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Effects of malnutrition on child development: Evidence from a backward district of India

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ABSTRACT

Background: In India, under-nutrition among the poor children imposes greater burden in rural areas. Particularly rural children are more vulnerable to malnutrition because they receive foods having low nutritional values along with discriminatory distribution of food within the household. Also in early childhood due to lack of appropriate care they suffer from recurrent infections and multiple diseases either causing delayed development or fatal effect. The demographic and socio-economic factors influence the nutritional status and neuro-development of the vulnerable children.

Methods: The aim of present study is to assess the nutritional status of developmentally challenged children of less than five years through Z-scores of height-for-age, weight-for-height and weight-for-age by demographic characteristics in a backward district of the state of West Bengal, India. Indices of nutritional status are calculated based on the WHO Child Growth Standards.

Result & conclusion: It has been observed that there are gender differences and age group variations in the nutritional status of children who are developmentally challenged. Under-nutrition is a major problem with vulnerable children in rural area who suffer from developmental delay.

1. Introduction

The children, particularly in rural areas of India are vulnerable to malnutrition because of insufficient dietary intakes, recurrent infections, lack of proper care, and uneven distribution of food within the family. Optimal nutrition in infancy and early childhood is essential to meet the demands of rapid growth and development. Under-nutrition reduces immunological capacity to defend against diseases, and recurrent infections, in turn reduce and deprive the body from essential nutrients. This leads to the dismal growth of children which adversely affect child's mental and physical development and, learning capacity in future life.[1] Under nutrition, which is an important determinant of maternal and child health, has significant negative effects on brain and cognitive development of children.[2] The UNICEF report says, one of the main causes of child mortality worldwide can be attributed to under-nutrition, and is estimated to cause at least half of all child deaths.[3] According to the UNICEF-WHO-World Bank Joint Child Malnutrition Estimates of 2016, globally for children under 5 years, 155 million and 52 million children were stunted and wasted respectively. Moreover, 17 million children under 5 were severely wasted.[4] India is one among the many countries where malnutrition is a major underlying cause of child mortality and developmental challenges. The 3rd National Health and Family Health Survey (NFHS-3), 2005-06 of India reports that, almost every second child is undernourished in India.[5]

Every newborn baby has to go through a complex process of growth & development at various levels to ultimately emerge as a normal adult. Any deviation in these stages of development may lead to developmental disability. Malnutrition is the hidden cause behind disability for hundreds of millions of children worldwide, according to UNICEF's State of the World's Children's report.[6] The research outlines the scale of the problems caused by poor diet, which can leave young children vulnerable to conditions that may lead to physical and intellectual disabilities.

Access to sufficient nutritious food is often an issue of concern to families having a member with disabilities because of poverty and unequal distribution of resources within the household. Access to nutritious food for women with disabilities and their children is consistently overlooked in both the nutrition and disability sectors, placing those women and children at increased risk.[7] The World Health Organization (WHO) uses the term “disability” to refer to a loss of health, where health means having full functional capacity in such domains as mobility, cognition, hearing and vision.[8] It emphasizes that, persons

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with disabilities include those who have physical, mental, intellectual or sensory impairments which in interaction with various barriers may hinder their full and effective participation in society on an equal basis with others. Around 15% of the world's populations, over a billion people, live with disabilities.[9] According to UN Enable (UN Website particularly developed for disability), women and children with disabilities are particularly at a greater risk of abuse. About 90% of children with disabilities worldwide do not attend school. Children with disabilities are at a 1.7 times greater risk of being subjected to some form of violence.[10] According to Child Rights International Network (CRIN) over 150 million children worldwide have a disability and 90% of the children with disabilities will not survive pass twenty years of age.[11] The British Department for International Development (DFID) has recognized that, 'disability is a major cause of social exclusion and it is both the cause and consequence of poverty'.[12]

The Census 2011[13] showed that, in India 20.42 lakhs, that is 1.24% of the total children aged 0–6 years are disabled. Thus, one in every hundred children in the age group 0–6 years suffered from some type of disability. Around 71% of the total disable children (near about 14.52 lakh) are living in rural area of our country. The states of Uttar Pradesh (20.31), Bihar (14.24), Maharashtra (10.64) and West Bengal (6.48) together contributed more than 50 percent of the disabled children (0–6 years) of the country.[14] With a large birth cohort of almost 26 million per year, India would account for the largest share of birth defects in the world.[15]

