Prevalence of double burden of malnutrition among urban school going Bodo children aged 5-11 years of Assam, Northeast India

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ABSTRACT

BACKGROUND: Overweight, obesity and thinness are major important anthropometric determinants of adverse public health issues, which lead to the development of several preventable non-communicable disease and ill-health conditions.

AIMS AND OBJECTIVES: The objectives of the present study were to assess the prevalence and certain socioeconomic and demographic factors affecting the double burden of malnutrition among urban children of Assam, Northeast India.

MATERIALS AND METHODS: The present cross-sectional study was undertaken among 1017 (528 boys; 489 girls) the tribal Bodo children aged 5-11 years of Udalguri district of Assam, Northeast India by using the stratified random sampling method. Height and weight were obtained using standard anthropometric procedures and Body Mass Index (BMI=weight/height^2, kg/m^2) was calculated. The prevalence of thinness, overweight and obesity was assessed by using recently proposed age-sex specific BMI based international classification/reference of Cole et al.

RESULTS: The overall prevalence of overweight (boys 13.45%; girls 11.04%) was found to be slightly greater than obesity (boys 11.93%; girls 10.02%). The result showed that 11.93% and 11.04% were suffering from thinness among boys and girls, respectively. Binary logistic regression analysis showed that the odds were found to be significantly associated with ≤ 10th standard mothers' education, 1st earning head and Rupees <10000 income households ($p < 0.05$) for thinness. Similarly, greater risks were observed in 5-6 years, 7-9 years, ≥7 household members and a lower association with ≤ 10th standard mothers' education for being overweight-obesity ($p < 0.05$).

CONCLUSION: The emergence of overweight-obesity with greater degree of thinness, hence the prevalence of 'double burden of malnutrition' in this population. Appropriate nutritional intervention programmes, dissemination of nutrition related awareness among parents and community level are necessary to reduce the future possibility of double malnutrition burden among other ethnic populations of India.

Key words: Anthropometry, Malnutrition, Public Health, Child Health Status, Nutrition Assessment, Obesity, Thinness

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DOI: ***10.2427/11497***
Accepted on November 12, 2015

DISCLAIMERS: Authors have no conflict of interests.

INTRODUCTION

Obesity is an important determinant of adverse public health issue which increases the relative health risks of non-communicable diseases and related mortalities and morbidities in a population [1]. Currently, India is undergoing a rapid socioeconomic, demographic and epidemiological transition and evidences have shown a decrease in the prevalence of undernutrition with simultaneous acceleration of overweight-obesity incidences in urban regions [2-3]. Recent trends have suggested that the double burden of malnutrition is becoming increasingly apparent in addition to the increasing burden of non-communicable diseases affecting the populations of the middle income countries such as China, Egypt, India, Mexico, Philippines and South-Africa [4-5]. A significant proportion of Indian children residing in urban regions were markedly affected by overweight-obesity [2,6-10]. Several investigations have already demonstrated that the prevalence of undernutrition has still remained a significant public health issue and a vast proportion of the population belong to the underprivileged and undernourished segments in India [11-17]. The anthropometric measures have played a pivotal role to determine the magnitude of malnutrition [11-13,15]. Body mass index (BMI= weight/ height kg/m^2) is widely used as a surrogate anthropometric measure for assessment of thinness and overweight-obesity in children [1,18]. Very recently, new international references for pre-adults have been proposed to determine the prevalence of thinness [19] and overweight-obesity [20].

Recent trends have shown that children are less likely to suffer from undernutrition [2,17], but the prevalence of overweight and obesity have been accelerating among those residing in urban and sub-urban regions in India [6-10]. Nevertheless, the urban advantages have been fading in the last decades, since the significant changes in the diet and lifestyles of urban dwellers has resulted in rapid processes of industrialization, urbanization and globalization, spreading the development of overweight and obesity in other areas [2,8,17,21]. There is growing recognition of the emergence of the "double burden" of malnutrition, with the subsequent occurrence of both under- and over-nutrition among populations [17,22,23,24]. The higher socioeconomic status, education, demographic factors and lifestyle modification have revealed a greater risk of being overweight-obese [1,2,9,10]. Studies have already confirmed that several socioeconomic and demographic factors have played a significant role in the prevalence of undernutrition among Indian children [2,8,13,15,23,25,26]. Moreover, increasing prevalence of childhood overweight-obesity is now considered to be a serious public health concern with the simultaneous existence of undernutrition and the prevalence of obesity becoming increasingly apparent in urban affluent Indian children [2,8,9,17]. However, the current trends have also shown that the individuals belonging to the lower socioeconomic setting have increased prevalence of overweight and obesity [22,24].

