ITALIAN JOURNAL OF PUBLIC HEALTH

Nutritional status among the Shabar tribal children living in urban, rural and forest habitats of Orissa, India

Suman Chakrabarty, Premananda Bharati

Biological Anthropology Unit, Indian Statistical Institute, Kolkata, India

Correspondence to: Premananda Bharati, Biological Anthropology Unit, Indian Statistical Institute, 203 B.T. Road, Kolkata 700 108, West Bengal, India. E-mail: bharati@isical.ac.in

Abstract

Background: The current trend towards increasing urbanization due to urban migration among the scheduled tribes in developing countries like India should be reflected in differential nutritional outcomes and its associated factors. The aims of the present study are to investigate the nutritional status amongst Shabar children living in urban, rural and forest habitats and factors associated to nutritional state.

Methods: This cross sectional study was conducted among 577 Shabar children (boys and girls) aged 5 to 19 years (258 urban, 195 rural and 124 forest). The anthropometric nutritional indices, socio-economic condition and disease prevalence were used to evaluate the present conditions.

Results: The results revealed that children from forest regions had the highest prevalence of under-nutrition followed by their rural and urban counterparts, 33.87%, 24.62% and 20.16%, respectively. Malaria prevalence in forest areas and economic conditions in rural and urban habitats might have been significantly related to underweight and stunting.

Conclusions: To reduce the prevalence and the extent of under-nutrition, it is essential to improve the economic conditions and to simultaneously carry out measurements for reducing malaria specifically in forest habitats.

Key words: under-nutrition, children, socio-economic factors, tribe, habitats, India

Introduction

Under-nutrition is associated with more than half of all child deaths throughout the World [1]. It is a source of major waste of resources and lost productivity, because children who are undernourished are less productive both physically and intellectually as adults [2]. In developing countries like India, which accounts for about 40 % of undernourished children in the World [3], under-nutrition is largely due to dietary inadequacy in relation to children's needs [4]. In India, many children live in backward and drought-prone rural areas [5], urban slums [6] and those belonging to the socially backward groups like scheduled caste [7] and tribal [8] communities who are highly susceptible to under-nutrition. But conditions are worst among the scheduled tribal communities. Most of the tribal people of India have their own geographically isolated life style. Inadequate food habits, along with traditional socio-cultural and biological activities, may lead to a high proportion of child as well as adult under-nutrition [9 - 11]. In connection with the above, choosing an appropriate nutritional status measure is a complex decision based on objective data collection [12]. To combat this problem, the use of anthropometric measurements is the most common one used because this method is simple and inexpensive compared to other existing methods [13].

The studies on nutritional status of pre-adolescent and adolescent tribal children aged between 5 to 19 years have rarely been carried out at a national level. In 1998-1999, the National Nutrition Monitoring Bureau (NNMB) had extensively studied the nutritional status of tribal adolescent children from nine Indian states mainly from southern India [10]. Maurya and Jaya reported similar poor conditions from multiple tribal children in Bihar [14]. Tribe specific studies also revealed undernourished conditions among Oraon, Santal and Munda communities in Bihar [15]. In the Kalahandi district of Orissa, 89.3 % of Gond children aged between 6-14 years were underweight [9]. A recent study showed that the prevalence of under-nutrition [stunting (17.9%), underweight (33.7%) and wasting (29.4%)] among Santal children of the rural area of Puruliya district of West Bengal was not an exception [16]. The nutritional status of children was affected by school enrollment [17], socio-economic status [18], income constraints [19, 20], type of family etc [10]. The Orissa Health Strategy 2003 has advocated for improving the health status of tribal populations by reducing mortality and morbidity [21]. It indicated that the tribal people

suffer disproportionately from malaria [22].

The majority of the above mentioned studies on tribal communities reported that the scheduled tribes lived in forest and rural areas. However, there is a trend towards increasing urbanization through urban migration among these tribes in India like in other social groups [23]. As a result, they live in different habitations like urban, rural and forest areas.This situation has also been noticed in a single tribal group in India [23]. In view of this wide distribution, it is assumed that the prevalence of under-nutrition and its associates amongst children may vary habitation-wise in a single tribe. Therefore, the aims of the present study are to find out whether there is any variation in nutritional status amongst Shabar tribal children and if so, whether there is an association between it and some selected socio-economic and morbidity traits.

