally, 155 million under five children or 23% of all under-five children are stunted. Over the last decade (2006 to 2016), in India the prevalence of stunted children has decreased from 48% to 38%, but this prevalence is higher when compared with other lower and middle income countries such as Sri Lanka (15%), Vietnam (25%). In India, prevalence of stunting varies by the states, it ranges from about 20% in Kerala to about 48% in Bihar.

Aim: The study aimed to evaluate predictors of stunting among children under five years of age living in the states of Kerala and Bihar, to assess the potential differences in the sets of predictors between these states.

Methods: Secondary analysis of the National Family Health Survey 2015-16 (NFHS-4) data was conducted. Descriptive data analysis was conducted using the chi-square and t test. For identifying the predictors, those variables with different distribution between the stunted and non-stunted groups at the level of significance $p<0.25$ in the chi-square or t test were entered into the logistic regression analysis, first in univariate, then in multivariable. For categorical variables an effect size of 5% was used. For the continuous variables the clinical significance was checked, as the continuous variables are unit sensitive. For the association between stunting and food diversity score, the confounders of association were identified. Multivariable regression model was used to identify the association between stunting status and food diversity score after adjusting for the identified confounders.

Results: For Kerala after controlling for all the other significant variables the predictors of stunting were; each month increase in age of the child (O.R. = 0.99), low wealth index category (OR = 2.01) or middle wealth index category (OR = 1.45), Children from Muslim families (O.R. = 1.87), each month increase in the duration of breastfeeding (O.R. = 1.01).

The stunting status was not statistically significantly associated with the food diversity score after adjusting for the identified confounders.

For Bihar after controlling for all the other significant variables the predictors of stunting were; each one-month increase in the age of the child (O.R. = 1.03), low birth weight (O.R. = 1.81), each unit rise in the birth order (O.R. = 1.06), birth interval of less than 24 months (O.R. = 1.24). Mothers who were 20 years old or younger at the time of the delivery (O.R. = 1.17). Each one centimetre rise in the height of the mother (O.R. = 0.94). Mother having no education (O.R. = 1.33), belonging to scheduled caste, scheduled tribe or other backward classes caste (O.R. = 1.24), low (O.R. = 1.82) and middle wealth index (O.R. = 1.38), each month increase in duration of breastfeeding (O.R. = 1.04). The stunting status was statistically significantly associated with the food diversity score (O.R. = 0.97) after adjusting for the identified confounders.

Conclusion: Study hypothesis was correct we found different sets of predictors of stunting for Kerala and Bihar. Identified modifiable variables were food diversity score, birth weight, birth interval. State specific interventions should be designed to reduce stunting. Interventions should target vulnerable population groups with low socio-economic status, Hindu and Muslim religion, lower education, and backward class. Educational interventions should cover; importance of diversity in the children’s diet, importance of antenatal care and family planning to promote birth intervals of more than 24 months**.**

Introduction and Literature Review

"Malnutrition is defined as an imbalance between nutrient requirements and intake that results in cumulative deficits of energy, protein, or micronutrients that may negatively affect growth and development".[1] Malnutrition can be divided into undernutrition and overnutrition.[2] UNICEF defines undernutrition as lack of nutrition needed for the proper growth and development of children's body and mind.[3] The three major indicators of undernutrition are stunting, wasting[1*], and underweight[2*].[2,4–6] Stunting is defined as "children who are too short for their age" i.e. "below minus two standard deviations from the median height-for-age of WHO child growth standards".[7,8] Stunting is a measure of chronic undernutrition or chronic malnutrition.[9,10] Globally, most prevalent form/type of undernutrition among under-five children is stunting, due to its high prevalence and adverse impact on health and development of the child, stunting is recognized as the main indicator of childhood undernutrition.[2,11–13]

According to 2017 global data, among all the children under five years of age, nearly 155 million (23%) children were stunted, nearly 52 million (8%) were wasted and nearly 101 million (16%) were underweight.[14,15] Globally, approximately half of the total deaths among children under five years of age are attributable to undernutrition.[16] This translates into about three million undernutrition-related annual deaths among under-five children.[16] Globally, there has been a considerable decline in the prevalence of stunting among children aged less than five years, from 40.0% in 1990 to 23.0% in 2017.[13,14] Maternal and childhood underweight account for approximately 138 million disability adjusted life years (DALY's) and are the greatest nutrition-related health burden globally. [11,17]

---

[1] "Wasting is defined as children who are too light for their age" i.e. "weight-for-age below -2 Standard Deviations (SD)".
[2] "Underweight is defined as children who are too thin for their height" i.e. "weight-for-height below -2 SD" [7,8]

Undernutrition is a major contributor to under-five mortality and morbidity.[13] Prospective community-based studies in Africa and Asia have shown that anthropometric indicators of undernutrition are predictive of increase in mortality among children.[18] Brain requires high amounts of energy and nutrition during childhood as most of the cerebral growth occurs during this period.[13] Stunting (or undernutrition in general) has adverse effects on parts of the brain involved in memory, locomotor skills and cognition.[19] Stunting keeps children from reaching their full potential and can have irreversible effects on brain (direct structural damage), organ growth, and intelligence quotient (IQ).[9,16,20–24] Several cross-sectional studies conducted in low-income and middle-income countries show that stunted children are less likely to stay enrolled in school or are enrolled late and have low cognitive scores for their age when compared to their non-stunted counterparts.[25–30] Stunting in childhood leads to short stature in adult life, delay in attaining motor functions (e.g. walking) and poor school performance, which results in poor education and consequently affect individual's work capacity and productivity.[25,28,29] Such low productivity can lead to poor employment opportunities and affect earning potential in later life, as labour market requires good education and cognitive skills. [23,25,31,32] According to the World Bank, there is an association between economic productivity and adult height; with each one percent loss in adult height there is a 1.4% loss of economic productivity.[33] Stunted children on an average, earn 20% less as adults when compared to non-stunted children.[33] The mechanisms mentioned above explain how stunting during childhood can adversely affect economic productivity at a national level. The healthcare and economic cost of stunting could reduce a country's gross domestic production on an average up to three percent.[33]

Stunted children have decreased resistance/immunity towards infections, hence, higher frequency, delayed recovery and increased severity of infections when compared to non-stunted children, which makes them more susceptible to death from common infections. [13,16,31] Frequent infections deteriorate the nutritional status of stunted children, making them even more susceptible to infections, this traps the child into a vicious circle of recurring sickness and deteriorating nutrition and health status.[31] Stunting leads to several morbidities in children such as diarrhea, [25,34] acute respiratory infections, [25,34,35] and other common infections[16]. Childhood stunting also increases the risk of mortality in later life; stunted children are more susceptible to diseases such as obesity, hypertension, impaired glucose tolerance, coronary heart disease etc. in their later life (as adults). [25,36,37] According to the Food and Agricultural Organization of the United Nations, annually nutritional deficiencies and undernutrition cost up to $2.1 trillion.[11]

Under five stunting is a public health problem in India. The prevalence of stunted children in India is among the highest in the world.[33] According to child malnutrition estimates in India based on the joint dataset of UNICEF, World Health Organization, and World Bank Group, childhood stunting has decreased from 62.7% in 1990 to 38.4% in 2017. Nevertheless, the percentage of stunted children is higher in India when compared to other low and middle income countries (LMICS) such as Myanmar (29.2%), Vietnam (24.6%) and Indonesia (36.4%).[14] There is significant variation in the prevalence of under-five undernutrition across different states of India.[36] According to the 2015-16 National Family Health Survey-4 (NFHS-4) results, the overall prevalence of childhood stunting is 38.0% in India with the highest rates in the states of Bihar (48.0%), Uttar Pradesh (46.0%), and Jharkhand (45.0%) and the lowest rates in the states of Goa (20.0%) and Kerala (20.0%).[38] In terms of healthcare cost and income loss due to child undernutrition, India experiences an estimated 50 million Disability Adjusted Life Years annually, which translates into economic loss of approximately $50 billion (approximately 2 % of GDP).[39,40]

During the last three decades, programs such as Public Distribution System (PDS) and Integrated Child Development Services (ICDS) have been implemented to tackle the rising problem of undernutrition in India. However, results from PDS and ICDS have been below expectations and so far, no study has rigorously assessed the impact of these programs.[36]

Improper infant feeding practices and lack of access to health care are linked with undernutrition.[41] Studies have found that inappropriate breastfeeding practices such as delayed initiation of breast-feeding and lack of exclusive breast-feeding until the child is six months of age are linked with childhood stunting.[7,42–44] Children under five years of age being exclusively breast-fed[3*] by their mothers for the first six months were at lower risk of being stunted compared to children under five years of age who were not exclusively breast-fed by their mothers for the first six months.[45] Children who were given their first complementary food after 12 months of life were found to be at greater risk of developing undernutrition when compared to children who were given their first complementary food within 12 months.[45] Initiation of breastfeeding after the first six hours of life is found to be a risk factor for childhood stunting.[42] Several studies on predictors of stunting among children aged less than five years in low-income and middle-income countries found that mother's educational status, age of the child, sex of the child, birth order of the child, number of children in the family, wealth index or socio-economic status of the family and maternal employment status were associated with children's undernutrition status.[2,5,31,46–49] Studies suggest that there is an increased likelihood of children's stunting if their mother had no education when compared with children having mothers with secondary or higher level of education.[5,31,47–49] Studies show that children of

[3*] We define exclusive breast-feeding as feeding with only breast milk, no other solid or liquid food is given to the child, not even water.

