Socio-economic Correlates and Prevalence of Undernutrition among Nyishi Tribal Pre-school Children of Northeast India

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ABSTRACT: The prevalence of undernutrition is considered to be the major public ill-health issue and causes premature mortality and morbidity among people of many developing countries. The objectives of the present study are to determine the prevalence and effect of certain socio-economic and demographic factors on undernourished children. The cross-sectional study was carried out among 543 Nyishi tribal children (215 boys and 328 girls) aged 1-4 years of Papum Pare District of Arunachal Pradesh, Northeast India. Anthropometric measurements of height and weight were measured using standard procedure. The age-sex specific Z-score values and body mass index (BMI) was calculated. The prevalence of stunting, underweight and thinness was determined by using and comparing with the WHO (2007) reference. The results of the binary logistic regression analysis showed that sex, age, the dependent children and the toilet facility in the area are found to have significant effect on the child undernourishment ($p<0.05$). Though the specific causes of undernutrition prevailing in the pre-school children could not be ascertained from this present study but results highlighted the problem of undernutrition among the children. An appropriate nutritional intervention program and strategies are needed to improve the undernutritional status among the children of the Nyishi tribe .

INTRODUCTION

Undernutrition is a serious public health issue in developing countries including India and causes several ill-health conditions and premature mortality and morbidity among children (Nandy *et al*., 2005; Black *et al*., 2013; Svedberg, 2011; Varadharajan *et al*., 2013; Kumar *et al*., 2015). It is an underlying cause of mortality in 2.2 million children <5 years (Black *et al*., 2008, 2013).It is estimated that globally around 6.6 million <5 years children died in 2012, where the undernutrition identified as the major underlying cause of mortality estimated to be 45.0% of all deaths in children (World Health Organization (WHO, 2012). It has been estimated that 70.0% of the world's undernourished children live in Asia, giving that region the highest concentration of worldwide childhood undernutrition (Varadharajan *et al*., 2013; Ramachandran, 2014; Bhadoria *et al*., 2017). National Family Health Survey (NFHS-4) data showed that high proportion of children aged <5 years were suffering in stunted (38.4%), underweight (35.7%) and wasting (21.0%) (NFHS-4, 2015-16). The high prevalence of undernutrition, ill-health and infectious diseases are associated with scarcity food and essential nutrients significantly in developing countries including India (Svedberg, 2011; Meshram *et al*., 2012; 2017; Ramachandran, 2014; Erismann *et al*., 2017; Ambadekar and Zodpey, 2017). The

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prevalence of undernutrition during childhood is having severe detrimental effects on health and related morbidity in those children who survive to adulthood (Nandy *et al*., 2005; Ambadekar and Zodpey, 2017; Bhadoria *et al*., 2017). India shows the highest occurrence of childhood undernutrition in the world and it has been estimated that more than half of the children are undernourished in India (Nandy *et al*., 2005; Svedberg, 2011; Varadharajan *et al*.,2013; Ramachandran, 2014; Smith and Haddad, 2015; Patil *et al*., 2017; Seshadri and Ramakrishna, 2018).