Methods

Study population and area

The Shabar tribe is one of the major scheduled tribe of Orissa [23]. Traditionally, they were a Mundari speaking group of the Austro-Asiatic language family. However, presently they speak regional *Oriya* language. They are distributed in different geographical locations like urban, rural and forest areas in the Khurda and Cuttack districts of Orissa, India [24]. The Sample of the present study was collected from three urban hamlets (Bhubaneswar City), three rural villages (Jatani block area) of the Khurda district and three forest villages located inside Chandaka-Domapara Elephant Sanctuary of the Cuttack district of Orissa.

Data

In Total, 577 children (including boys and girls) aged between 5 to 19 years (258 urban, 195 rural and 124 forest) participated in the present study. Complete enumeration was done during data collection from the nine settlements. No statistical sampling was done because of obvious operational difficulties in the field, for instance, the unavailability and unwillingness of the certain individuals. This study was approved by the ethical committee of the Indian Statistical Institute, Kolkata.

Data collection

The data of the present study was cross sectional in nature, and was collected by the following methods:

Socio-economic: The pre-tested and pre-structured household schedule was used to collect socio-economic information like age, sex, marital status, place of birth, occupation, education, income, sources of income, expenditure, household assets etc. from the head of household or, where absent, from some other elderly member of the household.

Age was recorded through the official anganbadi records or horoscope or in relation to specific festival or to some important local event like natural calamities etc and also cross checked from different sources.

Anthropometry: Anthropometric measurements including height (cm) and weight (kg) were measured following the standard techniques [25]. Height and weight were recorded to the nearest 0·1 cm and 0·5 kg respectively.

Reported morbidity: A structured schedule was used to collect reported morbidity (information about type and occurrence of diseases).

Analytical procedure

Nutritional status: Two nutritional indices such as "weight for age z score" (WAZ), "height for age z score" (HAZ) were calculated using World Health Organization (WHO) standards [26]. On the other hand, "weight for height z score" (WHZ) and Body Mass Index [BMI = weight (kg)/height (m^2)] for age percentile indices were calculated using National Center for Health Statistics (NCHS) standards [27]. Z- Scores <-2 SD of the above indices were considered as underweight (WAZ), stunting (HAZ) and wasting (WHZ). <5^{th} percentile of BMI was considered as under-nutrition. All cut-offs were internationally recommended [28].

Economic classification: Monthly per capita income and expenditure were calculated in terms of rupees (Rs). Percentages of per capita expenditure from income were measured. The percentage values were classified in the following way:

- Economic condition "High" = Per capita total and food expenditure < 80 % from per capita income
- Economic condition "Low" = Per capita total and food expenditure ≥ 80 % from per capita income

The above economic classification based on expenditure groups is certainly arbitrary. It may, however, be noted that the main purpose of such classification is to identify the effect that economic condition may have on under-nutrition in the present population as shown in another population [29].

Statistical analysis

Contingency $\chi 2$ test was used to assess the association between socio-economic condition and morbidity and nutritional status. Step-wise logistic regression was performed to identify the significant factors associated with under-nutrition. All the analyses were done using SPSS 11.0 version and Excel 2000.

Socioeconomic condition of the households

A high illiteracy was observed in all the three

habitats. The majority of children from rural and forest areas studied up to class IV, specifically among the forest group. Higher illiteracy was also observed among females in all the three habitats among adults.

The role of females as earners increased from urban to rural areas and then to forest areas. It was noted that the proportion of non-earner males was higher in urban areas. Sources of earning differed by habitation and sex-wise. The Majority of urban males were engaged as daily wagers and some did Government and Non-Government jobs. Urban females were engaged exclusively in household activities and some in daily labor. Rural males and females were mainly engaged as daily wagers, while forest males and females were engaged in wood cutting and selling.

Cultivable land was higher in forest compared to rural households but forest groups were not able to utilize their land due to protected habitats. Mean per capita income, expenditure and food expenditure was significantly higher in urban households compared to rural and forest households. Highest differences of per capita income, expenditure and food expenditure were found between urban and forest areas, while least differences were noticed between rural and forest areas. Higher per capita food expenditure was noted in the forest and rural households.

It was noted that all the children under study were unmarried.