underweight mothers (BMI<18.5 kg/m^2) are more likely to be stunted when compared with children of mothers with normal weight (BMI 18.5 to 25 kg/m^2) or overweight (BMI 25 to 29.9 kg/m^2).[5,50] The reviewed literature suggests that stunting status among children under five years of age depends upon gender; stunting is more prevalent in boys than girls.[5,51,52] Studies show that the risk of stunting increases with the age of the child, children of the age group 24-35 months had higher odds of being stunted,[5] and children among the age group of 0-11 months had lower odds of being stunted.[31] The risk of childhood stunting increases with the increase in birth order (more than 3).[47,48,50,53] Short birth intervals (<24 months) are associated with higher risk of stunting. [9,48] Presence of infectious diseases in childhood; such as pneumonia, diarrhoea, malaria and meningitis are found to be the predictors of stunting.[2,5,54] Community-based studies conducted in low-income countries found that the odds of stunting increases multiplicatively with each day of diarrhoea or diarrhoea episode before the age of two years.[55] Region/place of residence is also found to be a risk factor for stunting, children living in rural areas were found to be at a higher risk of stunting compared to children living in urban areas. [6,11,31] Number of children (under age of 18 years) in the family has been found to be a predictor for childhood stunting, children from families with three or more children were at a relatively higher risk of being stunted when compared to children from families with two or less children.[31,56]

Low socioeconomic status is found to be a risk factor for childhood stunting in several studies. [31,36,49] Maternal employment status is found to be a determinant of childhood stunting, that is high prevalence of childhood stunting was observed among those children whose mothers were working (in the fields etc.), this could be explained by the fact that working mothers will pay less attention to their child’s nutrition simply because they will not have enough time for it.[31,57] Age of the mother at the time of delivery is found to be a risk factor for childhood stunting, the risk of children's undernutrition decreases with the increase in age of the mother (>20 years). [9,57] Low birth weight (less than 2.5 kg) is a risk factor related to childhood stunting; low birth weight babies have higher odds of being stunted compared to normal birth weight babies (2.5 to 5 kg).[31] Religion is also found to be related to child's stunting status, higher percentage of children from Hindu and Muslim families were found to be stunted compared to children from Christian, Sikh, Jains, Parses, etc.[58] A study conducted in India in the year 2015 depicted that childhood anaemia in India is associated with caste (schedule-cast, schedule tribe etc.) of the household, similar findings could be observed between caste of the household and children's stunting status.[59] Birth length of the baby is also a significant determinant of undernutrition, studies show that each one centimetre increase in birth length is associated with 50% decrease in the risk of child's undernutrition.[60] Making earlier and more frequent antenatal care visits by mothers during pregnancy with the given child is also found to be a protective factor for both underweight and stunting in the child.[43,46] Studies conducted in India and other LMIC's found that each one centimetre increase in maternal height has been associated with some decrease in the risk of child's stunting status.[61–63] Lack of proper nutritious food in the child's diet has been found to be a predictor of stunting (and undernutrition in general).[64,65] A study conducted in Armenia in the year 2014, among children five to 17 months old, found that with each unit increase in food diversity score (range 0 to 10), the odds of child undernutrition decreased by 63%.[60]

Aim

The study aimed to evaluate the predictors of stunting among under-five children living in the states of Bihar and Kerala and to assess the potential differences in the sets of predictors between these states.

Rationale

We hypothesised that the states of India could be different in factors related to childhood stunting. There is a research gap in this area which is hindering the development of well-targeted state-level interventions to reduce stunting in India. Rationale for choosing Bihar and Kerala among all the states of India was:

- Based on NFHS-4 data, the proportion of under-five stunted children is the highest in Bihar and the lowest in Kerala.[38]

Research Questions

1. What are the predictors of stunting among under-five children living in the state of Bihar and the state of Kerala?

2. Are there differences in the sets of predictors of stunting between the states of Kerala and Bihar?

3. Is there an association between child's stunting status and food diversity score among 6-36 months old children living in Bihar and in Kerala, after adjusting for confounders?

This study followed the Professional Publication Framework. The study population included children under five years of age living in the states of Bihar and Kerala.

Methods and Materials

Secondary data analysis was conducted, using data from the publicly available, (NFHS-4) dataset, collected during nationally representative cross-sectional survey conducted in 2015-16 in India.

Dataset

NFHS-4 was carried out in 2015-16 by the International Institute for Population Sciences (IIPS), Mumbai under the supervision of the Ministry of Health and Family Welfare (MoHFW), Government of India. It contained information on population, nutrition, and health of each state and union territory of India.

In this survey, four questionnaires (household, woman, man, and biomarker) were used to collect data. The data was collected in 19 different languages. An informed consent from the each of the respondents was obtained.

The total sample size included approximately 601,509 households in India. The sample size was designed to produce reliable estimates for all the districts and states of India.

For Bihar data collection was conducted in all the 38 districts of the state from 16 March to 8 August 2015 by the Academic Management Studies (AMS). Information was collected from 36,772 households.[38]

For Kerala data was collected from 8 March to 3 October 2016 by Society for Promotion of Youth & Masses (SPYM). Information was collected from 11,555 households.[38]

Target population

A subsample was taken from the dataset of NFHS-4 for the states Bihar and Kerala, including data regarding the youngest children in the family aged under five years. The youngest child in the family was chosen in order to eliminate bias that could have been present because of including the same mother several times in the analysis, in case she had more than one child under-five years.

Inclusion criteria

- Included in NFHS-4, 2015–16 survey
- Child under five years of age (zero to 59 months) for the first and second research questions
- Child between six to 36 months of age for the third research question[4*]
- Living in the state of Bihar or Kerala at the time of the survey
- Youngest child in the family

Dependent variable

Stunting status was the only dependent/outcome variable for the study, it was dichotomized (presence or absence). (Table A)

Independent variables

The independent variables for the study were sex of the child, age of the child, birth order, birth interval, wealth index of the family, maternal educational status, number of children (under 18) in the household, birth weight of the child, age of the mother at delivery, family's residence (rural/urban), duration of breast feeding of the child, initiation of breastfeeding within first hour of child's life, caste of the household, religion of the household, maternal height, diarrhoea episode during last two weeks, antenatal visit by mother during pregnancy and food diversity score. The food diversity score (independent variable of interest) was generated based on the food types that were given to the child during one day prior to the interview.[64,66] A total of nine food types with high nutritional value were included. These include: food made from grains (roti, chapatti, rice, idli etc.),

[4*] The independent variable of interest (food diversity score) will be calculated for children between six to 36 months of age, because complementary feeding is introduced into the child's diet after the first six months of life, and the information in the NFHS-4 dataset regarding the food items which child received during one day prior to the interview are available for children below 36 months only.

green-leafy vegetables, any fruit (ripe mangoes, papayas, cantaloupe or jackfruit etc.), any meat (chicken, duck, other), any eggs, any fish, any milk product (cheese, milk etc.), any food made from beans, peas, lentils or nuts, and Vitamin A rich fruits and vegetables (pumpkin, carrot, red sweet potato). The score was the cumulative sum of the positive answers to any of the listed food types. Thus, the range of food diversity score was from 0 to 9. Food items such as readymade food, potatoes and sugar were not included in the calculation of food diversity score as these food items lack nutritional value. (Table B)

Analysis

SPSS software version 21 was used for conducting the data analysis. Descriptive data analysis was conducted to present the frequencies and proportions of the dichotomous and categorical variables (outcome and independent). For the continuous (independent) variables, means and standard deviations were calculated. Chi-square test was used to find out any significant difference in the distribution of categorical (independent) variables across the stunted and non-stunted group, and t-test was used to find out any significant differences in the distribution of continuous (independent) variables across the stunted and non-stunted group. The outcome variable for the study was dichotomous (presence or absence of stunting), therefore data was analysed using logistic regression. Dummy variables were created for those categorical variables having more than two categories.

To answer the first and second research question, those variables with different distribution at the level of significance $p<0.25$ in the chi-square or t test were entered into the logistic regression analysis, first in univariate, then in multivariable. During the latter, we added the variables manually and removed the insignificant ones (at the level of significance $p<0.05$ with 95% confidence interval). For the categorical variables, effect size was used to assess the magnitude, in which the given characteristic predicts stunting status among children under five years of age. Only those categorical variables associated with at least 5% higher or lower odds of the outcome (stunting) were kept in the final adjusted multivariable logistic regression model. For the continuous variables the clinical significance was checked, as the continuous variables are unit sensitive.

To answer the third question, first, univariate logistic regression analysis was conducted between each potential confounder (related to the outcome at the significance level of $p<0.05$) and the dependent variable. Then, to check whether all the potential confounders that are significantly associated with the dependent variable are also significantly associated with the independent variable of interest (food diversity score), univariate linear regression analysis was conducted with the food diversity score as the outcome variable and the other covariates/potential predictors as independent variables. After identifying the variables that were significantly associated with both the independent variable of interest and the dependent variable (i.e. were the confounders), we looked at the association between the independent variable of interest and the dependent variable in the multivariable logistic regression model adjusted for all the confounders. For categorical variables, effect size of 10% was used: we kept in the adjusted model only those confounders that, when being included in the model, change the odds ratio of the main association (between the dependent and independent variables) by 10% or more. For the continuous variables, the clinical significance was checked.

For the multivariable models, Hosmer-Lemeshow goodness of fit and collinearity (Variable inflation factor) were checked.

Ethical considerations

Approval for the study was taken from American University of Armenia's Institutional Review Board. An exempt status was granted to the study as the dataset did not have any personal identifiers.