Childhood disability is mostly a consequence of developmental delay & challenge, in various domains like, motor, cognitive, visual, auditory and social development, leading to motor disabilities (cerebral palsy), mental retardation, visual impairment, hearing impairment, speech delay, behavioural problems and learning disabilities. Many studies have shown that children exposed to severe acute malnutrition in early life have poor cognitive function, poor school achievement and behavioural problems.[16-18] Again, stunting and underweight are also reported to be associated with developmental delay from studies conducted in India and Bangladesh.[19,20] The main underlying causes of developmental delays in India are malnutrition, diseases, congenital factors, inadequate hygiene, lack of access to a health care system, poverty etc. Developmental delays in early childhood are estimated to affect about 10 percent of children in India.[21]

The present study has conducted in Purulia, a backward district in the state of West Bengal, India. About 43.65% families in the rural areas of the district belong to BPL category. A high proportion of the populations (88.93%) in the district are in the rural areas. Overall literacy level in the district during 2011 Census is 65.38% and for female it is alarmingly low (37.15%).[13] Thus with high poverty level and low female literacy, likelihood of childhood malnutrition and developmental delays were expected to be high. It becomes important to understand the age-wise trend in prevalence of underweight, stunting and wasting and identify the critical age for intervention, to identify and treat malnutrition and early developmental delay. The National Family Health Survey-4 (NFHS-4) one of the important source of exhibiting the status of child malnutrition in India indicates about 35.7 percent of the children under 5 years of age are moderately to severely underweight (thin for age), 38.4 percent are moderately to severely stunted (short for age), and approximately 21 percent are moderately to severely wasted (thin for height).[22] The Table 1 shows a comparison between NFHS 3 and 4 surveys in India and in the state of West Bengal. Along with nutritional status other important information are also presented to understand the gravity of the situation in this context.

The main objectives of the present study are: (i) to assess the variations of nutritional status among the children having developmental challenges with the children of no such problems through the nutritional indices (Z-scores) of weight-for-age, height-for-age and weight-for-height of children; (ii) to assess the effect of different age groups in children on the nutritional status of children in district; (iii) to determine whether the gender disparities in nutritional status can be attributed to the age of children.

Table 1
The State of Children in India and west Bengal.
Source: National Family Heath Survey 3 and 4, IIPS, India.

Proportion of young children with the following characteristics	India		West Bengal	
	2005–06 (NFHS-3)	2015–16 (NFHS-4)	2005–06 (NFHS-3)	2015–16 (NFHS-4)
Undernourished[a]	42.5	35.7	38.7	31.5
Stunted[a]	48.0	38.4	44.6	32.5
Wasted[a]	19.8	21.0	16.9	20.3
Not fully immunized[b]	56.5	38.0	35.7	15.6
Suffer from anaemia[c]	69.4	58.4	61.0	54.2
Not Breastfed within an hour of birth[d]	76.6	58.4	76.3	52.5
Children under age 6 months exclusively breastfed[e]	46.4	54.9	58.6	52.3

[a] Below −2 standard deviations, based on the WHO standard.
[b] 12–23 months for immunization.
[c] Children aged 6–59 months.
[d] Children under age 3 years and based on the last child born in the 5 years before the survey.
[e] Based on the youngest child living with the mother.

2. Material & methods

Particularly in rural areas of India, where access to health care resources is limited and illiteracy is high, developmental problems in children are also observed. But unfortunately these children are largely unattended in rural areas. However, it is not possible to survey the entire blocks or villages to find out the desired children having such problems, because it involves lots of time and money. So, the main problem is to identify the children having developmental problems in the rural households. According to Special Newborn Care Units (SNCU) Technical Reports, approximately 20 percent of babies discharged from health facilities in India are found to suffer from developmental delays or disabilities at a later age.[15] Thus, the potential source may be to follow up high risk babies discharged from the Newborn Care Unit of different districts and state hospitals of India and identify early markers of developmental delay to determine the imminent burden of developmental challenges and also study the various aetiological factors and associations in the rural population.