Therefore, the coexistence in children of 'double burden' of malnutrition representing opposite sides of the energy balance equation presents a unique difficulty for public health policy and interventions. The present study was undertaken to investigate the importance and close associations of several socio-demographic, socioeconomic factors which lead to the development of such nutritional manifestation in Bodo children. Moreover, the assessment of nutritional status among children belonging to the nutritionally vulnerable segments of the developing countries should be emphasized, not only for the nutritional risk identification, but also to implement an intervention programme for the improvement of the overall health condition. Therefore, the objective of the present study were, thus, to assess the prevalence and association of certain socioeconomic and demographic factors affecting the double burden of malnutrition (both overweight-obesity and thinness) among Bodo children residing in the urban and sub-urban regions of Assam, Northeast India. Moreover, such exploration is needed to understand the specific causes of the dual burden of malnutrition condition and to implement appropriate policy recommendations in different ethnic populations.

MATERIALS AND METHODS

Subjects and study area

The present cross-sectional study was conducted among 1017 (528 boys; 489 girls) school going indigenous Bodo children aged 5-11 years of Udalguri district (26O46'N 92O08'E to 27O77N 95O15E) of Assam, Northeast-India, by using a stratified random sampling method. Ethnically, the indigenous Bodo tribal population shows affinity with the Mongoloid group, speaking a language belonging to the the Tibeto-Burman linguistic family group. A total of 10 Government primary schools (1st to 5th standard) situated in study area were covered. These schools were selected due to identical subject strengths, easy-accessibility and homogeneity of the subjects. The minimum number of subjects required for reliably estimating the prevalence malnutrition was calculated following the standard sample size estimation method procedures [27]. Where, the anticipated population proportion of 50% to ascertain the general level of accuracy, absolute precision of 5% and confidence interval of 95% are taken into consideration. The children were initially grouped into Bodo tribal and non-Bodo tribal or non- tribal populations. The subjects were identified based on the surnames, physical and cultural features and also verified from the official documents and school records. However, the subjects were selected and approached irrespective of minimal sample size collection, classes and sections of the each selected school under this studied region. Special care was taken so that each category (sex/age) had a minimum of 60 children. The age of the children was recorded from school records and subsequently verified from birth certificates and relevant official documents. The data were collected during the period of November 2011 to October 2012. To avoid the necessary subject selection bias, all the subjects were free from any physical deformities, nutritional deficiencies and previous surgical episodes were examined and included prior to the collection of anthropometric and socioeconomic data by the investigators, while individuals with those characteristics among children were excluded. The study was conducted in accordance with the ethical guidelines of human experiments as laid down in the Helsinki Declaration [28].

Socioeconomic and Demographic data collection

The pre-structured interview schedule was used to obtain necessary information on sex, age, family detail, number of sibs, child birth order, father and mother education, occupation, number of earning heads and monthly household income. The data were collected from the subjects through personal interview by visiting schools and households visit by interviewing with either of the parents. In order to elicit valid responses ample care was taken while briefing the questions to the respondents at the time of investigation. The socioeconomic status (SES) was evaluated using a modified version of the scale of Kuppuswamy [29]. This scale allows determination of SES based on a score calculated from education, occupation and monthly family income status of the children, which has a combination of social and economic scale. Based on the above-mentioned scale, the children belonged to lower to middle income SES groups.

Anthropometric measurements recorded

The anthropometric measurements of height and weight were obtained using standard procedures (30). Height was measured with the subject standing erect on a plain surface and head was oriented in the Frankfort horizontal plane from floor to vertex using anthropometer, nearest to 0.1 cm. The weight was measured wearing minimum cloth and bare footed with the help of a portable digital weight machine nearest to 0.1 kg. The technical error measurement ($TEM=\sqrt{(\Sigma D^2/2N)}$, D=difference between the measurements, N=number of individuals measured) was calculated using the standard method to determine the accuracy of the anthropometric measurements [31]. The co-efficient of reliability (R) was subsequently calculated using TEM by the following equation: $R= \{1-(TEM)^2/SD^2\}$, SD= standard deviation of the measurements. A total of 50 children was measured both by the authors (BB and NM) and the intra-observer and inter-observer TEM were observed to be within the cut-off values (R=0.95) [31]. Hence, the recorded anthropometric measurements by BB and NM in the present investigation were considered to be reliable and reproducible. All the anthropometric measurements in the course of the present study were subsequently recorded by one of the authors (BB). The subject covered under this present study was also measured with ample precision to avoid any possible systematic errors in the process of anthropometric data collection [32].