Anthropometric assessment of child undernutrition rely on height, weight, skin-fold thickness and the most commonly used conventional anthropometric measures of stunting (low height-for-age), wasting (low weight-for-height), underweight (low weight-for-age) and thinness (low BMI-for-age) or wasting (low weight-for-height) (Nandy *et al*., 2005; Mondal and Sen, 2010; Sen and Mondal, 2012; Meshram *et al*., 2012; Mondal and Sen, 2010; Debnath *et al*., 2018; Sharma and Mondal, 2018). Each anthropometric measure reflects distinct biological processes of nutritional status (WHO,'95; Nandy *et al*., 2005; Mondal and Sen, 2010). However, the principal aim of assessment is to improve the overall nutritional status, reduce the risks of morbidity which is associated with inadequate nutrition intake and/or a similar manifestation (WHO,'95, 2007). Several studies have been reported that high prevalence of child undernutrition is a major public health problem in Indian children (Nandy *et al*., 2005; Bose *et al*., 2007; Kshatriya and Ghosh, 2008; Sen and Mondal, 2012; Tigga *et al*., 2015; Mondal *et al*., 2017; Meshram *et al*., 2012, 2017; Varadharajan *et al*., 2013; Debnath *et al*., 2018; Sharma and Mondal, 2018). Several socio-economic and socio-demographic variables influence the prevalence of undernutrition (Bose *et al*., 2007; Mondal and Sen, 2010; Sen and Mondal, 2012; Ghosh-Jerath *et al*., 2013; Mondal *et al*., 2015;Tigga *et al*., 2015; Rengma *et al*., 2016; Debnath *et al*., 2017, 2018; Sharma and Mondal, 2018). Socio-economic and demographic characteristics such as the child's age and sex, birth orders, number of dependent children and parent's education, livelihood and socio-economic conditions have shown significant associated with the prevalence of undernutrition (Choudhury *et al*. 2000; Som *et al*. 2007; Mondal and Sen, 2010; Ghosh-Jerath *et al*., 2013; Tigga *et al*., 2015; Rengma *et al*., 2016; Mondal *et al*., 2017; Sharma *et al*., 2017; Debnath *et al*., 2018). Several researchers have reported a major issue related to gender discrimination against the female child, and some observe that girls were more vulnerable to undernutrition than boys in India (Choudhury *et al*. 2000; Bose *et al*., 2007; Som *et al*., 2007; Mondal and Sen, 2010; Sen and Mondal, 2012; Aurino, 2017; Debnath *et al*., 2018).

The prevalence of undernutrition is being considered as a serious problem among the most underprivileged and vulnerable segments of the population in India. Similar to the general nutritional trends of India, the magnitude of undernutrition is greater among the tribal populations of northeast India. There is a much paucity of studies conducted among the vulnerable segments of the tribal children in India. Therefore, the objectives of the present study are to assess the prevalence of undernutrition using conventional anthropometric measures and to ascertain the effects of socio-economic and demographic correlates and prevalence of undernutrition among tribal children of Arunachal Pradesh of northeast India.

MATERIALS AND MEDHODS

The present community based cross-sectional study was carried out among 543 Nyishi tribal children (215 boy; 328 girls) of aged 1-4 years residing in rural areas of Kemin and Kakoi block of Papung Pare district of Arunachal Pradesh, India. The community area has a total population of 1,76,385 individuals (90,447 males; 85,938 females) with a literacy rate of 82.14% (Census of India, 2001). This community block consists of tribal communities of Nyishi tribe, and Hill Miri and Aditribal populations. There are some government healthcare facilities and supplementation programs in this area under study, which includes Integrated Child Development Scheme (ICDS) and mid-day meal facility in primary and junior high schools by Government of India. Initially the subjects identified for the present study belong to the major dominant ethnic group of Nyishi tribal population. Ethnically the populations are showing affinity with the population having Tibetan origin and also belonging to Sino-Tibetan linguistic family. They trace their ancestry from Tibetan origin and some asserts that some of them have migrated from the plains area many centuries ago.

The subjects belonging to the children aged 1-4 years were identified by utilizing two-stage stratified random sampling method. Initially the subjects were classified into two different categories as Nyishi Tribal or non-Nyishi population, and finally the Nyishi children belonging to the age-group of 1-4 years were included in the present investigation. Those children who were not found within the age-group of 1-4 years were excluded. A total of 630 children (250 boys; 380 girls) were initially approached for the present study. Later it was found that 87 children (35 boys; 52 girls) were not belonging to the age-group 1-4 years, hence they were not included for the study sample, thus the final sample size consists of 543 children (215 boy; 328 girls). The minimum number of individuals required for reliably estimating the prevalence of undernutritionin for the present study was calculated following a standard method of estimating sample size (Lwanga and Lemeshow,'91). In this method, the anticipated population proportion of 50%, absolute precision of 5% and confidence interval of 95% were taken into consideration. Therefore, the minimum number of sample was estimated to be 386. Age of the subjects was collected using their birth certificates and relevant official records issued by the local government officials. A total of 14 mainly homogenous villages were covered for the collection of data. The data were covered during the period of October 2013 to February 2014.