Resources

The available resource for the study was the NFHS-4, 2015-16 database. In addition, a computer system with functioning SPSS-21 software was used to efficiently manage and analyse data. To facilitate the data extraction process from the NFHS-4 dataset, a database guide was created by merging all the necessary questions from the questionnaires used in the NFHS-4 survey. The required/necessary questions were all those that had information regarding each of the variables that were included in the study. (Database guide)

Results

The merged dataset was restricted to the target population, the youngest children in family aged 0-59 months of age living in the states of Kerala and Bihar. The total sample consisted of 3,358 children from Kerala and 18,406 children from Bihar.

Kerala

Descriptive analysis –The sample consisted of almost equal proportions of male and female children. Some variables (out of 19) were not statistically significantly associated with the stunting status like gender of the child, birth interval, recent episode of diarrhoea, body mass index (B.M.I) of the mother, making antenatal visit(s) and place of residence, at the level of significance $p<0.25$. Children of stunted group had higher proportion of low birth weight (17.4%) when compared to the non-stunted group (13.8%). Not-stunted children were more likely to have a mother with higher education (40.6%) than stunted children (28.5%). Children from the stunted group were more likely to have a mother who was less than 20 years old at the time of delivery (10.7%) when compared to non-stunted children (8.9%). Higher percentage of children were breastfed immediately after birth in the stunted group when compared to non-stunted children. While comparing wealth index we found that 48.5% of children in the non-stunted group belonged to richest category compared to 38.3% of the stunted children. The trends were the opposite for the poor and poorest categories, with a higher proportion of stunted children belonging to poor (2.5%) and poorest (0.4%) categories when compared to non-stunted children (1.1% and 0.2% respectively). Two-thirds (66.5%) of stunted children belonged to the other backward class (O.B.C) and 2.2% belonged to scheduled tribe category when compared to 58.5% and 1.4% of the non-stunted children, respectively. Almost equal proportion of Hindu religion (51%) was observed among families of the stunted and non-stunted children. More percentage of Muslim religion (40.2%) was observed among families of the stunted children when compared to non-stunted children (33.4%). The mean age of the child was found to be the same among stunted group and the non-stunted group. Among the stunted group and the non-stunted group, the mean number of children living in the family was found to be the same. The mean height of the mother was found to be higher in the non-stunted group (155.4 cm) when compared to the stunted group (153.8 cm). The birth order of the youngest child was found to be the same in the stunted group and the non-stunted group. Duration of breastfeeding was found to be almost the same among the stunted and the non-stunted group. The mean food diversity score was higher among the stunted group (2.6) when compared to the non-stunted group (2.2). (Table 1)

Predictors – Table 2 presents the univariate logistic regression of selected characteristics with stunting status of the youngest children aged 0-59 months. Only the significant variables in the univariate analysis were added to the multivariable analysis one by one removing the insignificant ones.

Table 3 depicts the adjusted multivariable logistic regression model for the predictors of stunting among under five children. The predictors of stunting were found to be age of the child, height of the mother, wealth index, religion of the family and duration of breast feeding. It was found that, after controlling for all the other significant variables, the risk of stunting decreased by 1% with each month rise in the age of the child. Children belonging to a household with low wealth index category (OR = 2.01, 95% CI 1.11 – 3.63) or middle wealth index category (OR = 1.45, 95% CI 1.13 – 1.88) were at higher risk of being stunted when compared to children from high wealth index group. Children from Muslim families had 87% higher risk of stunting when compared to children from families of other religion such as Sikh, Parsi, Christian, etc (OR = 1, reference group). The risk of stunting increased by 1% with each one-month increase in the duration of breastfeeding. The Variance Inflation factor (VIF) for the model was found to be < 2. The Hosmer-Lemeshow goodness-of-fit value for the model was 0.078.

Association – The confounders of the association between stunting status and food diversity score for children aged 6-36 months were found using Table 2 and Table 4. The confounders were as follows; initiation of breastfeeding after birth, duration of breast feeding (months) and height of the mother in centimetres. Table 5 depicts multivariable logistic regression model for the association between the stunting status (outcome) and the food diversity score (exposure of interest) after controlling for the identified confounders mentioned above. This table shows that the food diversity score was not statistically significantly associated with the stunting status after adjusting for the identified confounders (OR = 1.04, 95% CI 0.95 – 1.13, p = 0.43). The Variance Inflation factor (VIF) for the model was found to be < 2. The Hosmer-Lemeshow goodness-of-fit value for the model was 0.488.

Bihar

Descriptive analysis –The sample consisted of 54.4% male children. All the variables were statistically significantly associated with the stunting status at the level of significance p<0.25 except Initiation of breastfeeding after birth. Almost equal proportions of boys and girls were included in stunted and non-stunted groups.

Children of stunted group had higher proportion of low birth weight (17.3%) when compared to the non-stunted group (10.7%). Stunted children were more likely to have a birth interval of less than 24 months (24.3%) when compared to non-stunted children (20.3%). The distribution of recent episode of diarrhoea among the stunted and non-stunted children were almost the same. The proportion of those having a mother who was less than 20 years old at the time of the delivery were equal among children in the stunted and non-stunted group. Not-stunted children were less likely to have a mother with no education (48.2%) than stunted children (62.6%). Stunted children were more likely to have a mother who did not receive any antenatal visit (46.8%) when compared to non-stunted children (40.5%). Among stunted children the proportion of those residing in rural areas was found to be higher (91.9%) when compared to the non-stunted children (87.6%). While comparing wealth index we found that lower proportion of children in the non-stunted group belonged to poorest category (50%) compared to of the stunted children (62.9%). The trends were the opposite for the rich and richest categories, with a lower proportion of stunted children belonging to rich (4.5%) and richest (1.0%) categories when compared to non-stunted children (9.6% and 3.3% respectively). Higher proportion (26.2%) of stunted children belonged to the scheduled caste when compared to non-stunted children. Equal proportions of scheduled tribe (3.0%) and equal proportions of OBC families (58.0%) were observed among stunted and non-stunted groups. Similarly, equal percentages of families following Muslim religion (18.0%0 and equal percentages of families following Hindu religion (81.0%) were observed among stunted and non-stunted groups of children. The mean age of children was higher in the stunted group (26.9 months) when compared to the non-stunted group (21.2 months). Among the stunted group and the non-stunted group, the mean number of children living in the family was found to be the same. The mean height of mothers was higher in the non-stunted group (150.8 cm) when compared to the stunted group (148.7 cm). The birth order of the youngest child was found to be higher in the stunted group (3.0) when compared to the non-stunted group (2.7). The duration of breastfeeding was found to be longer in the stunted group (20.2 months) when compared to the non-stunted group (14.7 months). The mean food diversity score was higher in the stunted group (2.1) when compared to the non-stunted group (1.6) (Table 6).

Predictors – Table 7 depicts the results of the univariate logistic regression of selected characteristics with stunting status of the youngest children aged 0-59 months. Only the significant variables in the univariate analysis were added to the multivariable analysis, removing the insignificant ones one by one.

Table 8 depicts the multivariable logistic regression model of predictors of stunting among under five children. The predictors of stunting were found to be age of the child, birth weight of the child, birth order of the child, birth interval, age of the mother at the time of the delivery, height of the mother, maternal education, duration of breastfeeding, and wealth index and caste of the household. It was found that, after controlling for all the other significant variables, with each one-month increase in the age of the child the risk of stunting increases by three percent. The risk of stunting is higher by 81.0% for low birth weight children when compared to normal birth weight children. The risk of stunting increases by 6.1% with each unit rise in the birth order. Children with birth interval of less than 24 months are at 1.24 times higher risk of stunting when compared to children with a birth interval greater than or equal to 24 months. Mothers who were 20 years old or younger at the time of the delivery had 17% higher risk of their child to be stunted when compared to mothers who were more than 20 years old at the time of the delivery. Each one centimetre rise in the height of the mother decreases the odds of stunting of their children by 6.1%.

Mother having no education had 1.33 times higher odds of their child being stunted when compared to mothers with either primary, secondary or higher level of education. Children belonging to scheduled caste, scheduled tribe or other backward classes caste found to be at 1.24 times higher risk of being stunted when compared to children belonging to other caste. Children from households belonging to low wealth index (O.R. = 1.82, 95% C.I. 1.58 – 2.10) and middle wealth index (O.R. = 1.38, 95% C.I. 1.17 – 1.63) had higher odds of stunting when compared to children born in household with high wealth index. With each one-month increase in duration of breastfeeding the risk of child's stunting status increased by 4.0%. The interaction term for age of the child and the breastfeeding duration represents the change in the effect of one-month increase in age for each month increase in duration of breast feeding, meaning that, in our case, with each one-month increase in the age of the child, the effect of one-month increase of breastfeeding duration on child's stunting status decreases by 1%. The Variance Inflation factor (VIF) for the model was found to be < 2. The Hosmer-Lemeshow goodness-of-fit value for the model was 0.103.

Association – The confounders of the association between the stunting status and the food diversity score for under-five children aged 6-36 months were found using Table 7 and Table 9. The confounders were as follows; age of the child, birth interval, recent episode of diarrhoea, birth order, caste of the household, duration of breast feeding (months).

Table 10 depicts multivariable logistic regression model for the association between the stunting status (outcome) and the food diversity score (exposure of interest) after controlling for the identified confounders mentioned above. This table shows that the food diversity score was statistically significantly associated (OR = 0.97, 95% CI 0.94 – 0.99, p = 0.004) with the stunting status after adjusting for the identified confounders. We found that the odds of stunting of the child decreases by 3.4% with each one unit rise in the food diversity score.