Assessment of Nutritional Status

The prevalence of thinness, overweight and obesity was assessed by comparing the age-sex specific proposed international reference and cut-offs of Cole et al. [19-20]. These newly proposed references are suggested to encourage direct comparison of childhood thinness and overweight-obesity that provide a classification for the worldwide public health purposes [19-20].

Statistical Analysis

Statistical analyses were done using the Statistical Package for Social Science (SPSS, version 17.0). The independent sample t-test was used to assess sex-differences in the anthropometric variables. One way analysis of variance (ANOVA) was also done to assess the mean differences among the ages in both sexes. The 2×2 chi-square analysis (χ^2) was utilized to assess differences between age- and sex-specific prevalence of thinness, overweight and obesity. The Yates correction term was also taken into consideration. This correction terms adds to the accuracy of the χ^2 analysis determinants when the number of cases are small (<5 cases). Binary logistic regression (BLR) analysis was fitted to estimate the crude odds ratios (ORs) and 95% confidence intervals (CIs) associated with thinness and overweight-obesity, separately. The BLR analysis allows the creation of categorical depended variables and the odds were obtained by comparing with the reference category. To create dichotomous dependent variables, thinness vs. normal and overweight-obesity vs. non-overweight-obesity were coded as '1' and normal was coded as '0' in separate regression models respectively. The predictor variables of sex (boys; girls), age (5-6 years; 7-9 years; 10-11 years), family size (≤4; 5-6; 7≥), number of sibs (0-1; 2; ≥3), child birth order (1;2; ≥3) father and mother education (≤10 standard; ≥11 standard), occupation (cultivator; service/ business), number of earning heads (1; ≥2), income (Rupees.10000; >Rupees.10000) were entered as dummy variables and results were obtained by comparing with reference categories, separately. The p-value of <0.05 and <0.01 was considered to be statistically significant.

RESULTS

The minimum sample size estimated for each sex was 384 and, therefore the selected sample size was found to be greater than the estimated minimum sample size for both sexes (N=768). Finally, a total of 1206 subjects belonging to the indigenous Bodo tribal population was identified and approached. A total of 134 (76 boys; 58 girls) was excluded due to inappropriate or absence of reliable age records, and 55 (32 boys; 23 girls) declined to participate. Therefore, the final sample consisted of 1017 (528 boys; 489 girls) children belonging to the age group 5-11 years, with the overall (participation rate = 94.78%, which was appreciably higher that the estimated sample size. Age-sex specific subject distribution, mean and standard deviation of height, weight, BMI and prevalence of thinness, overweight and obesity among Bodo tribal children are presented in Table 1. Age-specific mean height and weight increased with age in both sexes, but the only exception was observed in 11 years (boys). However, age-specific mean BMI did not show any age related trends. The mean BMI was ranged from 16.47 kg/m^2 (in 8 years) to 18.60 kg/m^2 (in 5 years) and 16.67 kg/m^2(in 7 years) to 17.93 kg/m^2 (in 5 years) among boys and girls, respectively. The sex differences in anthropometric variables of height (t=0.18. d.f., 1015), weight (t=1.23. d.f., 1015) and BMI (t=1.50. d.f., 1015) was observed not to be statistically significant using independent sample t-test analysis (p>0.05). However, the age-specific differences were found to be statistically significant in height (F-value: 92.90; d.f., 6, 527), weight (F-value: 32.33; d.f., 6, 527) and BMI (F-value: 3.61; d.f., 6, 527) among boys and height (F-value: 36.57; d.f., 6, 488) and weight (F-value: 84.06; d.f., 6, 488) in girls utilizing ANOVA analysis (p<0.01) (Table 1).