Socio-demographic data including age, sex, monthly household income, toilet facility, dependent children and parental education and occupation were recorded for each household. A structured schedule was completed by house visits and interviewing the subjects and their parents. The socio-economic status (SES) was evaluated using a modified version of the scale of Kuppuswamy's (Mishra and Singh, 2003). The scale determines the SES based on a score calculated from education, occupation and monthly household income. It was subsequently observed that all selected children belonged to a lower SES group. All the subjects included in the sample were free from any physical deformities, and previous histories related to medical and surgical reports if any, were checked before including them in sample, the time of data collection during the field work. An informed consent was obtained from local village level authorities and parents prior to the data collection for this study. The present study was conducted in accordance with the ethical guidelines for human experiments as laid down in the Helsinki Declaration (Touitou *et al*., 2004).

Anthropometric Measurements

The anthropometric measurements of weight and height were recorded following standard procedures (Gibson, 2005; Hall *et al*., 2007). Weight was recorded to the nearest 0.10 kg with the subject standing motionless on a portable weighing scale. Height was measured to the nearest 0.10 cm using an anthropometer with the subject standing in erect position with the head oriented in the Frankfort Horizontal plane. However, for children younger than 2 years of age, an Infantometer was used to measure the length with standard anthropometric procedures. The differences in anthropometric measurements were calculated for testing the co-efficient of reliability [$R=\{1-(TEM)^2/SD^2\}$, the SD= standard deviation of all measurements] using the technical error measurement {$TEM=\sqrt{(\Sigma D2/2N)}$, D=difference between the measurements, N= number of individuals measured} (Ulijaszek and Kerr,'99). For the calculation of TEM, height and weight of the 50 children other than the present study were measured by the both author NB and NM. Very high values of R (>0.98) were obtained for height and weight using TEM analysis of intra- and inter observer values were found within the cut-off values (0.95) as suggested (Ulijaszek and Kerr,'99). Hence, the anthropometric measurements were obtained in this study are free from observer bias and hence reproducible. The TEM values were not considered for further statistical consideration, and all the measurements were subsequently recorded by the author NB.

Assessment of Nutritional Status

The assessment of undernutrition was done based on the conventional anthropometric measures of height-for-age (stunting), weight-for-age (underweight) and BMI-for-age (thinness) (WHO, 2007). The interpretation of the three indices involves a comparison with international reference population to determine the undernutrition status was already recommended (WHO, 2007). The severity of undernutrition has been subsequently assessed in the present study by utilizing the Z-score to the classification of World Health Organization. The age and sex specific Z- scores value was calculated using the LMS-method. This method is based on three important curves known as L (lambda), M (mu), and S (sigma) curves. The M curve is the median or a 50th percentile curve, the S curve is a measure of the coefficient of variation, and the L curve is the power of the Box-Cox transformation, which measures the changing skewness of the distribution with age. The age specific Z-score (Z) was calculated using following equation: $Z=\{(X/M)^{*}L-1\}/(L^{*}S)$. [Where, X=height/weight/BMI, L, M and S are the age specific values of appropriate table corresponding reference populations]. A child with age-sex specific Z-score value below –2 SD from any indices is considered to be undernourished (WHO,'95, 2007).

Statistical Analysis

The data were compiled in MS-Excel and analyzed using Statistical Package for Social Sciences (SPSS, Inc., Chicago, IL; version 17.0). Normality was tested using the Shapiro-Wilk test for each of the anthropometric variable sex and age groups-wise, and p-values observed to be statistically not significant in most of the categories ($p>0.05$). One way analysis of variance (ANOVA) using the *Scheffe* procedure was done to assess the age-specific mean differences in the anthropometric variables. Chi-square analysis was utilized to assess the differences in prevalence of undernutrition. Binary logistic regression (BLR) model analysis was fitted to estimate the odds of being affected by the conventional anthropometric measures (i.e., stunting, underweight and thinness) of undernutrition. The BLR analysis (e.g., univariate/multivariate model) allows the creation of categorical depended variables and the odds were obtained by comparing with reference category. The predictor variables were sex, age, birth order, dependent children, father's education, mother's education and toilet facility were entered in the separately. In this model, children who were undernourished (<–2SD) were coded as '0' and those with the higher or equal to –2 SD (normal) were coded as '1'. These values were entered into the logistic regression model as response variables instead of the actual z-score values for each anthropometric measure. Similarly, the predictor variables were coded separately and entered into the regression model as a set of dummy variables. A p-value of <0.05 was considered to be statistically significant.