For the present study in Purulia district of West Bengal, a group of personnel like block level health workers and local NGO workers were trained for initially identifying children from community, block wise according to their home address collected from the district hospital records for the babies discharged from the SNCU over a period of two years (2010–2012). They may be considered as 'at-risk' babies for developmental challenges. Finally, these block representatives were utilized for motivating and mobilizing the parents of the babies to attend the screening camp organized (with their child), where the expert team performs screening & assessment of the child to arrive at a definite diagnosis. The screening camps were organized at different blocks of Purulia district during the period 2012 to 2014.

Children below five years of age were screened for developmental delay and malnutrition by a specialized team comprising of Developmental Pediatrician, Ophthalmologist, Developmental specialists, with the help and support of local government officials and social welfare organizations (NGOs), working in this field in the district. Children with various developmental delays and challenges were identified. This team identified a large number of children, approximately 146 in number (450 children attended the screening camp during the period) in different blocks, with some developmental delays or challenges of different nature like, cerebral palsy, mental retardation, speech delay, hearing and visual impairment and behavioural

Table 2
Distribution of number of children according to developmental status by demographic characteristics in the District of Purulia, West Bengal, India.

Characteristics	Category	Developmental delay		Normal development		Total no. of children	Odds ratios (95% CI)	CHI-Square
		NO.	Col %	NO.	Col %			
Age group of child	0–5 months	14	9.6	18	5.9	32	RC	7.03 (df = 3, p = 0.07)
	6–11 months	21	14.4	49	16.1	70	2.038 (0.809–5.129)	
	12–23 months	69	47.3	117	38.5	186	1.269 (0.564–2.855)	
	> = 24 months	42	28.8	120	39.5	162	1.544 (0.664–3.587)	
Sex of the child	Male	98	67.1	184	60.5	282	RC	1.83 (df = 1, p = 0.17)
	Female	48	32.9	120	39.5	168	1.343 (0.863–2.089)	
Type of baby	Twin	12	8.2	20	6.6	32	RC	0.40 (df = 1, p = 0.52)
	Single	134	91.8	284	93.4	418	0.872 (0.386–1.969)	
Birth weight	< 2.5 kg	94	64.4	114	37.5	208	RC	34.2 (df = 2, p = 0.001)
	> = 2.5 kg	39	26.7	170	55.9	209	3.121 *** (1.839–5.294)	
	Not available	13	8.9	20	6.6	33		
Gestation type	Preterm (less than 37 weeks)	62	42.5	84	27.6	146	RC	31.1 (df = 2, p = 0.001)
	Term (37 weeks and above)	59	40.4	202	66.4	261	3.706 *** (1.793–7.661)	
	Not recorded	25	17.1	18	5.9	43		
Total		146	100.0	304	100.0	450		

Note: RC = Reference Category for logistic Regression; *** indicates significance at 1% level. CI = confidence interval.

problems. So, in this analytical comparative cross-sectional study multistage data collection procedures were employed.

To assess nutritional status of these children (450 in number), anthropometric measurements were done which included weight, height, length and mid-arm circumference. Different socio-economic and demographic information for the children are also collected. Anthropometry is recognized as the most useful technique to assess the growth and nutritional status of individuals or populations.[23,24] Assessment of nutritional status is considered on the justification that in a well-nourished population, we can get a statistically predictable distribution of children of a specified age with respect to height and weight. For a bigger population, there will be variation in height and weight and approximately this follows a normal distribution. Now, if we can use a standard reference population as a point of comparison then it facilitates to find out the differences in the anthropometric status of subgroups in a population and also help to determine the changes in nutritional status over time. The use of a reference population is based on the empirical finding that well-nourished children in all population groups for which data exist follow very similar growth patterns before adolescence.[5] However, to facilitate the analysis of changes in nutritional status over time, nutritional status of children has also been recalculated using the new WHO standard.

Each of the nutritional status indicators is expressed in standard deviation units (Z-scores) from the median of the reference population. Generally, a Z score of −2 has been utilized as a cut-off point for estimation of status of malnutrition of children. The Z-score is defined as the deviation of the value observed for an individual from the median of the reference population, divided by the standard deviation (SD) of the reference population. It is possible to compute Z-scores of the nutritional indices like, weight for-age, height-for-age, weight-for-height, head circumference-for-age and arm circumference-for-age. For the present study first three measures were considered. Each index provides different information about growth and body composition, which is used to assess nutritional status.