Results

Table 1 shows habitation-wise nutritional status of children aged between 5 to 19 years based on weight for age, height for age, weight for height and BMI for age anthropometric nutritional indices. The highest prevalence of underweight (33.87%), stunting (45.16%), wasting (12.10%), and under-nutrition of <5th percentile of BMI for age (52.42%) was observed amongst forest children. Out of the four nutritional indices, the prevalence of underweight and wasted children significantly ($p<0.05$) varied between the three habitats. However, least differences in under-nutrition were found between forest and rural children except for the height for age index, where the percentage of stunted children (39.92%) was higher in urban compared to rural children (35.38%).

The highest prevalence of underweight was seen in the forest children in both sexes, even when Habitation area and gender were considered (38.33% of boys and 29.69% of girls) (Figure 1). The prevalence of underweight significantly ($p<0.05$) varied between the habitats in both the sexes. On the other hand, forest Shabar boys suffered from a significantly higher prevalence of stunting ($p<0.05$) (53.33%) (Figure 2). The percentages of stunted girls were more or less equally distributed in all the three habitats, where the highest prevalence was noted in the urban area (41.98%). In the case of under-nutrition, based on less than the 5th percentile of BMI for age, Figure 3 shows that a higher difference of under-nutrition was found among the boys than

Table 1. Habitation-wise nutritional status amongst children aged 5-19 years using reference standards WHO and NCHS.

Nutritional indices	Urban		Rural		Forest		Total	
	n	%	n	%	n	%	n	%
Weigh for age (z-score)£								
Normal and above (≥ -2 SD)	206	79.84	147	75.38	82	66.13	435	75.39
Underweight (<-2 SD)	52	20.16	48	24.62	42	33.87	142	24.61
Total	258	100.00	195	100.00	124	100.00	577	100.00
Chi-square value				8.492*				
Height for age (z-score) £								
Normal and above (≥ -2 SD)	155	60.08	126	64.62	68	54.84	349	60.49
Stunting (<-2SD)	103	39.92	69	35.38	56	45.16	228	39.51
Total	258	100.00	195	100.00	124	100.00	577	100.00
Chi-square value				3.064				
Weight for height (z-score)†								
Normal and above (≥ -2 SD)	246	95.35	178	91.28	109	87.90	533	92.37
Wasted (<-2SD)	12	4.65	17	8.72	15	12.10	44	7.63
Total	258	100.00	195	100.00	124	100.00	577	100.00
Chi-square value				7.090*				
BMI for age†								
Normal and above (≥ 5th percentile)	143	55.43	96	49.23	59	47.58	298	51.65
Under-nutrition (<5th percentile)	115	44.57	99	50.77	65	52.42	279	48.35
Total	258	100.00	195	100.00	124	100.00	577	100.00
Chi-square value				2.753				

* p<0.05; £ Reference standard [26]; † Reference standard NCHS [27]

Figure 1. Sex and habitation-wise prevalence of underweight amongst children aged 5 – 19 year using WHO reference standard [26].