RESULTS

The age-sex specific subject distribution, descriptive statistics of weight, height, BMI, weight-for-age, height-for-age and BMI-for-age among Nyishi children is depicted in Table 1. The age-specific mean height and weight were gradually increases with age among boys and girls. The overall mean BMI was found to be significantly higher among boys 16.18±2.19, kg/m^2 than girls 16.06±2.72, kg/m^2 ($p<0.05$).The age and sex specific mean BMI were not showing any age-specific trend among boys and girls. The age-specific mean was found to be higher of 16.89±1.95 kg/m^2 (in 3 years) and 16.94±2.18 kg/m^2 (in 2 years) among boys and girls, respectively. Using ANOVA, the age-specific mean difference in weight, height and BMI was found to be statistically significant (see Table 1) among boys and girls ($p<0.01$).

The overall mean Z score of WFAZ ("0.48 vs. "0.63) and BMIFAZ (0.05 vs. 0.10) was found to be higher among the girls than the boys indicates boys were found to be more vulnerable than their girls counterparts but the overall mean HFAZ was found to be higher among boys than girls (–1.13 vs. –1.39) ($p<0.05$). The mean age-specific mean BMI was ranged –1.64 to 0.85 (in boys) and "0.40 to 0.70 (in girls). The sex-specific mean of WFAZ, HFAZ and BMIFAZ were not showing any age-specific trend among boys and girls but the mean values showed (see Table 1) that the boys were found to be more vulnerable than their female counterparts in three conventional anthropometric indices of HFAZ, WFAZ and BMIFAZ ($p<0.01$). Using ANOVA, the age specific mean difference in WFAZ, HFAZ and BMIFAZ was found to be statistically significant among the boys and girls ($p<0.01$).

TABLE 1

Age and sex specific descriptive statistics of anthropometric variables among Nyishi tribal children of Arunachal Pradesh

Age	Number		Weight		Height		BMI		WFAZ		HFAZ		BMIFAZ	
	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls
1 year	32	104	8.34 ±1.03	7.33 ±2.49	70.68 ±2.07	66.38 ±6.60	16.73 ±2.21	16.25 ±3.70	-1.18 ±1.14	-0.45 ±2.00	-1.70 ±0.75	-1.11 ±2.14	-0.26 ±1.62	-0.40 ±2.47
2 years	72	44	11.80 ±1.89	10.56 ±.0.50	85.82 ±4.01	79.33 ±4.32	15.99 ±2.00	16.94 ±2.18	-0.13 ±1.17	-0.69 ±0.41	-0.19 ±1.14	-2.19 ±1.34	-0.03 ±1.68	0.70 ±1.51
3 years	87	82	13.34 ±1.95	12.62 ±1.73	88.84 ±5.02	87.47 ±4.66	16.89 ±1.95	16.48 ±1.85	-0.54 ±1.27	-0.83 ± 1.14	-1.73 ±1.31	-1.99 ±1.22	0.85 ±1.49	0.67 ±1.29
4 years	24	98	13.83 ±1.29	14.23 ±2.02	101.50 ±3.83	97.42 ±8.68	13.43 ±1.20	15.10 ±1.97	-1.70 ±0.65	-1.09 ±0.93	-1.03 ±0.85	-0.82 ±2.03	-1.64 ±1.11	-0.25 ±1.49
Total	215	328	12.14 ±2.47	11.15 ±3.46	86.54 ±9.09	82.66 ±14.17	16.18 ±2.19	16.06 ±2.72	-0.63 ±1.26	-0.48 ±1.51	-1.13 ±1.33	-1.39 ±1.89	0.10 ±1.71	0.05 ±1.88
F-value			71.71**	220.38**	258.38**	385.51**	20.93**	6.71**	13.55**	24.93**	26.61**	9.78**	17.73**	8.03**

**p<0.01

TABLE 2

Age and sex specific prevalence of undernutrition (<–2SD) using conventional anthropometric measures among Nyishi pre-school tribal children

Age (in years)	Weight-for-age		Height-for-age		BMI-for-age	
	Boys	Girls	Boys	Girls	Boys	Girls
1	10 (31.25)*	13 (12.50)	14 (43.75)	24 (23.08)	6 (18.75)	28 (26.92)
2	8 (11.11)	05 (11.36)	11 (15.28)	27 (61.36)	12 (16.67)	7 (15.91)
3	14 (16.09)	18 (21.95)	41 (47.13)	45 (54.88)	8 (9.20)	5 (6.10)
4	12 (50.00)	17 (17.35)	8 (33.33)	35 (35.71)	10 (41.67)	21 (21.43)
Total	44 (20.47)	53 (16.16)	74 (21.86)	131 (39.94)	36 (16.74)	61 (18.60)