Prevalence of thinness, overweight and obesity

The overall prevalence of thinness was found to be 11.93% and 11.04% among boys and girls, respectively, using the international classification [19] (Table 1). The overall prevalence of mild thinness (11.72% vs. 14.52%) and moderate thinness (0.83% vs. 2.07%) was found to be higher among boys than girls, but severe thinness (4.60% vs. 4.14%) was found to be higher among girls than boys (p>0.05). Age

TABLE 1

AGE-SEX SPECIFIC SUBJECT, DESCRIPTIVE STATISTICS (MEAN ±SD) OF ANTHROPOMETRIC VARIABLES AND PREVALENCE OF THINNESS, OVERWEIGHT AND OBESITY AMONG CHILDREN OF ASSAM, NORTHEAST INDIA

AGE/SEX CATEGORY		SUBJECTS (N)	HEIGHT (CM)	WEIGHT (KG)	BMI (KG/M²)	THINNESS (LOW BMI-FOR-AGE)†	OVERWEIGHT††	OBESITY††
5 YEARS	Boys	63	108.79±7.02	21.87 ±3.68	18.60±3.39	2 (3.17)	09 (14.29)	21 (33.33)
	Girls	61	109.44±8.43	21.34 ±4.30	17.93±3.62	2 (3.28)	06 (9.84)	17 (27.87)
6 YEARS	Boys	81	114.12±8.12	22.57 ±4.40	17.49±3.79	14 (4.93)	10 (12.35)	21 (25.93)
	Girls	73	112.17±7.66	21.96 ±4.14	17.63±3.91	4 (5.48)	07 (9.59)	18 (24.66)
7 YEARS	Boys	66	117.46±6.58	23.92 ±5.22	17.32±3.38	6 (16.67)	11 (16.67)	09 (13.64)
	Girls	67	117.17±7.80	23.31 ±5.55	16.67±3.68	11 (16.42)	06 (8.96)	08 (11.94)
8 YEARS	Boys	81	122.41±8.35	24.66 ±5.12	16.47±3.05	14 (14.81)	09 (11.11)	05 (6.17)
	Girls	66	121.33±7.88	24.65 ±5.08	16.76±3.13	12 (18.19)	11 (16.67)	05 (7.58)
9 YEARS	Boys	105	126.24±6.79	27.98 ±4.47	17.67±3.37	8 (5.71)	19 (18.10)	05 (4.76)
	Girls	86	125.29±7.68	26.28 ±3.71	16.75±1.87	6 (6.98)	09 (10.47)	01 (1.16)
10 YEARS	Boys	72	131.79±5.16	29.07 ±5.08	16.67±2.26	11 (15.28)	04 (5.56)	00 (0.00)
	Girls	71	130.02±7.99	28.92 ±5.15	17.06±2.29	11(15.49)	09 (12.68)	00 (0.00)
11 YEARS	Boys	60	128.14±7.26	29.51 ±4.56	18.10±3.69	8 (13.33)	09 (15.00)	02 (3.33)
	Girls	65	132.35±6.45	30.25 ±4.25	17.31±2.40	8 (12.30)	06 (9.23)	00 (0.00)
F-VALUE‡/ TOTAL	Boys	528	92.90**	32.33**	3.61**	63 (11.93)	71 (13.45)	63 (11.93)
	Girls	489	84.06**	36.57**	1.69*	54 (11.04)	54 (11.04)	49 (10.02)

*p>0.05, **p<0.01; Values are in parentheses indicates percentages, ‡ ANOVA value between ages, † Cole et al.(19); †† Cole et al.(20)

and sex-specific prevalence of mild thinness was found to be higher among 11 years (11.67%) and 10 years (14.08%) among boys and girls, respectively. The sex difference in prevalence of thinness grades was found to be statistically not significant using χ^2-analysis ($p>0.05$). The overall prevalence of overweight (12.29%) was found slightly greater than obesity (11.01%). The sex-specific prevalence of overweight (13.45% vs. 11.04%) and obesity (11.93% vs. 10.02%) was found to be higher among boys than girls ($p>0.05$), using the proposed international classification of Cole (20) (Table 1). The proposed references and cut-offs of thinness, overweight and obesity assessment grade were found to be similar to proposed cut-offs of adult chronic energy deficiency (BMI<18.50 kg/m²), overweight (BMI ≥25.00 kg/m2) and obesity (BMI ≥30.00 kg/m²), respectively [18]. Age-specific prevalence of overweight was higher among 9 years (18.10%) and among 8 years (16.67%) among boys and girls respectively. The age-specific prevalence of obesity was higher among 5 years in boys (33.33%) and girls (27.87%) ($p>0.05$). Prevalence of obesity and overweight did not show any age related trends, but the prevalence was found to be significantly higher among children belonging to earlier age groups. The age-specific sex difference in the prevalence of overweight and obesity was found statistically not significant using χ^2 analysis ($p>0.05$).