The “height-for-age” (HAZ) or “stunting” reflects chronic undernutrition during the most critical periods of growth and development in early life. It is defined as the percentage of children aged 0–59 months whose height for age is below minus two standard deviations (−2 SD) (moderate and severe stunting) and minus three standard deviations (−3 SD) (severe stunting) from the median of the WHO Child Growth Standards.[25] Stunting reflects failure to receive adequate nutrition over a long period of time and is also affected by recurrent and chronic illness. Similarly, “weight-for-age” (WAZ) or “underweight” is a composite form of under-nutrition that includes elements of stunting and wasting. It is defined as the percentage of children aged 0–59 months whose weight for age is below minus two standard deviations (moderate and severe underweight) and minus three standard deviations (severe underweight) from the median of the WHO Child Growth Standards.[25] Lastly, “weight-for-height” (WHZ) or “wasting” reflects acute under-nutrition. It is defined as the percentage of children aged 0–59 months whose weight for height is below minus two standard deviations (moderate and severe wasting) and minus three standard deviations (severe wasting) from the median of the WHO Child Growth Standards.[25] Wasting represents the failure to receive adequate nutrition in the period immediately preceding the survey and may be the result of inadequate food intake or a recent episode of illness causing loss of weight and the onset of malnutrition. Severe acute malnutrition is defined as the percentage of children aged 0–59 months whose weight for height is below minus three standard deviations from the median of the WHO Child Growth Standards. In this respect ‘Mean’ values may be presented to get an idea about the overall nutritional situation of the children of different age groups and sexes.

The present study mainly concentrates on child level factors like, child's age, sex, birth weight, gestational period (term or preterm) and singleton or twin, for the assessment of developmental differentials among the children. Again, to compute Z-scores of the nutritional indices variables, age and sex of the children are primarily considered in this study.

3. Results

The data of the present study are described in Table 2 under important demographic and health characteristics. Maximum incidence of developmental delay has been detected in the age group of 12–23 months. Again prevalence (percentage) of developmental delay is comparatively higher among twin babies than in singletons, although not statistically significant. Low birth weight and prematurity (gestation period less than 37 weeks) are found to be contributory factors for delayed development. The percentage of low birth weight (LBW) is 64.4 percent for the children suffering from developmental delay compared to normal children having such birth weight is 37.5 percent only. Similarly, gestational period less than 37 weeks is much higher (42.5) for challenged children compared to normal children (27.6). Binary logistic regression has been used to analyze the adjusted effects of selected important predictors of developmental delay. The regression analysis yields odds ratios (OR), which indicates the magnitude of the predictor variable on the probability of the outcome occurring. The odds ratios in this analysis are the measure of the odds of occurrence of

Table 3
Percentage of all children (with or without developmental delay) under age five years classified as malnourished according to three anthropometric indices of nutritional status: height-for-age, weight-for-height and weight-for-age by demographic characteristics in the District of Purulia, West Bengal, India.