* Values in parenthesis indicates percentages

Prevalence of Undernutrition among Nyishi Pre-school Tribal Children

The age and sex-specific prevalence of undernutrition among the Nyishi children is presented in Table 2. The overall prevalence of stunting (38.41% vs.38.94%) and thinness (18.60% vs. 16.74%) was found to be higher among girls than boys (p>0.05), but the prevalence of underweight was higher among boys than girls (20.47% vs.16.16%) (p>0.05). The age specific prevalence of undernutrition is not showing any specific trends among boys and girls but the magnitude of undernutrition was found to be higher among the higher age groups (e.g., 3-4 years). The age and sex specific prevalence of undernutrition suggested that the girls are found to be more susceptible than their male counterparts (p<0.05). The age-and sex specific differences in the prevalence of undernutrition were found to be statistically not significant using chi-square analysis (p>0.05).

Binary Logistic Regression Analysis and Association of Socio-economic and Demographic Variables

The results of BLR model was fitted on the data to estimate the odds of being stunted, underweight and thinness among the children are shown in Table 3. The results indicate that several variables have significant influences in determining whether a child is stunted, underweight or thinness. It is apparent that the odds of female children being stunted and thinness were 1.50 times and 1.25 higher than male children, respectively but found to be 0.62 times significantly lower than boys in underweight (p<0.05). The odds were found to be lower in the early age groups in underweight, stunting and thinness, but a greater odds were also observed among 1 year (1.09 times) and 3 years (1.63 times) in thinness and stunting, respectively. The odds of children belonging to higher birth orders of e”3rd and 2nd were found to have 1.66 times and 1.55 times being underweight and thinness, respectively (p>0.05). For those belonging to large number of dependent (e.g., e”5) families were found to have 2.94 times significantly greater odds for being underweight (p<0.01), but the odds were found to be significantly lower in case of stunting (0.52 times) and thinness (0.30) (p<0.05). The results showed that lower mother and fathers education found to have greater risks for being underweight (1.45 times), stunting (1.21 times) and thinness (1.44 times) respectively (p>0.05), but the odds were also found to be significantly in d”5th standard fathers and mothers education in case of stunting (0.60 times) and thinness (0.50 times), respectively. The children belonging to the ‘no-toilet facility’ found to have 2.04 times (p<0.01) and 1.22 times (p>0.05) times greater risk of thinness and stinting, respectively.

DISCUSSION

Assessment of the undernutrition among children bear great importance in the several developing countries including India, where the majority of the population are undernourished and underprivileged (Nandy *et al*., 2005; Singh *et al*., 2006; Bose *et al*., 2007; Som *et al*., 2007; Mondal and Sen, 2010; Sen and Mondal, 2012; Tigga *et al*., 2015; Debnath *et al*., 2017, 2018). The developing countries are still remain vulnerable in terms of poor access to healthcare, food insecurity, undernutrition, and high prevalence of

TABLE 3

Binary logistic regression analysis and association of sex, age, birth order, dependent children, parents education and toilet facility with the prevalence of undernutrition among Nyishi children

