Low height-for-age among Limbu and Mech children and adolescents from two districts of West Bengal, India

Sudip Datta Banik[1], Paramita Bhattacharjee[2], Barun Mukhopadhyay[3]

(1) Department of Human Ecology, Cinvestav-Merida, Yucatan, Mexico.
(2) Former Ph.D. scholar, Department of Anthropology, Vidyasagar University. Midnapore, West Bengal, India.
(3) Biological Anthropology Unit. Indian Statistical Institute. Kolkata, West Bengal, India.

CORRESPONDING AUTHOR: *Sudip Datta Banik, Department of Human Ecology, Centro de Investigación y de Estudios Avanzados del IPN (Cinvestav-IPN) - Carretera Antigua a Progreso Km 6, C.P. 97310. Merida, Yucatan, Mexico – email: dattabanik@cinvestav.mx; sdbanik@hotmail.com*

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ABSTRACT

Background: Low height-for-age (stunting) is a state of chronic undernutrition in children and adolescents. Studies reported that India has very high prevalence of stunting in children, particularly from rural and tribal communities. Objective of the present study was to record prevalence of stunting in 6 to 18 year-old boys and girls from two tribal communities (Limbu and Mech) in Darjeeling and Alipurduar districts of West Bengal, India. The study also aimed to compare height-for-age of the participants with WHO growth reference curves of the similar age range for boys and girls.
Methods: In this cross-sectional study, the sample comprises 1523 individuals of both sexes from Limbu (377 boys, 379 girls) and Mech (365 boys, 402 girls) communities. Height data was normalised using LMS.
Results: Overall frequency of stunting among 6 to 18 year-old boys (33%) and girls (34.7%) was remarkably high. Prevalence of stunting was higher in Limbu boys (43.5%) and girls (44.6%) than their age-peers from Mech community (boys 22.2%, girls 25.4%). Height data after normalisation shows that all centile curves of height of Limbu and Mech boys and girls are consistently below the height-for-age reference curves of WHO. Limbu and Mech children appear to be taller with respect to their median (50th percentile) height when compared with the median height of children in the dataset of Indian Council of Medical Research.
Conclusions: High frequency stunting in Mech and Limbu children was recorded and situation of girls was worse. There was a tendency of decline in prevalence of stunting with advancement of age among children.

Keywords: Stunting, children, adolescents, LMS

INTRODUCTION

Child growth and nutritional status are important public health indicators for communities and countries. Stunting or growth failure as a chronic malnutrition in children and adolescents is defined by low height-for-age Z-score (HAZ) i.e. less than minus two standard deviations (SD) from median height-for-age of the reference

population [1, 2]. High prevalence of stunting among children and adolescents in India is one of the major concerns of the scientists and policy makers. In India, studies reported remarkable rate of stunting among children and adolescents. A study on nutritional status of 534 adolescents aged 12 to 18 years in rural north India reported high rate of stunting. Prevalence of stunting was 37.2% among girls and 41.0% among boys and overall prevalence rate was 38% [3]. A report from 116 school going adolescents (aged 10-19 years) of Periurban area of Wardha, Pune from western province of India shows poor nutritional status of adolescents including 34.5% stunting where boys are found to be suffering more (72.5%) than girls (27.5%) [4]. From eastern India, studies among children and adolescents reported high degree stunting [5, 6, 7, 8, 9, 10, 11]. Other studies from Aligarh, north India [12], Gujarat, western India [13] and Andhra Pradesh from South India [14] also reported high prevalence of stunting in children and adolescents.

According to the 2011 census of India, more than 84 million tribal people comprise 8.6% of the total population [15]. A vast majority of tribal populations are socioeconomically disadvantaged compared to other populations. A study [16] observed nutritional status of 309 Kamar tribal children (161 boys and 148 girls) aged 4 to 12 years of Chattishgarh State in India. The study revealed that around 84% boys and 47% girls were stunted. Studies among children and adolescents from tribal communities also reported high prevalence of stunting from eastern and north-eastern India [17, 18, 19, 20, 21]. However, compared to the studies carried out in the communities living in urban and rural areas of India, reports from underprivileged sections of the society especially the tribal communities are relatively less.

Mere reporting the rate of stunting in children from any particular community or region perhaps is not enough unless height-for-age data are compared with WHO growth reference curves. A country's development can be gauged by monitoring child growth and nutrition and comparing the results with growth reference such as those of the World Health Organization [2] and Centers for Disease Control and Prevention (CDC) [22]. It is convenient smoothing and normalising cross-sectional growth and nutrition data from a specific population, before comparing with any reference curves like WHO. Mathematical methods such as LMS [23] are useful in normalising empirical and asymmetrical data such as anthropometric measurements. Normalising centile curves of variables allow growth trend interpretation along with child and adolescent nutritional status evaluation [24, 25, 26, 27, 28, 29]. The LMS method summarises a variable distribution using curves representing the skewness (L), median (M), and coefficient of variation (S) with a Box-Cox Power Exponential [28]. Studies have been done building child growth and nutrition databases and comparing them with growth charts in Argentina [30], Australia [31], Bahrain [32], Japan [33], Kuwait [34], and the United Arab Emirates [35]. No study of this kind has yet been done representing any population in India. However, growth reference curves based on data from rural children are available [36].