The Variance Inflation factor (VIF) for the model was found to be < 2. The Hosmer-Lemeshow goodness-of-fit value for the model was 0.068.

Note: An unexpected direction of association between the food diversity score and the stunting status was found during descriptive comparisons in both states (Table 1 and Table 6). However, in both cases, this unexpected direction of association disappeared after controlling for child's age.

The prevalence of stunting was much lower in Kerala (20.3%) when compared to Bihar (44.8%). While comparing the maternal education for the two states, we found that very low proportion of the mothers living in Kerala had no education (0.2%), while 38.1% had higher than secondary educational level, whereas in Bihar this trend was found to be the opposite: 56.2% of mothers with no education and only 4.7% with higher than secondary education. Similarly, almost half of the population of Kerala belonged to the richest wealth category (46.5%) and only a few (0.3%) belonged to the poorest wealth category, whereas in Bihar this trend was found to be the opposite: 56.2% in the poorest category and 2.3% in the richest category.

Discussion

The two states largely differed in their socio-demographic characteristics, with much higher proportions of population in Kerala belonging to high socio-economic groups and having higher levels of education when compared to Bihar. As expected, difference in the prevalence of stunting was observed between these states, with Kerala having much lower prevalence of stunted children (20.3%) when compared to Bihar (44.8%).

Predictors – The study hypothesis was confirmed, as the states differed in the predictors of stunting. The study identified various predictors of stunting for both Bihar and Kerala. The majority of the literature-based potential predictors included in this study were found to be the predictors of stunting in Bihar, except the variables such as male gender of the child, presence of diarrhea during the last two weeks, delayed initiation of breastfeeding, not receiving any antenatal care, rural residence and number of children aged less than 18 years living in the household. These variables were not associated with the stunting status in any of the two states, a result that was inconsistent with the literature. [67]

Variables such as height of the mother, duration of breastfeeding and wealth index were the identified common predictors of stunting in the states of Bihar and Kerala. For both states, the height of the mother was adversely associated with the child's stunting status, which is consistent with the literature.[61–63] The longer duration of breastfeeding was found to be a risk factor for stunting, this result was also consistent with other studies.[67,68] In the literature, a similar finding was explained by the following factors: longer breastfeeding was commonly combined with delayed initiation of complimentary feeding (>12 months), maternal unemployment, poverty leading to lack of money to buy nutritious complementary foods for the child, and lack of knowledge on proper nutritious food for the child. Therefore, longer duration of breastfeeding could be associated with higher odds of the child to be stunted. Similarly, early cessation of breast-feeding (<12 months) could be related to timely initiation of complimentary feeding (at 6 months) and thus could be associated with lower risk of stunting.[67] The above mentioned variables were missing in our study and therefore we could not control for their effect on the association of interest. Still, we can assume that delayed complimentary feeding or lack of it and low level of maternal knowledge on child nutrition could be the reasons for the observed positive relation between the duration of breastfeeding and the stunting status of the child.

Children from lower wealth index group were found to be at a relatively greater risk of being stunted when compared to children from higher wealth index group; this relationship is consistent with the literature. [31,36,49] In Kerala, higher age of the child was found to be a protective factor for stunting, but in Bihar higher age was found to be a risk factor for stunting. The results of studies conducted in low/lower middle income countries are consistent with the finding in Bihar, suggesting that with increase in age of the child the risk of stunting also increases.[5,31] In Kerala, higher risk of stunting was observed in families belonging to Hindu and Muslim religion, this result is consistent with another study conducted in India.[58] In Bihar higher risk of stunting was observed among children who had low birth weight (<2500g) when compared to normal birthweight children, a result consistent with the literature.[31] Short birth intervals (<24 months) were found to be a risk factor for stunting in the state of Bihar, similar findings were reported by other studies.[9,48] In Bihar, mothers who were less than 20 years old at the time of the delivery had a higher risk of their child being stunted when compared to mothers who were more than 20 years old at the time of the delivery. This result is also consistent with the literature.[9,57]

A study conducted in India in the year 2015 found that childhood anaemia in India is associated with backward caste (schedule-cast, schedule tribe, other backward class etc.) of the household. Our study found similar direction of association between backward classes and child's stunting status (in Bihar).[59]

Association – The stunting status was not statistically significantly associated with the food diversity score in Kerala, after adjusting for the identified confounders. In Bihar this association was statistically significant. After adjusting for the identified confounders the risk of stunting status was decreasing with each unit rise in the food diversity score. Lack of proper nutritious food in the child's diet has been found to be a predictor of stunting.[64,65] Similarly, a study conducted in Armenia in 2014, among children five to 17 months old, found that with each one point increase in food diversity score (range 0 to 10), the odds of child undernutrition decreased by 63%.[60]

Findings from Bihar can be generalised to other states of India having similar socio-demographic characteristics. Similarly, findings from Kerala can be generalised to other states of India having similar-to-Kerala socio-demographic characteristics.

Strengths

This study used a nationally representative, NFHS-4 dataset with a large sample size. The sample was weighted for the analysis, which further strengthened the representativeness of the study. Also, this was the first study in India that looked at the differences in the sets of predictors of under-five stunting between the states of India having quite different socioeconomic situation (Bihar and Kerala).

Limitations

The study was restricted in the selection of potential predictors: variables such as initiation of complimentary feeding, maternal knowledge on nutritious feeding of the child were missing in the dataset, and the variable - employment status of the mother was dropped because of high percentage of missing values (82%). Recall bias might be another issue in this study, especially for the variable of duration of breastfeeding of the child. The study used a cross-sectional survey, thus, we cannot find any causal relationship.

Recommendations

As identified from our study, states of India that are different in socio-economic and educational characteristics, are also different in the prevalence and predictors of under-five stunting and its predictors. Therefore, we recommend the policy makers to develop state specific interventions to reduce the burden of stunting in India. Interventions should target vulnerable population groups with low socio-economic status, Hindu and Muslim religion, lower education, and backward class. Most of the public health intervention in lower and middle income countries focus primarily on increasing the breast-feeding duration of the child. However, this alone is not enough to solve the problem of under-five stunting, therefore, public educational interventions should also cover:

- ✓ Importance of diversity in the children’s diet,
- ✓ Importance of antenatal care at the time of pregnancy,
- ✓ Family planning – promoting birth intervals of more than 24 months.

A significant proportion of world’s under-five stunted children live in India, thus reduction of under-five stunting in India alone might notably bring down the global burden of this public health problem.

Future implications of the study

The study results could be used for the development and implementation of nutritional surveillance programs in the states of Kerala and Bihar and the other states of India. The study could also be used for planning future research among under-five children in Bihar, Kerala and other states of India.

References

1. Mehta NM, Corkins MR, Lyman B, et al. Defining pediatric malnutrition: a paradigm shift toward etiology-related definitions. *J Parenter Enter Nutr*. 2013;37(4):460-481. doi:10.1177/0148607113479972.

2. Black RE, Victora CG, Walker SP, et al. Maternal and child undernutrition and overweight in low-income and middle-income countries. *Lancet*. 2013;382(9890):427-451. doi:10.1016/S0140-6736(13)60937-X.

3. Undernutrition - wikiprogress. http://wikiprogress.org/articles/imported/Undernutrition/. Accessed December 18, 2017.

4. Hong R, Banta JE, Betancourt JA, et al. Relationship between household wealth inequality and chronic childhood under-nutrition in Bangladesh. *Int J Equity Health*. 2006;5(1):15. doi:10.1186/1475-9276-5-15.

5. Masibo PK, Makoka D. Trends and determinants of undernutrition among young Kenyan children: Kenya Demographic and Health Survey; 1993, 1998, 2003 and 2008–2009. *Public Health Nutr*. 2012;15(9):1715-1727. doi:10.1017/S1368980012002856.

6. Meshram II, Arlappa N, Balakrishna N, et al. Prevalence and determinants of undernutrition and its trends among pre-school tribal children of Maharashtra State, India. *J Trop Pediatr*. 2012;58(2):125-132. doi:10.1093/tropej/fmr035.

7. Levels & trends in child malnutrition. http://www.who.int/nutgrowthdb/jme_unicef_who_wb.pdf. Accessed June 4, 2017.

8. Levels and trends in child malnutrition 156 million. http://www.who.int/nutgrowthdb/jme_brochure2016.pdf?ua=1. Accessed June 5, 2017.

9. Kismul H, Acharya P, Mapatano MA, Hatløy A. Determinants of childhood stunting in the Democratic Republic of Congo: further analysis of demographic and health survey 2013–14. *BMC Public Health*. 2018;18(1):74. doi:10.1186/s12889-017-4621-0.

10. Types of undernutrition: growth failure - types of undernutrition. https://www.unicef.org/nutrition/training/2.3/2.html. Accessed February 20, 2018.

11. Menon P, Ruel MT, Morris SS. Socio-economic differentials in child stunting are consistently larger in urban than in rural Areas. *Food Nutr Bull*. 2000;21(3):282-289. doi:10.1177/156482650002100305.

12. Demirchyan A, Petrosyan V, Sargsyan V, Hekimian K. Predictors of stunting among children ages 0 to 59 months in a rural region of Armenia. *J Pediatr Gastroenterol Nutr*. 2015;62(1):150-156. doi:10.1097/MPG.0000000000000901.

13. Prendergast AJ, Humphrey JH. The stunting syndrome in developing countries.

Paediatr Int Child Health. 2014;34(4):250-265. doi:10.1179/2046905514Y.0000000158.

14. WHO | Joint child malnutrition estimates - levels and trends (2016 edition). WHO. http://www.who.int/nutgrowthdb/estimates2015/en/. Published 2017. Accessed March 2, 2018.