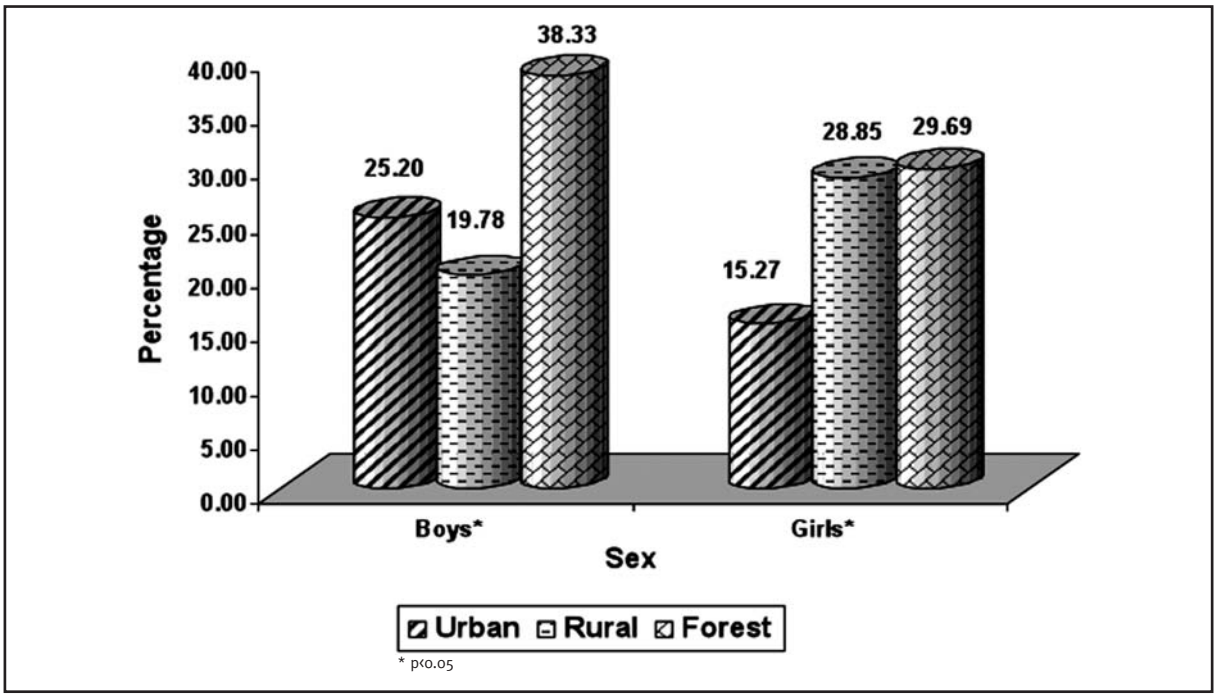
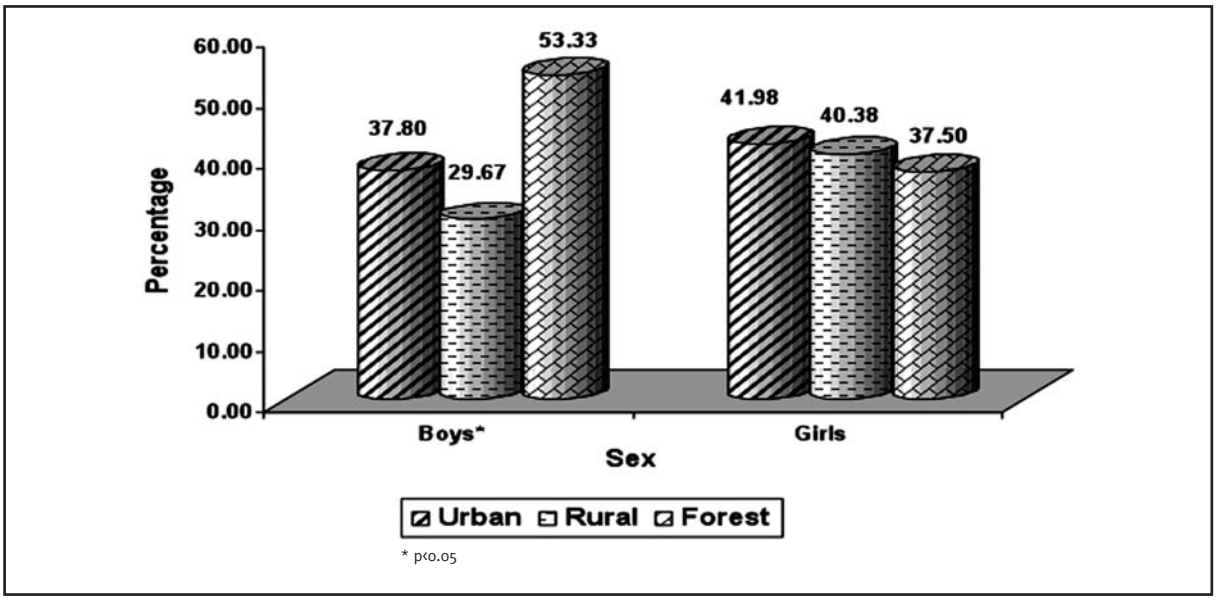


Figure 2. Sex and habitation-wise prevalence of stunting amongst children aged 5 – 19 years using WHO reference standard [26].



girls, where the highest prevalence was noted amongst forest boys (60.00%).

Table 2 illustrates the socio-economic state and morbidity condition of the children studied. It was evident that more than 35% of children from rural and forest areas were dropouts from school. 81.45 % of forest children lived in large families (family member ≥ 6) compared to about 60 % from urban and rural areas. The percentages of overall per capita household expenditure from the income earned increased from urban to rural and to forest habitats. 88.71% of forest children belonged to those households who expend 80 % and above for nutrition followed by rural children (73.85%). More than 50 % of children in all three habitats had suffered from illnesses (cold and cough, skin diseases and diarrhea) in the 15 days prior to survey and the highest percentage of such illnesses was observed in the forest children (59.68%). It was noted that 66.94 % of forest children suffered from malaria compared to only 10.77 % of rural and 5.43 % of urban area children.