Binary logistic regression analysis and socioeconomic and demographic factors associated with the prevalence of thinness and overweight-obesity

The results of the BLR analysis, estimation of odds ratios (ORs) and 95%CIs with socioeconomic and demographic variables and with the prevalence of thinness and overweight-obesity among Bodo children are presented in Table 2. The odds are found to be greater in boys, ≥5-6 family size, ≥2 sibs, 2nd and >3rd birth order, ≤ 10th standard further education for being thin ($p>0.05$). The children belonging to 1st earning head family and ≤ Rupees. 10000 family income found to have significantly 2.56

times (p<0.01) and 1.57 times (p<0.05) greater risk factor for thinness, respectively. The odds were found significantly higher (1.78 times) for ≤ 10th standard mother education and found lower (0.52 times) for 7-9 years aged group for being thin (p<0.05). A significant 2.46 times and 5.12 times greater odds values were observed in children being overweight-obesity aged 5-6 years and 7-9 years, respectively (p<0.01). A significantly lower risk (0.541 times) of overweight were observed in lower mother education (≤ 10^{th} standard education) (p<0.05). The large number of family size (≥7) had significantly lower risk (1.62 times) for being overweight (p<0.05). The results showed greater risk in boys, 2 sibs (1.15 times), 1 earning head (1.10 times) and 'cultivator' father's occupation (1.22 times) categories. However, this greater risk for being overweight in children was found to be statistically not significant (p>0.05).

DISCUSSION

Several developing countries are currently undergoing rapid socioeconomic, demographic transition, which leads to the acceleration of preventable, non-communicable diseases and higher prevalence of overweight-obesity and slightly lower prevalence of undernutrition in

TABLE 2

BINARY LOGISTIC REGRESSION ANALYSIS AND SOCIOECONOMIC AND DEMOGRAPHIC FACTORS ASSOCIATION WITH THE PREVALENCE OF THINNESS AND OVERWEIGHT-OBESITY AMONG CHILDREN

VARIABLES		THINNESS				OVERWEIGHT-OBESITY			
		B	WALD	S.E.	CRUDE ODDS (95% CI)	B	WALD	S.E.	CRUDE ODDS (95% CI)
SEX	BOYS	0.087	0.197	0.197	1.09 (0.74- 1.61)	0.243	2.64	0.149	1.28 (0.95- 1.71)
	GIRLS ®	-	-	-	1	-	-	-	1
AGE (YEARS)	5-6	-0.471	3.21	0.263	0.62 (0.37-1.05)	0.898	28.83	0.167	2.46** (1.77- 3.41)
	7-9	-0.654	5.339	0.283	0.52* (0.30-0.91)	1.633	50.64	0.229	5.12** (3.26- 8.02)
	10-11 ®	-	-	-	1	-	-	-	1
FAMILY SIZE	≤ 4 ®	-	-	-	1	-	-	-	1
	5-6	0.251	1.053	0.245	1.29 (0.80-2.08)	0.279	2.67	0.171	1.32 (0.95- 1.85)
	≥ 7	0.122	0.246	0.246	1.13 (0.70-1.83)	0.480	6.24	0.192	1.62* (1.10- 2.36)
SIBS	0-1 ®	-	-	-	1	-	-		1
	2	0.145	0.511	0.284	1.49 (0.85- 2.59)	0.139	0.671	0.169	1.15 (0.82- 1.60)
	≥ 3	0.395	1.941	0.303	1.28 (0.71- 2.33)	-0.244	1.23	0.220	0.78 (0.51- 1.21)
BIRTH ORDER	1 ®	-	-	-	1	-	-	-	1
	2	0.032	0.019	0.248	1.38 (0.85- 2.25)	-0.115	0.469	0.168	0.891 (0.64- 1.24)
	≥ 3	0.322	1.676	0.262	1.34 (0.80- 2.23)	-0.103	0.277	0.196	0.90 (0.64- 1.32)
FATHER EDUCATION	≤ 10	0.213	0.942	0.219	1.24 (0.81- 1.90)	0.149	0.89	0.158	1.16 (0.85- 1.58)
	≥ 11 ®	-	-	-	1	-	-	-	1
MOTHER EDUCATION	≤ 10	0.569	4.30	0.274	1.78* (1.0.3- 3.03)	-0.614	4.745	0.282	0.541* (0.31- 0.94)
	≥ 11 ®	-	-		1	-	-	-	1
FATHER OCCUPATION	CULTIVATOR	0.039	0.032	0.218	1.04 (0.68- 1.60)	0.196	1.498	0.160	1.22 (0.89- 1.68)
	SERVICE/ BUSINESS ®	-	-	-	1	-	-	-	1
EARNING HEADS	1	0.939	5.47	0.401	2.56** (1.17-5.62)	0.095	0.195	0.216	1.10 (0.72- 1.68)
	≥ 2 ®	-	-	-	1	-	-	-	1
INCOME (RUPEES)	RUPEES. 10000	0.448	4.773	0.205	1.57* (1.05- 2.34)	-0.209	1.979	0.149	0.81 (0.61- 1.09)
	› RUPEES. 10000 ®	-	-	-	1	-	-	-	1