		Weight-for-age			Height-for-age			BMI-for-age		
Variables	Crude odds (B)	Wald	95% CI	Crude odds (B)	Wald	95% CI	Crude odds (B)	Wald	95% CI	
Sex	Boys ®	-	-	-	-	-	-	-	-	-
	Girls	0.62*	3.67	0.37-1.01	1.50*	3.70	0.99-2.23	1.25	0.75	0.76-2.05
Age (in years)	1	0.68	1.19	0.34-1.36	0.79	0.58	0.44-1.44	1.09	0.07	0.58-2.05
	2	0.48	3.41	0.22-1.05	0.93	0.05	0.51-1.70	0.59	2.10	0.28-1.21
	3	0.78	0.57	0.40-1.50	1.63	3.11	0.95-2.82	0.32**	9.07	0.15-0.67
	4 ®	–	–	–	–	–	–	–	–	–
Birth order	1 ®	–	–	–	–	–	–	–	–	–
	2	0.26**	7.79	0.10-0.67	0.92	0.09	0.53-1.61	1.55	1.69	0.80-3.02
	3	1.66	3.35	0.97-2.84	0.71	2.26	0.46-1.11	0.62	2.76	0.35-1.09
Dependentchildren	1-2 ®	–	–	–	–	–	–	–	–	–
	3-4	1.35	1.07	0.76-2.38	1.53	3.57	0.99-2.37	0.61	2.89	0.35-1.08
	5-6	2.94**	10.04	1.51-5.72	0.52*	5.27	0.30-0.91	0.30**	11.23	0.15-0.60
Father's education	≤ 5th standard	0.64	2.78	0.39-1.08	0.60*	5.78	0.41-0.91	1.44	2.09	0.88-2.36
	≤6th standard ®	–	–	–	–	–	–	–	–	–
Mother's education	≤ 5th standard	1.45	1.81	0.84-2.53	1.21	0.76	0.79-1.85	0.50**	6.73	0.31-0.85
	≤ 6th standard ®	–	–	–	–	–	–	–	–	–
Toilet Facility	Yes ®	–	–	–	–	–	–	–	–	–
	No	0.62	3.14	0.37-1.05	1.22	0.88	0.81-1.84	2.04**	7.82	1.24-3.37

®: Reference category; CI: Confidence interval; *p<0.05;**p<0.01

mortality and disease prevalence (Nandy *et al*., 2005; Smith and Haddad, 2015; Akseer *et al*., 2017). Therefore, assessment of nutritional status among nutritionally vulnerable segments of the population become imperative for developing intervention strategies and/or assess the efficacy of ongoing nutritional intervention programme in population. The present study has observed that the overall prevalence of stunting (boys: 21.86%; girls 39.94%) was greater than underweight (boys: 20.47%; girls 16.16%) (Table 2). Mandal *et al*. (2008) reported a greater prevalence of stunting (boys: 48.79%; girls: 50.82%) and underweight (boys: 58.83%; girls 62.52%) in West Bengal. The present study shows that the tribal children are more affected than general caste children (Bose *et al*., 2007; Som *et al*., 2007; Sen and Mondal, 2010; Sen and Mondal, 2012; Debnath *et al*., 2018). The prevalence of stunting and undernutrition were higher among Santal tribal children of West Bengal (17.62% stunting; 33.70% underweight 33.70%) (Chowdhury *et al*., 2008). The higher prevalence of stunting was found like those reported for Kamar children of Chhattisgarh (50.00%) (Mitra *et al*., 2007), Oraons of North Bengal (54.00%) (Mittal and Srivastava, 2006), tribal children of Bihar (54.00%) (Rao and Vijay, 2006). The results of the present study found lower than those reported for tribal children of Madhya Pradesh (stunting 51.60% and underweight 61.60%) (Rao *et al*., 2005), and Rajasthan (stunting 53.00% and undernutrition 60.00%) (Singh *et al*.,2006). A moderate prevalence of overall thinness (boys 16.74%; girls 18.60%) was observed among Nyishi tribal children (Table 1). Several studies have reported that boys were affected than girls in thinness (Chakraborty and Bose, 2009; Bisai and Manna, 2010; Bisai *et al*., 2010; Das and Bose, 2011; Yisak *et al*., 2015; Debnath *et al*., 2018). Several studies have reported a high prevalence of thinness 62.26% in Bengalee (Chakraborty and Bose, 2009), 63.40% in rural children (Mondal and Sen, 2010), 67.23% in Kora-Modi (Bisai *et al*., 2010), 56.40% in Santal Tribe (Das and Bose, 2011), 45.15% in Nepali children (Das and Banik, 2011). The recent study has advocated that undernutrition is better assessed as thinness than wasting (low weight-for-height) (Cole *et al*., 2007). The WHO ('95) proposed the classification for assessing the severity of the public health problems of undernutrition shows a high (>20.0%, in stunting) problem existed among Nyishi tribal children. Therefore, results of the present study have shown that the children are suffering from long-term nutritional deprivation.