The highest prevalence of underweight was noted amongst forest children. Other data for this group showed dropout from school (35.60%), total family members of ≥ 6 (34.70%), illness within

Figure 3. Sex and habitation-wise prevalence of under-nutrition (<5th percentile of BMI for age) amongst children aged 5 – 19 years using NCHS reference standard [27].

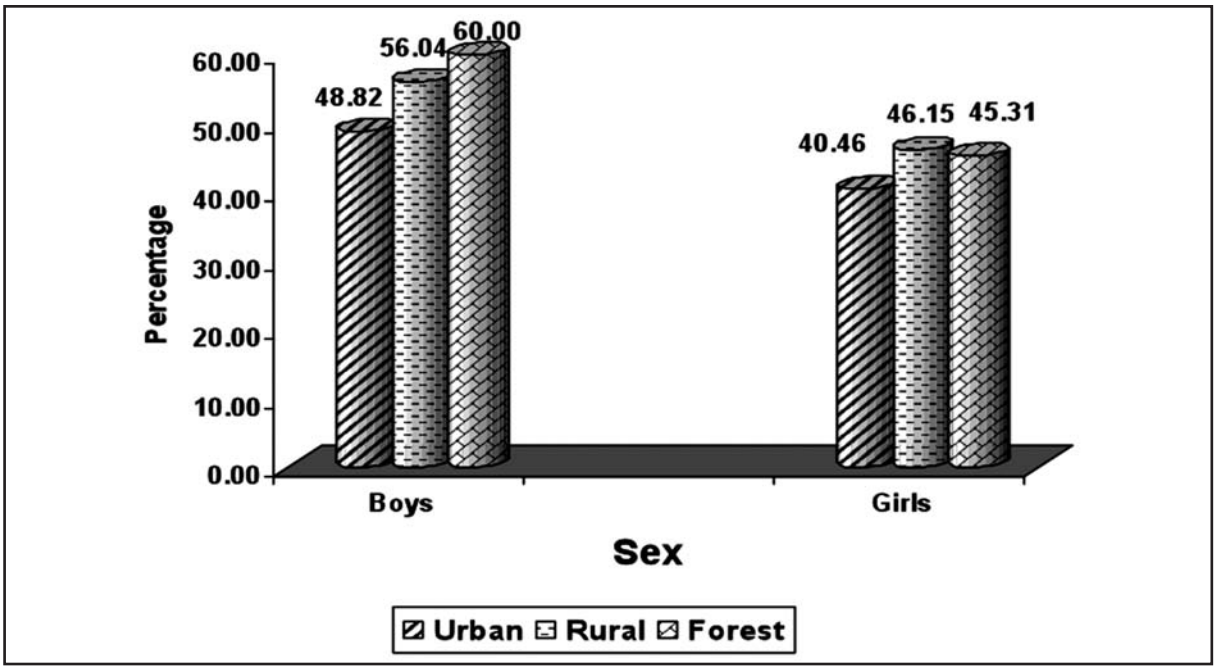


Table 2. Summary variables of socio-economic and health condition amongst studied children.

Variable	Urban		Rural		Forest	
	n	%	n	%	n	%
Drop out from school						
No	207	80.23	120	61.54	79	63.71
Yes	51	19.77	75	38.46	45	36.29
Family member						
≤ 5	98	37.98	75	38.46	23	18.55
≥ 6	160	62.02	120	61.54	101	81.45
Expenditure group						
<80% from income	116	44.96	51	26.15	14	11.29
≥80% from income	142	55.04	144	73.85	110	88.71
Illness within 15 days prior to survey						
No	119	46.12	90	46.15	50	40.32
Yes	139	53.88	105	53.85	74	59.68
Malaria						
No	244	94.57	174	89.23	41	33.06
Yes	14	5.43	21	10.77	83	66.94