® Reference category, *p<0.05, **p<0.01

populations [8,17,22]. The current nutritional trends showed that undernutrition is the predominant form of malnutrition, but a significant acceleration has been reported in overweight-obesity prevalence among higher socioeconomic groups among Indian children [2,3,7,8,10,17]. Several socioeconomic, socio-demographic and sedentary lifestyle changes are considered to have a crucial role to ascertain the impact of overweight-obesity, because the problems are emerging at a time when the prevalence of undernutrition remains a significant public health issue in India [2,3,17,24]. The present study demonstrated that the prevalence of overweight (12.29%) was found slightly greater than obesity (11.01%) (Table 1). Recent studies have reported that overweight-obesity has increased in Indian children of Delhi (22.00%)[8], Punjab (14.31%)[7], Andhra Pradesh (7.22%)[9] and Pune (19.9%)[6]. Such acceleration in overweight-obesity prevalence in the population could be attributed to favourable environmental condition, rapid urbanization, changes in dietary patterns and sedentary lifestyle factors [2,8,17,21]. Therefore, childhood overweight-obesity could be a challenge for the healthcare providers and certainly contribute to the related mortality and morbidity in the foreseeable future.

Despite of significant economic development in the developing countries, the prevalence of undernutrition still remains an important public health problem, that continues to be a major cause of ill-health conditions, premature mortalities and morbidities among Indian children [3,13,15,17,24,33]. Several studies have already reported the magnitude of the thinness prevalence using this newly proposed thinness reference [19] among Indian children [16,34-37]. The present study showed a moderate prevalence of overall thinness among the Bodo school going children (boys: 11.93%; girls: 11.04%; $p>0.05$). Several studies have reported that boys were more affected by thinness than girls among children [14,16,35,36]. The prevalence of thinness was found higher among Bengalee (62.26%)[34], rural children (63.40%)[35], Kora-Mudi tribe (67.23%) [36] and Santal tribe (56.40%)[37]. Therefore, the problem of thinness is persistent transversely among different Indian ethnic populations with variable proportions, which leads to the delay of physical growth, poor cognitive development and affected the linear mechanism of growth processes, especially among children [14,16,35-37]. The greater risks of undernutrition were reported with the advancement of age among Indian children [13,14,35,36]. The results of BLR analysis showed that children belonging to the lower ages (e.g., 7-9 years) observed to have significantly lower odds (0.52 times) than higher (10-11 years) ($p<0.05$). The results also showed that boys had a significantly greater risk (1.09 times) for being thin than girls ($p>0.05$). Studies have already reported that the odds for thinness were found to be greater among boys than girls in India [14,35,37]. In the present study, the odds for thinness was found to be significantly 1.57 times greater risk among children belonging to lower household income households (<Rupees.10000). Similar studies have already reported that the children belonging to lower income households were found to have a greater risk of undernutrition [12-14,15]. In the present study, the medium (5-6 individuals) and large family size (≥7 individuals) found to have greater risks of being undernourished ($p>0.05$). Mondal and Sen [13] have reported that the children and adolescents belonging to larger family size (≥7 number) had a greater risk for undernutrition (e.g., stunting). Similarly, children belonging to larger sibling category (e.g., 2 numbers) had 1.49 times greater risks of being thin among Bodo children ($p>0.05$). A similar study has reported that the children of higher birth order (e.g., ≥3rd) had significantly 2.50 folds higher risk of undernutrition than those born with lower birth orders [38]. It is possible that the socioeconomic burden on poor families with several children have led mothers to give less attention to their younger children, whose nutritional status suffered as a consequence [13]. The higher birth orders (e.g., 2nd and ≥3rd) had greater odds of being affected by thinness ($p>0.05$).