15. *Levels & Trends in Child Malnutrition*. http://www.who.int/nutgrowthdb/summary_jme_2013.pdf?ua=1. Accessed January 25, 2018.

16. Malnutrition - UNICEF Data. https://data.unicef.org/topic/nutrition/malnutrition/. Accessed December 18, 2017.

17. Ezzati M, Lopez AD, Rodgers A, Vander Hoorn S, Murray CJ. Selected major risk factors and global and regional burden of disease. *Lancet*. 2002;360(9343):1347-1360. doi:10.1016/S0140-6736(02)11403-6.

18. Pelletier DL, Frongillo EA, Habicht JP. Epidemiologic evidence for a potentiating effect of malnutrition on child mortality. *Am J Public Health*. 1993;83(8):1130-1133. doi:10.2105/AJPH.83.8.1130.

19. Levitsky DA, Strupp BJ. Malnutrition and the brain: changing concepts, changing concerns. *J Nutr*. 1995;125(suppl_8):2212S-2220S. doi:10.1093/jn/125.suppl_8.2212s.

20. McDonald C, Olofin I, Flaxman S, Fawzi W. The effect of multiple anthropometric deficits on child mortality: meta-analysis of individual data in 10 prospective studies from developing countries. *Am J*. 2013;97(4):896-901. doi:10.3945/ajcn.112.047639.

21. Smith VC. The importance of infant nutrition. *Int J Childbirth Educ*. 2016;31(1):32-34.

22. Prado EL, Dewey KG. Nutrition and brain development in early life. *Nutr Rev*. 2014;72(4):267-284. doi:10.1111/nure.12102.

23. Victora CG, Adair L, Fall C, et al. Maternal and child undernutrition: consequences for adult health and human capital. *Lancet*. 2008;371(9609):340-357. doi:10.1016/S0140-6736(07)61692-4.

24. Cheung Y, Yip P, Karlberg J. Fetal growth, early postnatal growth and motor development in Pakistani infants. *Int J Epidemiol*. 2001;30(1):66-72. doi:10.1093/ije/30.1.66.

25. Beasley NMR, Hall A, Tomkins AM, et al. The health of enrolled and non enrolled children of school age in Tanga, Tanzania. *Acta Trop*. 2000;76(3):223-229. doi:10.1016/S0001-706X(00)00101-7.

26. Moock PR, Leslie J. Childhood malnutrition and schooling in the Terai region of Nepal. *J Dev Econ*. 1986;20(1):33-52. doi:10.1016/0304-3878(86)90004-0.

27. Jamison DT. Child malnutrition and school performance in China. *J Dev Econ*.

1986;20(2):299-309. doi:10.1016/0304-3878(86)90026-X.

28. Hutchinson S, Powell C, Walker S, Chang S, Grantham-McGregor S. Nutrition, anaemia, geohelminth infection and school achievement in rural Jamaican primary school children. *Eur J Clin Nutr*. 1997;51(11):729-735. doi:10.1038/sj.ejcn.1600473.

29. Sigman M, Neumann C, Jansen AAJ, Bwibo N. Cognitive abilities of Kenyan children in relation to nutrition, family characteristics, and education. *Child Dev*. 1989;60(6):1463. doi:10.2307/1130935.

30. Ivanovic DM, Pérez HT, Olivares MG, Díaz NS, Leyton BD, Ivanovic RM. Scholastic achievement: a multivariate analysis of nutritional, intellectual, socioeconomic, sociocultural, familial, and demographic variables in Chilean school-age children. *Nutrition*. 2004;20(10):878-889. doi:10.1016/j.nut.2004.06.009.

31. Hien NN, Kam S. Nutritional status and the characteristics related to malnutrition in children under five years of age in Nghean, Vietnam. *J Prev Med Public Heal*. 2008;4141(44):232-240. doi:10.3961/jpmph.2008.41.4.232.

32. Hoddinott J. The economic cost of malnutrition the problem of widespread undernutrition. http://www.nutri-facts.org/content/dam/nutrifacts/media/media-books/RTGN_chapter_05.pdf. Accessed January 24, 2018.

33. What's at stake Stunting Policy Brief. http://www.who.int/nutrition/topics/globaltargets_stunting_policybrief.pdf. Accessed February 19, 2018.

34. Nandy S, Irving M, Gordon D, Subramanian S. Poverty, child undernutrition and morbidity: new evidence from India. *Bull World Heal*. 2005;83(3):210-216. doi:10.1590/S0042-96862005000300014.

35. Cunha A. Relationship between acute respiratory infection and malnutrition in children under 5 years of age. *Acta Paediatr*. 2000;89(5):608-609. doi:10.1111/j.1651-2227.2000.tb00347.x.

36. Pathak PK, Singh A. Trends in malnutrition among children in India: growing inequalities across different economic groups. *Soc Sci Med*. 2011;73(4):576-585. doi:10.1016/j.socscimed.2011.06.024.

37. Cost of Child Undernutrition short changed: the human and economic in Papua New Guinea. https://www.savethechildren.org.au/__data/assets/pdf_file/0009/228492/PNG-Nutrition-Report.pdf. Published 2017. Accessed January 24, 2018.

38. India national family health survey (NFHS-4) government of India. http://rchiips.org/NFHS/NFHS-4Reports/India.pdf. Accessed January 23, 2018.

39. The Cost of Malnutrition: Why Policy Action is Urgent | Food Security Portal. http://www.foodsecurityportal.org/cost-malnutrition-why-policy-action-urgent. Accessed January 27, 2018.

40. India loses up to $46 billion to malnourishment.

http://www.downtoearth.org.in/news/india-loses-up-to-46-billion-to-malnourishment-41181. Accessed January 27, 2018.

41. Allen D. Malnutrition in low income countries: lessons from the field. *Paediatr Nurs*. 2007;19(4):20-21. doi:10.7748/paed.19.4.20.s26.

42. Kumar D, Goel N, Mittal P, Misra P. Influence of infant-feeding practices on nutritional status of under-five children. *Indian J Pediatr*. 2006;73(417):417-421. doi:10.1007/BF02758565.

43. Pramod Singh GC, Nair M, Grubesic RB, Connell FA. Factors Associated With Underweight and Stunting Among Children in Rural Terai of Eastern Nepal. *Asia Pacific J Public Heal*. 2009;21(2):144-152. doi:10.1177/1010539509332063.

44. Onyango AW, Esrey SA, Kramer MS. Continued breastfeeding and child growth in the second year of life: a prospective cohort study in western Kenya. *Lancet*. 1999;354(9195):2041-2045. doi:10.1016/S0140-6736(99)02168-6.

45. Teshome B, Kogi-Makau W, Getahun Z, Taye G. Magnitude and determinants of stunting in children underfive years of age in food surplus region of Ethiopia: The case of West Gojam Zone. *Ethiop J Heal Dev*. 2010;23(2). doi:10.4314/ejhd.v23i2.53223.

46. Yimer G. Malnutrition among children in Southern Ethiopia: levels and risk factors. *Ethiop J Heal Dev*. 2000;14(3):283-292. doi:10.4314/ejhd.v14i3.9901.

47. Sommerfelt A, Stewart M. Childrens nutritional status. 1994. http://www.popline.org/node/293733. Accessed June 5, 2017.

48. Rayhan MI, Khan MSH. Factors causing malnutrition among under five children in Bangladesh. *Pakistan J Nutr*. 2006;5(6):558-562. doi:10.3923/pjn.2006.558.562.

49. Siddiqi MNA, Haque MN, Goni MA. Malnutrition of under-five children: evidence from Bangladesh. *Asian J Med Sci*. 2011;2(2):113-119. doi:10.3126/ajms.v2i2.3662.

50. Nahar B, Ahmed T, Brown KH, Hossain MI. Risk factors associated with severe underweight among young children reporting to a diarrhoea treatment facility in Bangladesh. *J Heal Popul Nutr*. 2010;28(5):476-483. doi:10.2307/23500012.

51. Wamani H, Åstrøm A, Peterson S. Boys are more stunted than girls in sub-Saharan Africa: a meta-analysis of 16 demographic and health surveys. *BMC*. 2007;7(1). doi:10.1186/1471-2431-7-17.

52. Olwedo MA, Mworozi E, Bachou H, Orach CG. Factors associated with malnutrition among children in internally displaced person’s camps, northern Uganda. *Afr Health Sci*. 2008;8(84):244-252. doi:10.4314/ahs.v8i4.7078.

53. Savage T, Derraik JGB, Miles HL, Mouat F, Cutfield WS, Hofman PL. Birth order progressively affects childhood height. *Clin Endocrinol (Oxf)*. 2013;79(3):379-385. doi:10.1111/cen.12156.

54. Sapkota G. Prevalence and predictors of underweight , stunting and wasting in under-

five children. *J Nepal Heal Res Counc 2009 Oct;7(15)120-126*. 2009;7(2):120-126.

55. Checkley W, Buckley G, Gilman RH, et al. Multi-country analysis of the effects of diarrhoea on childhood stunting. *Int J Epidemiol*. 2008;37(4):816-830. doi:10.1093/ije/dyn099.

56. Hien Ngoc Nguyen and Hao Ngoc Nguyen. Nutritional status and determinants of malnutrition.pdf. *Pakistan J Nutr*. 2009;8(7):958-964.

57. Radhakrishna R, Ravi C. Malnutrition in India: trends and determinants. *Econ Polit Wkly*. 2004;39:671-676. doi:10.2307/4414642.