Several socio-economic and socio-demographic factors have strong associations with the prevalence of undernutrition among children (Choudhury *et al*. 2000; Bose *et al*., 2007; Som *et al*., 2007; Sen and Mondal, 2010; Sen and Mondal, 2012; Tigga *et al*., 2015; Mondal *et al*., 2016; Sharma *et al*., 2017; Debnath *et al*., 2018). The BLR analysis in the present study showed that girls were 1.50 and 1.25 times more vulnerable than boys in stunting and thinness, respectively (Table 2). Studies have reported that rural girls were more likely to be undernourished than boys (Chowdhury *et al*., 2008; Sen and Mondal, 2010; Debnath *et al*., 2018). Numerous studies have also assumed that there might be gender-related discriminations made in basic amenities, intra-household food (e.g., protein or vitamin reach food such as egg, legumes, root vegetables and fruits) and resource allocation against girls in India (Bose *et al*., 2007; Ramli *et al*., 2009; Mondal and Sen 2010; Sen and Mondal, 2012; Aurino, 2017; Debnath *et al*., 2018; Sharma and Mondal, 2018). The results of the present study further showed that children belonging to lower age-groups (e.g., 1-3 years) had a lower risk odds to be undernourished ($p<0.05$) than the reference category (e.g., 4 years). Several studies have reported that the undernutrition risk was found to be greater in higher age groups in children (Ramli *et al*., 2009; Cheah *et al*., 2010; Mondal and Sen, 2010) Maternal education (such as ≤ 5th standard) also exhibited 1.45 times and 1.21 times greater odds of being underweight and stunting ($p<0.05$). A similar study also reported that illiterate household heads showed greater risks to undernutrition among children (Tigga *et al*., 2015; Debnath *et al*., 2018). It is also clear that children belonging to higher birth orders (e.g., 2nd and ≥ 3rd) had a greater risk of being undernourished ($p<0.01$). Studies had also shown that birth order has a significant effect on children undernutrition (Mondal and Sen, 2010; Sen and Mondal, 2012; Yisak *et al*., 2015; Debnath *et al*., 2018). Several studies have reported that households risk factors such as toilet facilities, household condition, water facility and fuel used for cooking effecting the nutritional status and health condition of children (Panigrahi and Das, 2014; Dinachandra Singh *et al*., 2015; Tigga *et al*., 2015; Rengma *et al*., 2016). The study further showed that the risk of greater underweight and stunting (p>0.05) was observed among children with poor facilities such as 'no-toilet facility'/'no proper sanitation' and belonging to the vulnerable segments of the population such as father's education not exceeding primary level (e.g., ≤ 5th standard). Studies showed that toilet (see Table 3) is one of the important measures of undernutrition (Ramli *et al*., 2009; Panigrahi and Das, 2014).

The existing literature also suggests that the gender differences in the prevalence of undernutrition were more pronounced in poor socio-economic groups with girls being more undernourished than boys (Som*et al*., 2007; Ramli *et al*., 2009; Sen and Mondal, 2010; Correia *et al*., 2014; Menezes *et al*., 2014; Tigga *et al*., 2015; Chatterjee *et al*., 2016; Debnath *et al*., 2018; Sharma and Mondal, 2018). The results of the present study also showed that undernutrition remained a major problem among both tribal children belonging to the lower socio-economic group in India. The significant effects of some other socioeconomic and demographic correlates (that is, birth order, no. of sibs, mothers' and fathers education and toilet facilities) on prevalence of undernutrition among the tribal preschool children can be attributed to the fact that poor access to food and amenities may have significant effect on the nutritional status of the children of growing ages.Therefore, the proper dissemination of knowledge and awareness related to nutritional requirement, improvement of socio-economic conditions, use of nutrient rich food, improvement of feeding practices and healthcare facilities among nutritionally vulnerable segments would be helpful to reduce undernutrition prevailing in poorer section of the society.

CONCLUSION

The results of this study indicate that prolong nutritional deprivation during early childhood existed among the tribal population of northeast India. Several socio-economic and demographic factors of sex, age, birth order, parent's education and absence of toilet facility were found to have a significant effect on the prevalence of undernutrition. It must be mentioned here that due to cross-sectional design, small sample size, lack of information related to the dietary history, resource allocation, cultural practices and disease morbidity related issues and it is difficult to draw a major conclusions and/or identifing the actual cause(s) and effect of such prevalence of undernutrition among Nyishi tribal children. Finally, appropriate intervention programme and strategies are needed to improve and control the prevalence of undernutrition and related risks of mortality and morbidity factors in the tribal population.

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