The overweight-obesity incidences have been changed radically in the past two decades as obesity rates have tripled in the developing countries [17,39]. There are substantial evidences suggested that socioeconomic, demographic, diet and increasing sedentary lifestyle and subsequent decrease in physical activity changes have triggered such prevalence in populations [2,9,17]. In the present study, the risk of overweight-obesity was found to be greater among children in higher household income groups (Rupees.>10000). Moreover, studies have already reported that the double burden of malnutrition in India was more likely to occur in high inequality states [17,23]. The nutrition transition describes the process in which major shifts in patterns of diet and physical activities occurred over time, although the stages and speed of transitions vary by country [3,22,39]. Therefore, the existence of 'double burden' of malnutrition may be due to improvement of socioeconomic status, the population experience the major nutritional transition at varying rates, as some may have insufficient resources to meet their children's calorie requirements, while others have more than enough resources to meet these requirements in Indian children. The present study showed that boys were found to have 1.28 times greater risk than girls in being overweight-obesity than girls ($p>0.05$). A large population based investigation has suggested that boys were found to significantly more overweight-obese than girls [8,25,40]. This could be attributed to the cultural differences, where the gender preferences may play an important role so that there is a preference for male child over daughters [13-15]. This may result as greater access to the resources, food allocation and a lower work load and physical activity among boys than girls with a consequent higher prevalence of overweight-obesity. The risk of overweight-obesity prevalence was found significantly greater in early age groups of 5-6 years (2.46 times) and 7-9 years (5.12 times) ($p<0.01$). Several studies have already confirmed that age has a significant effect on the prevalence of overweight-obesity [8,25]. The results showed that children belonging to the large family size (e.g., ≥7 individuals) and lower mothers' education (e.g., ≥10th standards) found to have significantly 1.78 times and 0.54 times greater and lower risk factor of being sufferer from overweight-obesity, respectively ($p<0.05$). Fernald and Neufeld [41] reported that large household size and lower maternal education were significantly associated with concurrent overweight in Mexican children ($p<0.05$).

It must be mentioned here that the poor education level and relatively less information about the adequate nutrition, food and dietary habits may lead to cause the improper or faulty feeding practices in children. Furthermore, it must be mentioned here that due to the cross-sectional design of the present study, lack of information on food and dietary consumption, diet diversification, physical activity measurement, resource allocation, cultural practices and disease prevalence it is difficult to draw a major conclusion and/or identify the actual cause(s) of double burden of malnutrition. It is already a well established fact that these unobserved effects of exogenous variables definitely could have a positive role to influence such nutritional manifestations in the populations.

CONCLUSION

The results of the present study have clearly shown that the prevalence of overweight and obesity has reached a relatively greater level among children residing in urban, sub-urban regions and higher income groups. The rapid increase, particularly the vulnerable segments of lower to middle socioeconomic groups in urban and sub-urban regions, thus calls upon for an urgent action of intervention. The persistence of undernutrition (e.g., thinness) coupled with an increasing prevalence of overweight and obesity among the tribal Bodo children residing in the urban settings in India and may also be indicative of poor prioritisation and commitment to the nutrition and public health issues in populations. This nutritional dichotomy has a result of inequitable accessibility to nutritional and other allied and related resources. Hence, appropriate nutritional intervention programmes are required to improve the nutritional status among children. Several socioeconomic and demographic variables significantly influenced the prevalence of thinness, overweight and obesity and sex, age, mothers' education, number of earning heads and household income were identified to be an important socioeconomic and demographic determinant variable. Moreover, the dissemination of nutrition related knowledge and awareness among parents and community levels could be helpful to reduce the future possibility of childhood overweight-obesity incidences and related consequences of mortalities and morbidities among populations.

ACKNOWLEDGEMENTS: The authors gratefully acknowledged the help and co-operation of the school authorities and local governing authorities, participants and their parents during the investigation. The extended help of Department of Anthropology, Assam University: Diphu Campus is also being acknowledged.

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