15 days prior to survey (35.10%) and affected by malaria within 3 months prior to survey (44.60%), respectively (Table 3). Out of these factors, underweight children significantly ($p<0.01$) varied only for malaria prevalence in the forest area. A similar significant relationship ($p<0.05$) was found amongst rural children between underweight and malaria prevalence. Besides these, a significantly ($p<0.01$) higher prevalence of underweight was found among the rural children (30.00%), who expended "80 % and above of household expenditure" on nutrition. On the other hand, the highest prevalence of stunting was also observed amongst forest children, who have a dropout rate from school of 60.00%, and the percentages for other factors were as follows; total family members of ≥ 6 (47.50%), expenditure group "80 % and above" (45.50%), illness within 15 days prior to survey (40.00%) and affected by malaria within 3 months prior to survey (47.00%), respectively. Out of these factors, stunted children significantly varied due to dropout from school in all the three habitats. A similar association was observed between expenditure group and stunted children in the rural area as shown in the case of underweight prevalence i.e. significantly ($p<0.05$) higher prevalence of underweight was found among the rural children (39.60%), who belonged to the " 80 % and above" household expenditure group.

Table 3. Factors associated with underweight amongst children aged 5-19 years.

Variables	Under-nutrition condition					
	Prevalence of underweight			Prevalence of stunting		
	Urban	Rural	Forest	Urban	Rural	Forest
Drop out from school						
No	39 (18.80)	27 (22.50)	26 (32.90)	73 (35.30)**	35 (29.20)*	39 (36.70)*
Yes	13 (25.50)	21 (28.00)	16 (35.60)	30 (58.80)	34 (45.30)	27 (60.00)
Family member						
≤ 5	21 (21.40)	20 (26.70)	7 (30.40)	34 (34.70)	33 (44.00)	8 (34.80)
≥ 6	31 (19.40)	28 (23.30)	35 (34.70)	69 (43.10)	36 (30.00)	48 (47.50)
Expenditure group						
<80% from income	21 (18.10)	4 (7.80)**	7 (50.00)	46 (39.70)	12 (23.50)*	6 (42.90)
≥80% from income	31 (21.80)	44 (30.60)	35 (31.80)	57 (40.10)	57 (39.60)	50 (45.50)
Illness within 15 days prior to survey						
No	24 (20.20)	17 (18.90)	16 (32.00)	53 (44.50)	28 (31.10)	26 (52.00)
Yes	28 (20.10)	31 (29.50)	26 (35.10)	50 (36.00)	41 (39.00)	30 (40.50)
Malaria						
No	50 (20.50)	39 (22.40)*	5 (12.50)**	37 (39.80)	60 (34.50)	17 (41.50)
Yes	2 (14.30)	9 (42.90)	37 (44.60)	6 (42.90)	9 (42.90)	39 (47.00)

Figures in parenthesis show percentages; *p<0.05; ** p<0.01

Step-wise logistic regression analysis (Table 4) also confirmed the results, where the rural children were more likely to be underweight in the ≥ 80% per capita expenditure of income group (OR = 5.170, p<0.01). The forest children were more likely to be underweight in the malaria exposed group (OR = 5.791, p<0.01). In the case of stunting, children from all the habitats were more likely to be stunted in the dropout from school group, where the highest odds ratio value (2.622) was found amongst urban children followed by forest children (2.586).

Discussion

It is evident from the present study that there was significant variation in under-nutrition prevalence amongst children from a single tribal community (Shabar) based on whether they lived in urban, rural and forest areas. Analysis of the various anthropometric nutritional indices amongst children aged between 5 to 19 years from three different habitats (urban, rural and forest) of Orissa revealed that the highest prevalence of underweight, stunted, wasted and under-nutrition, based on less than 5th percentile of BMI, was observed among forest children. However, the prevalence of underweight among the Gond tribal children of Kalahandi district of Orissa (89.30%) was higher compared to the studied Shabar children of all the three habitats [9]. The recent study shows the prevalence of under-nutrition [stunting (17.9%), underweight (33.7%) and wasting (29.4%)] seen among Santal children of rural areas of the Puruliya district of West Bengal was no exception [16] though much lower stunting prevalence and higher wasting prevalence was seen there compared to children from the present study. Least differences in under-nutrition were observed between forest and rural children, which may be due to lesser differences between their way of living compared to the urban group. The prevalence of under-nutrition was higher among boys compared to girls in forest areas. The National Nutrition Monitoring Bureau (NNMB) also reported a higher prevalence of under-nutrition in boys (63%) compared to girls (42%) among tribal children from nine states in southern India [10].