Demographic characteristics		Underweight (wt/age)					Stunting (ht/age)					Wasting (wt/ht)				
Sex	Age class	% below -3SD	% below -2SD	N	Mean	SD	% below -3SD	% below -2SD	N	Mean	SD	% below -3SD	% below -2SD	N	Mean	SD
All	0–5 mo.	46.4	75.0	28	−2.84	1.64	39.3	50.0	28	−2.14	1.73	25.8	48.4	31	−2.21	1.24
	6–11 mo.	36.8	67.6	68	−2.60	1.36	20.6	51.5	68	−1.79	1.81	17.6	51.5	68	−2.07	1.22
	12–23 mo.	35.3	63.6	173	−2.47	1.28	26.7	54.1	172	−2.10	1.51	21.1	50.3	171	−1.98	1.26
	24 ≥ mo.	46.2	79.3	150	−2.80	1.12	28.6	59.3	145	−2.34	1.27	28.5	56.2	142	−2.16	1.14
Total		39.6	69.7	419	−2.65	1.27	26.9	54.5	413	−2.14	1.51	23.1	51.7	412	−2.09	1.22
Male	0–5 mo.	43.8	81.3	16	−2.91	1.86	43.8	62.5	16	−2.60	1.76	26.3	47.4	19	−2.24	1.42
	6–11 mo.	43.9	75.6	41	−2.83	1.44	24.4	51.2	41	−1.98	1.76	24.4	56.1	41	−2.28	1.37
	12–23 mo.	37.9	63.8	116	−2.46	1.28	28.7	57.4	115	−2.20	1.46	20.0	50.4	115	−1.95	1.30
	24 ≥ mo.	44.4	80.7	90	−2.88	1.08	28.9	60.2	85	−2.46	1.22	27.5	60.0	82	−2.25	1.11
Total		41.4	72.2	263	−2.69	1.29	28.8	57.6	257	−2.27	1.46	23.7	54.1	257	−2.13	1.27
Female	0–5 mo.	50.0	66.7	12	−2.75	1.36	33.3	33.3	12	−1.53	1.56	25.0	50.0	12	−2.18	0.95
	6–11 mo.	25.9	55.6	27	−2.25	1.18	14.8	51.9	27	−1.51	1.88	7.4	44.4	27	−1.76	0.87
	12–23 mo.	29.8	63.2	57	−2.48	1.30	22.8	47.4	57	−1.90	1.61	23.2	50.0	56	−2.02	1.20
	24 ≥ mo.	44.0	74.6	60	−2.67	1.17	28.7	53.6	60	−2.16	1.32	24.9	47.8	60	−2.04	1.17
Total		36.5	65.4	156	−2.56	1.23	23.7	49.4	156	−1.92	1.56	21.9	47.7	155	−2.02	1.13

Note: Each Index is expressed in standard deviation (SD) units from the median of the International Reference Population (WHO growth standard).
"- 2SD" includes children who are below "- 3SD" from the International Reference Population median.
N – Total number of children considered for the anthropometric measurements; Mean – Mean of z scores; SD – standard deviation of z scores.

developmental delay as an adjusted effect of independent variables included in the analysis. The OR and Chi-squire values are shown in the last two columns of Table 2.

Sex wise and age wise percentage values of the *Z*-scores of the children of age 0–59 months are shown in Table 3. In this table irrespective of having developmental delay or not, total children for whom anthropometric measures are done presented. This has done to get an idea about the overall nutritional picture for the selected children in the district. However, there are some non-random errors happened at the time of anthropometric measurement taken in the heath camps and hence those cases are excluded from the total number of children. For this reason, total number of children (N) varies for the three anthropometric indices.

The percentage of undernourished children irrespective of age and sex is 69.7 percent of the total children indicating a miserable picture of the selected children in the district. Again near about 40 percent of the children (below – 3 SD) are found to be severely malnourished for the children attended in the medical camp during the study period. If we look up the picture age group wise, then the children above the 2 years of age (toddler and above) are suffering most from the malnourishment (79.3%). The children belonging to the age group of 0–5 months are in the second position (75%). Thus, new born and toddlers & above these two categories are suffering most from undernourishment, although there is tendency of reducing the phenomena over age. When age-wise 'average Z-scores' are plotted, it shows a non-linear trend (not shown here). The Z-scores first decrease and then show an increasing trend. So, the nutritional level of children falls at the beginning and then rises afterwards.

Now for our present study, if we observe the underweight data across sex, it can be said that male children are suffering more than their female counter part. Particularly for the age group of 0–5 months, male children (81.3%) are more undernourished than the female (66.7%). This may be due to the fact that female children are more immune than male up to the certain age from birth. During neonatal period biological factors and maternal factors strongly affect the health status. Whereas, after the neonatal period, that is during post neonatal and onwards heath status is attributed mainly to childhood diseases and accidents, which are governed by the social development and programmatic factors.[26] When the percentages of stunted children are compared the picture is not similar with underweight. Near about 55 percent of the children are moderately stunted and 27 percent are severely affected by stunting. Over all there is a declining tendency of percentage suffering from stunting over age group. But the rate of decline over age groups is very slow. Here also percentage of stunting is higher for (0–5) months age group and also for 24 months & above age group. The situation for gender discrepancy is similar to the case of weight-for-age. Higher proportion of males is suffering from moderate and severe stunting than females. However, in case of the present study in Purulia, moderate wasting is high (51.7%) and severe wasting is also high (23.1%).