58. Bharati S, Chakrabarty S, Som S, Pal M, Bharati P. Socio–economic determinants of underweight children in West Bengal, India. *Asian Pac J Trop Med*. 2010;3(4):322-327. doi:10.1016/S1995-7645(10)60078-8.

59. Vart P, Jaglan A, Shafique K. Caste-based social inequalities and childhood anemia in India: results from the National Family Health Survey (NFHS) 2005–2006. *BMC Public Health*. 2015;15(1):537. doi:10.1186/s12889-015-1881-4.

60. Hovhannisyan L, Demirchyan A, Petrosyan V. Estimated prevalence and predictors of undernutrition among children aged 5–17 months in Yerevan, Armenia. *Public Health Nutr*. 2013;17(5):1046-1053. doi:10.1017/S1368980013001171.

61. Subramanian S V., Ackerson LK, Smith GD, John NA. Association of maternal height with child mortality, anthropometric failure, and anemia in India. *JAMA*. 2009;301(16):1691. doi:10.1001/jama.2009.548.

62. Özaltin E, Hill K, Subramanian S V. Association of maternal stature with offspring mortality, underweight, and stunting in low- to middle-income countries. *JAMA*. 2010;303(15):1507. doi:10.1001/jama.2010.450.

63. Hambidge KM, Mazariegos M, Kindem M, et al. Infant stunting is associated with short maternal stature. *J Pediatr Gastroenterol Nutr*. 2012;54(1):117-119. doi:10.1097/MPG.0b013e3182331748.

64. Arimond M, Ruel MT. Dietary diversity is associated with child nutritional status: evidence from 11 demographic and health surveys. *J Nutr*. 2004;134(10):2579-2585. doi:10.1093/jn/134.10.2579.

65. Black RE, Allen LH, Bhutta ZA, et al. Maternal and child undernutrition: global and regional exposures and health consequences. *Lancet*. 2008;371(9608):243-260. doi:10.1016/S0140-6736(07)61690-0.

66. Demirchyan A. *Prevalence and Predictors of Undernutrition & Anemia among under-Five Children in Talin Region of Aragatsotn Marz , Armenia*.; 2014.

67. Teshome B, Kogi-Makau W, Getahun Z, Taye G. Magnitude and determinants of stunting in children underfive years of age in food surplus region of Ethiopia: The case of West Gojam Zone. *Ethiop J Heal Dev*. 2010;23(2):98-106. doi:10.4314/ejhd.v23i2.53223.

68. Marquis G, Habicht J, Lanata C, Black R, Rasmussen K. Association of breastfeeding and stunting in Peruvian toddlers: an example of reverse causality. *Int J Epidemiol*. 1997;26(2):349-356. doi:10.1093/ije/26.2.349.

69. Everything you want to know about healthy timing and spacing of pregnancy. http://www.who.int/pmnch/topics/maternal/htsp101.pdf. Accessed March 5, 2018.

70. Child Rights in India. Child in India Statistics and Children in India. http://childlineindia.org.in/child-in-india.htm. Accessed March 3, 2018.

Tables

Table 1 Descriptive analysis of selected characteristics by stunted status among families' youngest children aged 0-59 months in the state of Kerala, India (based on NFHS-4 data)

Characteristic	Stunted (N= 683)		Not-stunted (N= 2675)		P value	Total sample (N= 3358)	
	n	%	n	%		n	%
Gender of the child							
Female	349	51.1	1386	51.8	0.739	1735	51.7
Male	334	48.9	1289	48.2		1623	48.3
Birth weight of the child in grams							
Normal (≥2500)	599	82.6	2297	86.2	0.018	2856	85.4
Low (<2500)	118	17.4	369	13.8		487	14.6
Birth Interval							
≥24 months	643	94.6	2488	93.8	0.448	3131	93.9
<24 months	37	5.4	165	6.2		202	6.1
Diarrhea during last two weeks							
Absent	656	96.0	2581	96.5	0.538	3237	96.4
Present	27	4.0	94	3.5		121	3.6
Age of the mother at the time of delivery in years							
>20 years	610	89.3	2437	91.1	0.150	3047	90.7
≤20 years	73	10.7	238	8.9		311	9.3
Education of the mother							
No education	4	0.6	3	0.1	<0.001	7	0.2
Primary	11	1.6	16	0.6		27	0.8
Secondary	474	69.4	1570	58.7		2044	60.9
Higher	194	28.45	1086	40.6		1280	38.1
Initiation of breastfeeding after birth							
Immediately	258	70.1	935	63.6	0.020	1193	64.9
Not-immediately	110	29.9	534	36.4		644	35.1
Antenatal care							
Received	637	99.4	2460	99.4	0.958	3097	99.4
Not Received	4	0.6	15	0.6		19	0.6
Place of residence							
Urban	324	46.5	1239	46.3	0.623	1563	46.5
Rural	360	53.5	1435	53.7		1795	53.5
Wealth Index							
Poorest	3	0.4	6	0.2	<0.001	9	0.3
Poor	17	2.5	29	1.1		46	1.4
Middle	106	15.5	293	10.9		399	11.9
Rich	296	43.3	1049	39.2		1345	39.9
Richest	262	38.3	1299	48.5		1561	46.5

Characteristic	Stunted (N= 683)		Not-stunted (N= 2675)		P value		Total sample (N= 3358)	
	n	**%**	**n**	**%**			**n**	**%**
Caste of the household								
Scheduled Caste	71	11.3	276	11.2	<0.001		347	11.3
Scheduled Tribe	14	2.2	35	1.4			49	1.6
Other backward class	416	66.5	1436	58.5			1852	60.1
None of them	125	20.0	708	28.8			833	27.0
Religion of the household								
Hindu	352	51.5	1407	52.6	<0.001		1759	52.4
Muslim	274	40.2	894	33.4			1168	34.8
Other (Christian, Parsi, Sikh etc.)	57	8.3	374	14.0			431	12.8
	Mean	**S.D.**	**Mean**	**S.D.**	**P value**	**n**	**Mean**	**S.D.**
Age of the child (months)	27.94	15.40	28.74	16.68	0.260	3358	28.57	16.43
Number of children in the household	1.61	0.92	1.53	0.92	0.039	3358	1.54	0.93
Birth order	1.83	0.86	1.76	0.85	0.053	3358	1.78	0.85
Food diversity score (0 to 9)	2.60	2.16	2.16	2.19	0.002	1379	2.26	2.19
Height of the mother (centimeters)	153.82	6.74	155.39	5.63	<0.001	3356	155.07	5.90
Duration of breastfeeding (months)	18.35	10.89	16.94	11.31	0.004	3177	17.24	11.24

Table 2: Univariate logistic regression of selected characteristics with stunting status of the child as the outcome variable among families' youngest children aged 0-59 months in the state of Kerala, India (NFHS-4)

Characteristic	O.R.	95% C. I.		P value
		Lower	Upper	
Age of the child (in months)	0.99	0.99	1.00	0.260
Birth weight				
<2500 grams	1.32	1.05	1.67	0.016
≥2500grams	1			
Birth order of the child	1.09	0.99	1.21	<0.001
Number of children in the household	1.09	1.01	1.20	0.039
Age of the mother at the time of delivery				
≤20 years	1.22	0.93	1.69	0.160
>20 years	1			
Height of the mother (centimeters)	0.96	0.94	0.97	<0.001
Maternal education				
No education	5.51	1.15	26.34	0.032
Primary, secondary, higher	1			
Initiation of Breastfeeding after birth				
Immediately	1.34	1.05	1.71	0.200
Not-immediately	1			
Duration of breastfeeding (months)	1.01	1.00	1.02	0.004
Antenatal visit				
Not received	1.10	0.37	3.25	0.870
Received	1			
Type of residence				
Rural	0.96	0.81	1.13	0.620
Urban	1			
Wealth index				
Low (poorest, poorer)	2.41	1.38	4.20	0.002
Middle	1.52	1.20	1.94	0.001
High (richer, richest)	1			
Caste of the household				
S.T., S.C., O.B.C.[5]	1.63	1.31	2.01	<0.001
Others	1			
Religion of the Household				
Hindu	1.65	1.22	2.23	0.001
Muslim	2.02	1.48	2.76	<0.001
Other (Sikh, Parsi, Christian, etc.)	1			

[5] S.T.,S.C.,O.B.C. Scheduled tribe, scheduled caste, and other backward classes

Table 3: Multivariable logistic regression for predictors of stunting among children aged 0-59 months in the state of Kerala, India (NFHS-4)

Characteristic	O.R.	95% C.I.		P value
		Lower	Upper	
Age of the child (months)	0.99	0.98	0.99	0.013
Height of the mother (cm)	0.96	0.94	0.97	<0.001
Duration of breastfeeding (months)	1.01	1.00	1.02	0.003
Wealth index				
Low (poorest, poorer)	2.01	1.11	3.63	0.022
Middle	1.45	1.13	1.88	0.004
High (richer, richest)	1			
Religion of the household				
Hindu	1.38	1.01	1.89	0.044
Muslim	1.87	1.36	2.58	<0.001
Other (Sikh, Parsi, Christian)	1			

The Hosmer and Lemeshow test value was 0.078

Table 4: Univariate linear regression of the selected characteristics with food diversity score of the child as the outcome variable among families' youngest children aged 6-36 months in the state of Kerala, India (NFHS-4)