Higher percentage of school dropout and low economic status (expenditure group ≥ 80% from income) was found in both the forest and rural areas compared to their urban counterparts. The major reasons for school dropout also varied habitation-wise. Urban children dropped out from school mainly due to their unwillingness to study as well as a lack of interest shown by their family members whereas, the reasons for rural and forest children were based more on financial aspects as well as the unavailability of higher secondary schools in those areas. When questions were asked regarding the reason for school dropout specifically to the forest children, the major reason was lack of communication facilities and fear of free-living elephants inside the forest. While ill health (cold and cough, skin diseases and diarrhea) was common to all the habitats in the 15 days prior to survey, the prevalence of malaria was significantly different between the children of all three habitats. In India, the tribal community is estimated to be 8.2%, some 25 % of whom are affected by malaria [30]. The association of underweight and stunting with socio-economic and health traits revealed that malaria prevalence may have an impact on child underweight and that dropout from school may have influenced child stunting in forest areas. The relationship between malarial prevalence and

Table 4. Stepwise logistic regression analyses of factors related to underweight and stunted children aged 5-19 years.

Habitation and Step	Variables	OR	95 % confidence interval	
			Lower	Upper
	Underweight			
Urban				
	---	---	---	---
Rural				
1	Expenditure group			
	≥80% from income	5.170**	1.754	15.232
	<80% from income®			
Forest				
1	Malaria			
	Yes	5.791**	2.066	16.233
	No®			
	Stunted			
Urban				
1	Drop out from school			
	Yes	2.622**	1.402	4.905
	No®			
Rural				
1	Drop out from school			
	Yes	2.014*	1.104	3.675
	No®			
2	Drop out from school			
	Yes	2.041*	1.110	3.750
	No®			
	Family member			
	≥ 6	0.537*	0.292	0.988
	≤ 5®			
Forest				
1	Drop out from school			
	Yes	2.586*	1.220	5.484
	No®			

® Reference group; *p<0.05; ** p<0.01

underweight is complex because malaria often results in under-nutrition and also increases ill health. Despite this, the unavailability of foods due to protected forest habitats may be one of the causes for under-nutrition among forest group. In the case of rural children, economic inequalities might have played a significant role in increasing the prevalence of underweight children and dropout rates from school may have influenced child stunting. Dropout from school might have had the highest influence on child stunting in the urban area too. Nandy et al. also suggested that economic inequalities may determine childhood underweight and stunting, a result found amongst present rural children [31]. Caulfield et al. argued that the prevalence malaria may be associated with underweight rather than economic inequalities a trend mirrored by the present forest children [32]. Though drop out from school was a common factor for stunting in all the three habitats, there was no direct relationship between them, as rightly advocated by Fentiman et al. [17] i.e. if parents have low education, whether children go to school is less important, because children primarily need to earn money. Conversely, less education is strongly associated with low economic status and vice-versa.

Conclusions

Therefore, it is not only necessary to improve economic conditions, but the prevention of malaria in forest habitats is also important in order to eradicate child under-nutrition amongst the Shabar tribe when formulating nutritional intervention strategies for the population as a whole. However, it is imperative to mention that the possibilities to improve food sustainability and protection from malaria may not be easy in forest areas compared to urban and rural habitats, which, in this particular case, may be due to the protection of forests as an elephant sanctuary.

Such micro level population based studies in anthropological research highlight local problems specifically associated with Indian tribes who are undergoing rapid change in their livelihood.