To observe the difference between children having developmental challenges with normally growing, the data has been segregated into two parts, one with developmental delay and the other without developmental delay. For this the results are presented in Table 4 and Table 5 respectively.

Near about 74 percent and 50 percent of the developmentally challenged children are suffering from moderate and severe underweight problems respectively (Table 4). These proportions are much higher than the normal children whose respective z scores are presented in Table 5. However, the underweight is quite high (94.7% for moderate and 73.7% for severe) for the age group 6–11 months of developmentally challenged children. The same percentages for normal children are 57.1 and 22.4 for moderate and severely undernourished respectively (Table 5). Again, undernourishment increases as age increases for the developmentally challenged children. For developmentally challenged children more males are suffering from underweight problem compared to females (Table 4). But in case of normal children such biasness has not been observed (Table 5). This probably due to the gender bias in the family where parents are more concerned about the survival and wellbeing of male child suffering from developmental problems than female. So the parents usually bring more male children to camp for treatment than female. This may be due to under reporting of females suffering from such problems.

More or less same features are also observed in case of stunting in children. The percentage of severe stunting is higher for the developmentally delayed children (35.6) than the normal children (22.8). However, severe stunting is more or less constant over different age groups. But in case of normal children it shows a declining tendency as age increases. Again for developmentally challenged children more males are suffering from stunting problem compared to females showing the same features as before.

In case of developmentally challenged children, the percentages of

Table 4
Percentage of children (only with developmental delay) under age five years classified as malnourished according to three anthropometric indices of nutritional status: height-for-age, weight-for-height and weight-for-age by demographic characteristics in the District of Purulia, West Bengal, India.

Demographic characteristics		Underweight (wt/age)					Stunting (ht/age)					Wasting (wt/ht)				
Sex	Age class	% below -3SD	% below -2SD	N	Mean	SD	% below -3SD	% below -2SD	N	Mean	SD	% below -3SD	% below -2SD	N	Mean	SD
All	0–5 mo.	45.5	63.6	11	−2.72	2.26	36.4	54.5	11	−2.08	1.96	46.2	69.2	13	−2.88	1.41
	6–11 mo.	73.7	94.7	19	−3.64	0.83	40.0	65.0	20	−2.74	1.46	42.1	84.2	19	−2.96	1.34
	12–23 mo.	40.6	65.6	64	−2.78	1.31	35.9	56.3	64	−2.40	1.50	27.0	58.7	63	−2.19	1.14
	24 ≥ mo.	57.1	82.8	37	−3.22	1.29	34.2	57.1	37	−2.55	1.56	39.3	63.6	35	−2.59	1.14
Total		50.4	74.0	131	−3.03	1.37	35.6	57.6	132	−2.47	1.54	34.6	64.6	130	−2.49	1.22
Male	0–5 mo.	44.4	66.7	9	−2.56	2.28	33.3	55.6	9	−2.17	1.91	45.5	63.6	11	−2.82	1.48
	6–11 mo.	76.9	100.0	13	−3.86	0.77	42.9	57.1	14	−2.90	1.52	53.8	84.6	13	−3.24	1.52
	12–23 mo.	43.2	68.2	44	−2.75	1.20	38.6	56.8	44	−2.46	1.35	25.0	61.4	44	−2.21	1.10
	24 ≥ mo.	63.6	90.9	22	−3.58	1.23	45.5	72.7	22	−3.08	1.39	40.0	65.0	20	−2.70	1.16
Total		53.4	78.4	88	−3.10	1.37	40.4	60.7	89	−2.65	1.46	35.2	65.9	88	−2.55	1.27
Female	0–5 mo.	50.0	50.0	2	−3.44	2.85	50.0	50.0	2	−1.65	2.96	50.0	100.0	2	−3.17	1.27
	6–11 mo.	66.7	83.3	6	−3.18	0.83	33.3	83.3	6	−2.36	1.37	16.7	83.3	6	−2.37	0.53
	12–23 mo.	35.0	60.0	20	−2.84	1.55	30.0	55.0	20	−2.28	1.83	31.6	52.6	19	−2.16	1.26
	24 ≥ mo.	46.0	68.9	15	−2.67	1.24	15.3	30.6	15	−1.70	1.46	38.3	61.2	15	−2.45	1.13
Total		44.2	65.1	43	−2.88	1.38	25.6	51.2	43	−2.08	1.64	33.3	61.9	42	−2.36	1.12