Characteristic	B	95% C. I.		P value
		Lower	Upper	
Gender of the child				
Male	0.20	-0.02	0.42	0.075
Female	0			
Age of the child (in months)	0.81	0.17	0.19	<0.001
Birth weight				
<2500 grams	-0.03	-0.36	0.30	0.865
≥2500 grams	0			
Birth order of the child	0.03	-0.10	0.16	0.649
Birth Interval				
<24 months	0.08	-0.37	0.52	0.744
≥24 months	0			
Number of children in the household	0.08	-0.04	0.20	0.190
Recent episode of diarrhea (last two weeks)				
Present	0.11	-0.38	0.60	0.662
Absent	0			
Age of the mother at the time of delivery				
≤20 years	0.01	-0.36	0.39	0.940
>20 years	0			
Height of the mother (centimeters)	0.03	0.01	0.04	0.007
Maternal education				
No education	-0.19	-6.15	5.78	0.951
Primary, secondary, higher	0			
Initiation of breastfeeding				
Immediately	0.04	1.92	2.39	<0.001
Not-immediately	0			
Duration of breastfeeding (months)	0.17	0.15	0.18	<0.001
Antenatal visit				
Not received	-0.17	-1.47	1.13	0.799
Received	0			
Type of residence				
Rural	-0.10	-0.32	0.12	0.380
Urban	0			
Wealth index				
Low (poorest, poorer)	-0.33	-1.36	0.71	0.535
Middle (middle)	-0.23	-0.56	0.11	0.182
High (richer, richest)	0			
Caste of the household				
S.T., S.C., O.B.C.	0.05	-0.20	0.31	0.690
Others	0			
Religion of the Household				
Hindu	-0.05	-0.30	0.19	0.663
Muslim	0			
Other (Sikh, Parsi, Christian, etc.)	0.17	-0.16	0.50	0.315

Table 5: Multivariable logistic regressions for the association between stunting status and food diversity score controlled for the identified confounders among families' youngest children aged 6-36 months in the state of Kerala, India (NFHS-4)

Characteristic	O.R.	95% C.I.		P value
		Lower	Upper	
Food diversity score (0 to 9)	1.04	0.95	1.13	0.434

After controlling for the identified confounders: height of the mother in centimeters, initiation of breastfeeding and duration of breastfeeding

The Hosmer and Lemeshow test value was 0.488

Table 6: Descriptive analysis of the selected characteristics by stunted status among the youngest child aged 0-59 months in the state of Bihar, India (NFHS-4)

Characteristic	Stunted (N= 8251)		Not-stunted (N= 10155)		P value	Total sample (N= 18406)	
	n	%	n	%		n	%
Gender of the child							
Female	3667	44.4	4722	46.5	0.005	8389	45.6
Male	4584	55.6	5433	53.5		10017	54.4
Birth weight of the child in grams							
Normal (≥2500 grams)	3985	82.7	5991	89.3	<0.001	9976	86.6
Low (<2500 grams)	834	17.3	714	10.7		1548	13.4
Birth Interval							
≥24 months	6235	75.7	8080	79.7	<0.001	14315	77.9
<24 months	2006	24.3	2056	20.3		4062	22.1
Diarrhea during last two weeks							
Absent	7233	87.8	8774	86.5	<0.001	16007	87.1
Present	1004	12.2	1368	13.5		2372	12.9
Age of the mother at the time of delivery in years							
>20 years	6775	82.1	8276	81.4	<0.001	15042	81.7
≤20 years	1476	17.9	1888	18.6		3364	18.3
Education of the mother							
No education	5167	62.6	4899	48.2	<0.001	10066	54.7
Primary	1050	12.7	1208	11.9		2258	12.3
Secondary	1819	22.0	339	33.4		5211	28.3
Higher	215	2.6	654	6.4		869	4.7
Initiation of breastfeeding after birth							
Immediately	2410	36.9	2886	36.6	0.703	5296	36.7
Not-immediately	4128	63.1	5010	63.4		9138	63.3
Antenatal care							
Received	4369	53.2	6019	59.5	<0.001	10388	56.7
Not received	3842	46.8	4097	40.5		7939	43.3
Place of residence							
Urban	736	8.9	1264	12.4	<0.001	2000	10.9
Rural	1515	91.9	8890	87.6		16405	89.1
Wealth Index							
Poorest	5194	62.9	5081	50.0	<0.001	10275	55.8
Poor	1878	22.8	2366	23.3		4244	23.1
Middle	719	8.7	1400	13.8		2119	11.5
Rich	375	4.5	970	9.6		1345	7.3
Richest	84	1.0	336	3.3		420	2.3

Characteristic	Stunted (N= 8251)		Not-stunted (N= 10155)		P value		Total sample (N= 18406)	
	n	%	n	%			n	%
Caste of the household								
Scheduled Caste	2146	26.2	1990	19.8	<0.001		4136	22.7
Scheduled Tribe	254	3.1	326	3.2			580	3.2
Other backward class	4826	58.9	5945	59.1			10771	59.0
None of them	964	11.8	1792	17.8			2756	15.1
Religion of the household								
Hindu	6731	81.6	8318	81.9	0.700		15049	81.7
Muslim	1513	18.3	1828	18.0			3341	18.2
Other (Christian, Parsi, Sikh etc.)	6	0.1	5	0.1			11	0.1
	Mean	**S.D.**	**Mean**	**S.D.**	**P value**	**n**	**Mean**	**S.D.**
Age of the child (months)	26.89	14.79	21.21	16.32	<0.001	18406	23.75	15.91
Number of children in the household	2.29	1.71	2.07	1.63	<0.001	18406	2.17	1.67
Birth order	3.03	1.76	2.72	1.60	<0.001	18406	2.86	1.68
Food diversity score (0 to 9)	2.06	2.14	1.57	1.99	<0.001	10242	1.76	2.06
Height of the mother (centimeters)	148.66	5.87	150.77	6.34	<0.001	18360	149.83	6.23
Duration of breastfeeding (months)	20.22	12.29	14.73	11.68	<0.001	17643	17.20	12.26

Table 7 Univariate logistic regression of the selected characteristics with stunting status of the child as the outcome variable among families' youngest children aged 0-59 month in the state of Bihar, India (NFHS-4)

Characteristic	O.R.	95% C. I.		P value
		Lower	Upper	
Gender of the child				
Male	1.08	1.02	1.15	0.005
Female	1			
Age of the child (in months)	1.02	1.02	1.03	<0.001
Birth weight				
<2500 grams	1.75	1.57	1.95	<0.001
≥2500grams	1			
Birth order of the child	1.12	1.09	1.14	<0.001
Birth Interval				
<24 months	1.26	1.18	1.36	<0.001
≥24 months	1			
Number of children in the household	1.08	1.06	1.10	<0.001
Recent episode of diarrhea (last two weeks)				
Present	0.89	0.82	0.97	0.009
Absent	1			
Age of the mother at the time of delivery				
≤20 years	0.95	0.88	1.03	0.215
>20 years	1			
Height of the mother (centimeters)	0.94	0.94	0.96	<0.001
Maternal education				
No education	1.79	1.69	1.90	<0.001
Primary, secondary, higher	1			
Initiation of Breastfeeding				
Immediately	1.01	0.95	1.09	0.699
Not-immediately	1			
Duration of breastfeeding (months)	1.03	1.03	1.04	<0.001
Antenatal visit				
Not received	1.29	1.21	1.37	<0.001
Received	1			
Type of residence				
Rural	1.45	1.31	1.59	<0.001
Urban	1			
Wealth index				
Low (poorest, poorer)	2.70	2.42	3.02	<0.001
Middle (middle)	1.46	1.27	1.68	<0.001
High (richer, richest)	1			
Caste of the household				
S.T., S.C., O.B.C.[6]	1.63	1.49	1.77	<0.001
Others	1			

[6] S.T.,S.C.,O.B.C. Scheduled tribe, scheduled caste, and other backward classes

Table 8: Multivariable logistic regression for predictors of stunting among children aged 0-59 months in the state of Bihar, India (NFHS-4)

Characteristic	O.R.	95% C.I.		P value
		Lower	Upper	
Age of the child (months)	1.03	1.03	1.04	<0.001
Birth weight of the child (grams)				
<2500	1.81	1.61	2.03	<0.001
≥2500	1			
Birth order of the child	1.06	1.03	1.09	<0.001
Birth interval				
<24 months	1.24	1.12	1.37	<0.001
≥24 months	1			
Height of the mother (cm.)	0.94	0.93	0.94	<0.001
Age of the mother at the time of delivery				
≤ 20 years	1.17	1.04	1.30	0.048
> 20 years	1			
Maternal education				
No education	1.33	1.22	1.46	<0.001
Primary, secondary, higher	1			
Duration of breastfeeding (months)	1.04	1.04	1.04	<0.001
Interaction term for age of the child and breastfeeding duration	0.99	0.99	1.00	<0.001
Wealth index				
Low	1.82	1.58	2.10	<0.001
Middle	1.38	1.17	1.63	<0.001
High	1			
Caste of the household				
S.T., S.C., O.B.C.	1.24	1.10	1.40	<0.001
Others	1			

S.T.,S.C.,O.B.C. Scheduled tribe, scheduled caste, and other backward classes

The Hosmer and Lemeshow test value was 0.103

Table 9: Univariate linear regression of the selected characteristics with food diversity score of the child as the outcome variable among families' youngest children aged 6-36 months in the state of Bihar, India (NFHS 4)