References

1) Pelletier DL, Frongillo Jr EA, Schroeder DG, Habicht JP. The effects of malnutrition on child mortality in developing countries. Bull World Health Organ 1995; 73: 443 -8.
2) Gillespie S, Haddad L. Attacking the Double Burden of Malnutrition in Asia and the Pacific. Malina: Asian Development Bank and International Food Policy Research Institute, 2001.
3) James LF. India-Sector Review of Nutrition Programmes. A background paper prepared for the World Bank. New Delhi, 1998.
4) National Institute of Nutrition. Dietary guidelines for Indians - A manual. Hyderabad : National Institute of Nutrition, 2003.
5) Vijayaraghavan K, Brahmam GNV, Venkaiah K, Rao MK, Arlappa N. Diet and Nutrition Situation in Drought Affected Areas of Rajasthan. Hyderabad : National Institute of Nutrition, 2003.
6) Ghosh S, Shah D. Nutritional problem in urban slum children. Indian Pediatr 2004; 41: 682- 96.
7) Uppal M, Kumari K, Sidhu S. Clinical assessment of health and nutritional status of scheduled caste preschool children of Amritsar. Anthropol 2005; 7: 169-71.
8) National Nutrition Monitoring Bureau. Diet and Nutritional Status of Tribal Population Repeat Survey. Hyderabad : National Institute of Nutrition, 2000.
9) Balgir RS, Kerketta AS, Murmu B, Dash BP. Clinical assessment of health and nutritional status of Gond children in Kalahandi district of Orissa. Indian J Nutr Diet 2002; 39: 31-7.
10) Rao KM, Laxmaiah A, Venkaiah K, Brahmam GN. Diet and nutritional status of adolescent tribal population in nine states of India. Asia Pac J Clin Nutr 2006; 15: 64-71.
11) Banik SD. Health and nutritional status of three adult male populations of Eastern India: an anthropometric appraisal. Ital J Public Health 2009; 6: 294–302.
12) Patterson RE, Pietinen P. Assessment of nutritional status in individuals and populations. In: Gibney MJ, Margetts BM, Kearney JM, L. Arab, editors. Public Health Nutrition. Oxford: Blackwell Publishing Ltd, 2004: 66 - 82.
13) Food and Agriculture Organization (FAO). Sixth World Food Survey. Rome: Food and Agriculture Organization, 1996.
14) Maurya SP, Jaya N. Prevalence of malnutrition among tribal children. Indian J Nutr Diet 1997; 34: 214 - 20.
15) Rao TVRK, Vijay T. Malnutrition and anemia in tribal pediatric population of Purnia district (Bihar). Indian Pediatr 2006; 43: 181 - 2.
16) Chowdhury SD, Chakraborty T, Ghosh T. Prevalence of undernutrition in Santal children of Puruliya district, West Bengal. Indian Pediatr 2008; 45:43 - 6.
17) Fentiman A, Hall A, Bundy D. Health and cultural factors associated with enrolment in basic education: a study in rural Ghana. Soc Sci Med 2001; 52: 429 - 39.
18) Doan RM, Popkin BM. Women's work and infant care in the Philippines. Soc Sci Med 1993; 36: 297 - 304.
19) Leslie J. Women work and child nutrition in the third world. In: Leslie J, Paolisso M, editors. Women Work and Child Welfare in the Third World. Colorado: Westview Press, 1989.
20) Engle PL. Care and Child Nutrition. New York : UNICEF, 1992.
21) Health and Family Welfare Department. Orissa Vision 2010: A Health Strategy- Orissa State Integrated Health Policy. Strategies and Action Points. Government of Orissa, 2003.
22) Chhotray GP. Health status of primitive tribes of Orissa. ICMR Bull 2003; 33: 40-7.
23) Census of India. Census of India 2001: Final Population Totals. Registrar General and Census Commissioner. India. New Delhi : Controller of Publications, 2001.
24) Patnaik T. Shabar. In: Tribes of Orissa. Scheduled Castes and Scheduled Tribes Research and Training Institute. Cuttack: Bhubaneswar, Orissa Government Press 2004: 285 – 90.
25) Weiner JS, Lourie JA. Practical Human Biology. Oxford: Blackwell Scientific Publications, 1981.
26) World Health Organization (WHO). Child Growth Standards. Geneva: WHO, 2000.
27) Frisancho AR. Anthropometric Standards for Assessment of Growth and Nutritional Status. Michigan: The University of Michigan Press, 1990.
28) World Health Organization (WHO). Physical status. The use and interpretation of anthropometry. WHO Technical Report No. 854. Geneva: WHO, 1995.
29) Bharati P. A Study on the Relationship between Socioeconomic Condition, Nutrition, and Health in a Mahishya Population Sample. Thesis submitted at University of Calcutta. (Unpublished), 1983.
30) Nayak AN, Babu BV. Tribal Health Problems: an anthropological appraisal. Man in India 2003; 83: 301 - 3.
31) Nandy S, Irving M, Gordon D, Subramanian SV, Smith GD. Poverty, child undernutrition and morbidity: New evidence from India. Bull World Health Organ 2005; 83: 210 - 6.
32) Caulfield LE, Richard SA, Black RE. Undernutrition as an underlying cause of malaria morbidity and mortality in children less than five years old. Am J Trop Med Hyg 2004; 7: 55 - 63.