Note: Each Index is expressed in standard deviation (SD) units from the median of the International Reference Population (WHO growth standard).
"- 2SD" includes children who are below "- 3SD" from the International Reference Population median.
N – Total number of children considered for the anthropometric measurements; Mean – Mean of z scores; SD – standard deviation of z scores.

both moderately and severely wasting are quite high (64.6 and 34.6 respectively). The same figures for normal children (Table 5) under consideration are 45.7 (% below -2SD) and 17.7 (% below -3SD) only. This indicates developmentally challenged children are more suffering from wasting than children growing normally. At least in case of wasting there is hardly any gender differential between two sexes and this observation is true for both the categories of children having growth problem and without growth problem.

4. Discussion

In India one of the most important public health problem is malnutrition among vulnerable children. This problem not only obstructs the normal growth and development of children; it also has long-term implications. It creates negative impact on future health and life expectations of children. The study by Caulfied and others exhibited that near about 53% of all deaths in early childhood are attributable to being underweight.[27] In India 45% of girls and 43% of boys are underweight.[28] So, it is important to understand the age-wise trend in prevalence of underweight, stunting and wasting for vulnerable children and to identify the most critical age group when actions need to be taken to reduce the burden of under-nutrition among children having developmental problems. Past reports have indicated that underweight and stunting prevalence rates continue to rise in the first two years of life and then tend to stabilize.[5,29] From pregnancy to a child's second birthday, is critical for under-nutrition and thus intervention is essential during the period.[30]

In the present study it has been observed that, in the district of Purulia which is considered as one of the backward districts in India, at least for the selected sample children, there is marked difference in the nutritional status of developmentally challenged and normal children in terms of percentage of Z-score values of weight-for-age, height-for-age and weight-for-height. The percentage of undernourished children irrespective of age, sex and developmental aspect is also abnormally high

Table 5
Percentage of children (without developmental delay) under age five years classified as malnourished according to three anthropometric indices of nutritional status: height-for-age, weight-for-height and weight-for-age by demographic characteristics in the District of Purulia, West Bengal, India.

Demographic characteristics		Underweight (wt/age)					Stunting (ht/age)					Wasting (wt/ht)				
Sex	Age class	% below -3SD	% below -2SD	N	Mean	SD	% below -3SD	% below -2SD	N	Mean	SD	% below -3SD	% below -2SD	N	Mean	SD
All	0–5 mo.	47.1	62.4	17	−2.92	1.15	41.2	47.1	17	−2.18	1.63	11.1	33.3	18	−1.74	0.86
	6–11 mo.	22.4	57.1	49	−2.20	1.32	12.5	45.8	48	−1.40	1.81	8.2	38.8	49	−1.73	0.98
	12–23 mo.	32.1	62.4	109	−2.29	1.24	21.3	52.8	108	−1.92	1.49	17.6	45.4	108	−1.85	1.32
	24 ≥ mo.	39.9	77.0	113	−2.66	1.02	27.0	57.9	108	−2.26	1.15	22.2	52.5	107	−2.02	1.11
Total		34.7	67.7	288	−2.47	1.19	22.8	53.0	281	−1.99	1.47	17.7	45.7	282	−1.90	1.17
Male	0–5 mo.	42.9	100.0	7	−3.37	1.14	57.1	71.4	7	−3.15	1.49	0.0	25.0	8	−1.43	0.86
	6–11 mo.	28.6	64.3	28	−2.35	1.44	14.8	48.1	27	−1.50	1.70	10.7	42.9	28	−1.83	1.05
	12–23 mo.	34.7	61.1	72	−2.29	1.30	22.5	57.7	71	−2.03	1.50	16.9	43.7	71	−1.80	1.39
	24 ≥ mo.	37.9	77.2	68	−2.65	0.93	23.0	55.7	63	−2.23	1.08	23.4	58.3	62	−2.10	1.06
Total		35.4	69.1	175	−2.49	1.21	22.6	56.0	168	−2.07	1.42	17.8	47.9	169	−1.91	1.22
Female	0–5 mo.	50.0	70.0	10	−2.62	1.10	30.0	30.0	10	−1.50	1.42	20.0	40.0	10	−1.98	0.82
	6–11 mo.	14.3	47.6	21	−1.99	1.15	9.5	42.9	21	−1.26	1.97	4.8	33.3	21	−1.58	0.88
	12–23 mo.	27.0	64.9	37	−2.29	1.11	18.9	43.2	37	−1.70	1.47	18.9	48.6	37	−1.95	1.19
	24 ≥ mo.	43.4	76.5	45	−2.67	1.16	33.2	61.2	45	−2.31	1.26	20.4	43.4	45	−1.91	1.16
Total		33.6	65.5	113	−2.44	1.16	23.0	48.7	113	−1.86	1.53	17.7	42.5	113	−1.89	1.11