Characteristic	B	95% C. I.		P value
		Lower	Upper	
Gender of the child				
Male	-0.05	-0.13	0.02	0.161
Female	0			
Age of the child (in months)	0.14	0.14	0.15	<0.001
Birth weight				
<2500 grams	0.04	-0.09	0.18	0.519
≥2500grams	0			
Birth order of the child	0.03	0.01	0.06	0.004
Birth Interval				
<24 months	0.17	0.08	0.26	<0.001
≥24 months	0			
Number of children in the household	0.02	-0.00	0.04	0.077
Recent episode of diarrhea (last two weeks)				
Present	0.12	0.02	0.22	0.020
Absent	0			
Age of the mother at the time of delivery				
≤20 years	-0.06	-0.15	0.03	0.212
>20 years	0			
Height of the mother (centimeters)	0.01	-0.00	0.01	0.269
BMI of the mother				
<18.5 kg/m^2	0.06	-0.02	0.14	0.160
≥18.5 kg/m^2	0			
Maternal education				
No education	-0.07	-0.14	0.01	0.086
Primary, secondary, higher	0			
Initiation of breastfeeding				
Immediately	0.19	1.62	1.73	<0.001
Not-immediately	0			
Duration of breastfeeding (months)	0.12	0.12	0.13	<0.001
Antenatal visit				
Not received	0.06	-0.02	0.13	0.167
Received	0			
Type of residence				
Rural	-0.08	-0.21	0.05	0.215
Urban	0			
Wealth index				
Low (poorest, poorer)	-0.08	-0.21	0.04	0.177
Middle (middle)	0			
High (richer, richest)	0.06	-0.12	0.23	0.536

Characteristic	**B**	**95% C. I.**		**P value**
		Lower	**Upper**	
Caste of the household				
S.T., S.C., O.B.C.	-0.20	-0.31	-0.09	<0.001
Others	0			
Religion of the household				
Hindu	-0.24	-0.34	-0.14	<0.001
Muslim	0			
Other (Sikh, Parsi, Christian, etc.)	-1.35	-3.66	0.96	0.252

S.T.,S.C.,O.B.C. Scheduled tribe, scheduled caste, and other backward classes

Table 10: Multivariable logistic regression for the association between stunting status and food diversity score controlled for the identified confounders among families' youngest children aged 6-36 months in the state of Bihar, India (NFHS-4)

Characteristic	O.R.	95% C.I.		P value
		Lower	Upper	
Food diversity score (0 to 9)	0.97	0.94	0.99	0.004

After adjusting for the identified confounders; age of the child, birth order, birth interval, duration of breastfeeding, and caste of the household

The Hosmer and Lemeshow test value was 0.068

Appendix

Study variables

Table A: Dependent variable

Variable	Type	Measure
Presence of Stunting	Dichotomous	1 = Yes 0 = No

Table B: Independent variable

Variable	Type	Measure
Age of the child	Numeric (continuous)	Months
Gender of the child	Nominal	1 = Male 0 = Female
Birth weight of the child	Dichotomous	1 = <2500 gram 0 = >= 2500 gram
Birth interval	Dichotomous	1 = <24 months 2 = ≥ 24 months[69]
Birth order	Continuous	1 , 2 , ……..
Number of children under 18 years of age in the family[7*]	Numeric (continuous)	1, 2, 3, 4, ……
Diarrhea episode during last two weeks	Dichotomous	0 = Absent 1 = Present
Duration of breastfeeding	Continuous	Number of months the child was breastfed
Age of the mother at delivery	Numeric (continuous)	1= ≤20 years 0 = >20 years
Maternal height	Continuous	Centimeters
Maternal education	Categorical	1 = No education 0 = Primary, secondary, higher
Initiation of breast feeding	Dichotomous	1 = Immediately 0 = Not-immediately
Antenatal visit during pregnancy	Dichotomous	0 = Received 1 = Not received
Residence of the household	Nominal	0 = Urban 1 = Rural
Wealth Index	Ordinal	1 = Low (poorer and poorest) 2 = Middle 3 = High (richer, richest)
Caste of the household	Nominal	1 = Scheduled caste, scheduled tribe or other backward classes 0 = Other caste
Religion of the family	Nominal	1 = Hindu 2 = Muslim 0 = Other
Food diversity score[8]	Continuous	0, 1, 2, ….., 9

[7*] Government of India considers the age group of children below 18 years. [70]

WOMAN QUESTIONNAIRE

SECTION 1. RESPONDENT'S BACKGROUND

102. In what month and year were you born?

MONTH | | |

YEAR | | | | |

DON'T KNOW MONTH ____________________ 98

DON'T KNOW YEAR ____________________ 9998

105. Have you ever attended school?

YES ____________________ 1

NO ____________________ 2 →109

106. What is the highest standard you completed?

STANDARD ____________________

SECTION 2. REPRODUCTION

209. Just to make sure that I have this right: you have had in TOTAL _____ births during your life. Is that correct?

YES __ NO__

213. Is (NAME) a boy or a girl?

BOY ____________________ 1

GIRL ____________________ 2

215. In what month and year was (NAME) born? PROBE: What is his/her birthday?

MONTH

YEAR

216. Is (Name) still alive?

YES______________

NO_______________

222. Have you had any live births since the birth of (NAME OF LAST BIRTH)?

YES_________

NO__________

Birth Interval (B11) was calculated as the difference in months between the date of the current birth and the previous birth, counting twins as one birth

BASE: All births except the first birth and its twins.

SECTION 4. PREGNANCY, DELIVERY, POSTNATAL CARE AND CHILDREN'S NUTRITION

413. Did you see anyone for antenatal care for this pregnancy?

YES_________

NO__________

403. LINE NUMBER FROM 212

LAST BIRTH LINE NUMBER | | |

NEXT-TO-LAST BIRTH LINE NUMBER | | |

SECOND-FROM-LAST BIRTH LINE | | | NUMBER

444. How much did (NAME) weigh?

RECORD WEIGHT IN KILOGRAMS FROM HEALTH CARD, IF AVAILABLE

KG FROM CARD

1. ____ . ___ ___ __

KG FROM RECALL

2. ____ . ___ ___ ___

DON'T' KNOW ________99998

481. Did you ever breastfeed (NAME)?

YES _________ 1

NO __________ 2 (SKIP TO 488)

482. How long after birth did you first put (NAME) to the breast?

if less than one hour, record '00' hours.

if less than 24 hours, record hours.

otherwise, record days.

immediately__________00

hours 1 ___ ___

days 2 ___ ___

487. For how many months did you breastfeed (NAME)?

MONTHS ____ ____

DON'T KNOW ________98

492. Now I would like to ask you about liquids or foods that (NAME FROM 491) had yesterday during the day or at night. I am interested in whether your child had the item I mention even if it was combined with other foods. Did (NAME FROM 491) (drink/eat):

A. Any bread, roti, chapati, rice, noodles, biscuits, idli, or any other foods made from grains? 1. YES 2. NO 8. DON'T KNOW
B. Any pumpkin, carrots, squash or sweet potatoes that are yellow or orange inside? 1. YES 2. NO 8. DON'T KNOW
C. Any white potatoes, white yams, manioc, cassava, or any other foods made from roots? 1. YES 2. NO 8. DON'T KNOW
D. Any dark green, leafy vegetables? 1. YES 2. NO 8. DON'T KNOW
E. Any ripe mangoes, papayas, cantaloupe or jackfruit? 1. YES 2. NO 8. DON'T KNOW
F. Any other fruits or vegetables? 1. YES 2. NO 8. DON'T KNOW
G. Any liver, kidney, heart or other organ meat? 1. YES 2. NO 8. DON'T KNOW
H. Any chickens, duck, or other birds? 1. YES 2. NO 8. DON'T KNOW
I. Any other meat? 1. YES 2. NO 8. DON'T KNOW
J. Any eggs? 1. YES 2. NO 8. DON'T KNOW
K. Any fresh or dried fish or shellfish? 1. YES 2. NO 8. DON'T KNOW
L. Any foods made from beans, peas, lentils, or nuts? 1. YES 2. NO 8. DON'T KNOW
M. Any cheese or other food made from milk? 1. YES 2. NO 8. DON'T KNOW

N. Any other solid, semi-solid, or soft food? 1. YES 2. NO 8. DON’T KNOW

SECTION-5: CHILD IMMUNIZATIONS AND HEALTH

516. Has (NAME) had diarrhoea in the last 2 weeks?

YES ____________________ 1

NO ____________________ 2

DON'T KNOW ____________________ 8

BIOMARKER QUESTIONNAIRE

WEIGHT, HEIGHT FOR WOMEN

303. Weight in kilograms?

KG. [| |]

Not present 99994

Refused 99995

Other 99996

304. Height in centimetres?

CM.

[| |]

Refused 99995

Other 99996

HOUSEHOLD QUESTIONNAIRE

STATE ______________________________

CITY/TOWN/VILLAGE ______________________________

MEGA CITY/LARGE CITY/SMALL CITY/LARGETOWN/SMALL TOWN/RURAL ____________

(MEGA CITY=1, LARGE CITY=2, SMALL CITY=3, LARGE TOWN=4, SMALL TOWN=5, RURAL=6)

HOUSEHOLD SCHEDULE

4. Is (NAME) male or female?

34. What is the religion of the head of the household?

HINDU __________________________ 01

MUSLIM _________________________ 02

CHRISTIAN __________________________ 03

OTHER __________________________ 96

(Specify)

36. Is this a scheduled caste, a scheduled tribe, other backward class, or none of them?

SCHEDULED CASTE ______________________ 1

SCHEDULED TRIBE ______________________ 2

OTHER BACKWARD CLASS ______________________ 3

NONE OF THEM ______________________ 4

DON'T KNOW ______________________ 8

58. Does this household have a BPL card?

YES ______________________ 1

NO 5______________________ 2

DON'T KNOW ______________________ 8