Note: Each Index is expressed in standard deviation (SD) units from the median of the International Reference Population (WHO growth standard).
"- 2SD" includes children who are below "- 3SD" from the International Reference Population median.
N – Total number of children considered for the anthropometric measurements; Mean – Mean of z scores; SD – standard deviation of z scores.

(near about 70 percent) indicating a miserable picture. Irrespective of developmentally challenged or not more than 39 percent of children are found to be severely malnourished during the study period. Nutritional status differs significantly among different age groups of children. Particularly, the children below the 2 years of age are suffering most from the malnutrition. Now coming to the developmental aspects, the study established that, more than 70 percent and 50 percent of the developmentally challenged children are suffering from moderate and severe underweight problems respectively. But the underweight problem is much lower for the normal children. Again, the underweight is quite high (95% for moderate and 74% for severe) for the age group 6–11 months of developmentally challenged children. A high significant proportion of developmentally challenged children are male (Table 2). This may be due to gender bias in the family where parents are more concerned about the survival and wellbeing of male child suffering from developmental problems than female.

In our present study severe stunting is higher for the developmentally delayed children (36%) than the normal children (23%). But it is more or less constant over different age groups. For normal children it shows a declining tendency over age. Again, in case of developmentally challenged children more males are suffering from stunting problem compared to females. This may be due to more attention and reporting for male children those who are suffering from developmental challenges. However, in case of wasting, developmentally challenged children are suffering more from wasting than children growing normally. At least in case of wasting there is hardly any gender differential between two sexes are observed.

The findings of this study clearly indicate that preventive measures against under-nutrition in developmentally challenged children should be taken in the early days of their life, i.e., from conception to two years of life. Hence, improvement of gestational age at birth and birth weight are important measures to curb the incidence of developmental delay. So, measures should be taken to improve health and nutritional status of women prior to onset of pregnancy and during pregnancy. This certainly helps to reduce incidence of low birth weight (LBW) and under-nutrition. It is important to address the immediate causative factors of under-nutrition and awareness must be raised at family level to promote appropriate breastfeeding and complementary feeding practices among young growing children. Timely introduction of semisolid food at the end of 6 months, along with continuation of breastfeeding up to six months are essential for preventing under-nutrition in children.[31]

It has already been mentioned that, Purulia is a backward district in the state of West Bengal. According Indian Census of 2011, near about 44% families in the rural areas of the district belong to BPL category. Moreover, overall literacy level in the district during 2011 is 65% and for female it is alarmingly low (37%). So, poor status of women may be the primary cause which adversely influences birth weight as well as nutrition and health status of developmentally delayed children.

Finally, it can be said that, remoteness and poor communication facilities, along with poor resources create great obstacles to proper follow-up of these vulnerable children. Early intervention facilities through District Early Intervention Centers and home-based management have to be focused on to cater to the needs of these vulnerable children of rural community. Side by side, the status of women should be uplifted by increasing mother's literacy and giving empowerment to mothers in the decision-making process particularly on the issue of health care for children.

The main limitation of the present study is that, the results are mainly based on the sample of hospital records (i.e., SNCU records of the district hospital). Again, only the high risk babies born in the government hospital are included in the sample. So, it is very difficult to generalize the finding for the entire district. Unfortunately, private SNCU records for the district are not easily accessible and as the present study mainly concentrates on vulnerable poor rural population of the district, such data are not included in the study. This study is a community based observational study and hence no ethical clearance has been taken for this purpose.

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