In view of the above facts, the objectives of the present study are:

a. to study height-for-age of 6 to 18 year-old children and adolescents from two relatively less studied tribal communities - Limbu and Mech in the eastern Himalayan and Sub-Himalayan regions of the state of West Bengal, India;
b. to compare rate of low height-for-age (stunting) by age, sex and community in the sample;
c. to compare height-for-age of children and adolescents of the present study with growth reference curves representing samples from Indian (ICMR) and international (WHO) levels.

METHODS

The participants

The present study is descriptive cross-sectional in nature that was done between June 2010 and September 2012 among 6 to 18 year-old children and adolescents from two tribal communities: Limbu and Mech. The study area comprised selected villages from two districts of the state of West Bengal, India: Darjeeling and Alipurduar. Darjeeling is the northernmost district of the state of West Bengal. Siliguri is one of the sub-divisional towns of Darjeeling district and the doorway to the north-eastern Indian states and Nepal. Alipurduar has been announced to be the new and 20th district of the state of West Bengal (June 2014). Previously Alipurduar was one of the sub-divisional towns of Jalpaiguri district. The populations of Limbu and Mech are mostly concentrated in these districts.

The Limbu people mostly reside in hilly regions as well as *'Terai'* (Sub-Himalayan grassland) of Darjeeling and *'Dooars'* (foothills) areas of Jalpaiguri and Alipurduar districts. The Mech people mostly reside in the plains and *'Terai'* areas of Darjeeling and *'Dooars'* regions in Jalpaiguri and Alipurduar districts. The Limbus are indigenous people of the hill and mountain regions of east Nepal between *Arun* and *Mechi* rivers and they also came from as far as Tibet, Bhutan and Sikkim. They mainly live in Nepal. Some inhabit in Sikkim and a part of the Limbu population is scattered through Darjeeling, Kurseong, Kalimpong and Siliguri in West Bengal. The Mech population mostly resides in West Bengal and some parts of Assam State. Both Limbu and Mech mainly practice settled agriculture. Relatively poor Mech villagers also prepare country liquor and some of them are engaged mostly in menial service and petty business. In contrast, a

large section of the Limbus works in the army and in other government sectors. They are also engaged in business and work in non-government agencies too.

Sampling design

Census 2011 data [15] of 6 to 18 year old children and adolescents of these two communities were unavailable separately. Selection of study villages was done considering Census 2011 data following random sampling technique. From each selected village, households having children aged 6 to 18 years were identified. Thus, the sample represented 6 to 18 year-old boys and girls of Limbu and Mech communities from randomly selected villages in Darjeeling and Alipurduar districts of West Bengal. The principal selection criterion of the participants was being either Limbu or Mech as checked and verified from the official documents issued by the Government in favour of their identities as Scheduled Tribe (ST).

The study region consisted of 102 Limbu and 28 Mech settlements (villages and hamlets) in Darjeeling district, and 31 villages (Limbu and Mech people living side by side) in Alipurduar district of West Bengal. The Limbu villages, mostly located in Darjeeling hills were relatively smaller in size (with respect to the number of households) compared to the Mech villages. Fieldwork was done in Darjeeling district where Limbu settlements were found in several regions of Darjeeling, Kalimpong, Kurseong and Siliguri. The Mech settlements were found in Siliguri Sub-division, near Naxalbari-Kharibari, Bagdogra and Matigara regions. In Alipurduar district, selected Limbu and Mech settlements were found in Madarihat-Birpara and Falakata blocks (the block is an administrative division).

Number of children from two communities was different by village. However, when we considered the study region as a whole (both districts), individuals showed proportionately equal representation (50%) of Limbu and Mech communities. Using the formula for estimating size in simple random sampling [37] and assuming an approximate population size of 4000 boys and girls between 6 and 18 years in Darjeeling and Jalpaiguri districts (Alipurduar district did not exist at that time) and also assuming a confidence interval (CI) level of 99% and a limit for the estimation error of 0.05, a sample size of n was obtained. In this way, sample size of 1140 individuals was obtained with distribution by sex (boys 49%, girls 51%).

In addition, based on the earlier studies [8, 9] reporting prevalence of stunting among children and adolescents from Darjeeling district, the sample size was also calculated for further precision. Since there was no data from Limbu and Mech communities, approximate values of the prevalence of stunting in children and adolescents from the district were considered. Again, before conducting fieldwork for the present study, height was measured of randomly selected Limbu and Mech children and adolescents from the study regions (Darjeeling and Jalpaiguri districts) taking 20 by sex and age group (below and above 10 years), a total of 80 participants. Based on the results from the earlier reports and the analysis of the data from 80 participants, frequency of stunting (low height-for-age) was calculated. Rate of stunting in children and adolescents was high for age groups: below 10 years (boys 42%, girls 28%) and above 10 years of age (boys 36%, girls 34%). The results were different by age and sex as reported in earlier studies [8, 9]. Therefore, considering 95% CI level and relative precision of 15%, the sample size estimated was 1310 children and adolescents (boys 539, girls 770).

The sample size included additional 10% that is commonly considered to prevent the loss of some data (absence or disagreement of participants to take part in the survey, measurement errors and consequent elimination of data). After addition of 10% to the estimated size, the final sample size was 1441. During fieldwork, in different villages, children who had shown their interest to take part in the program voluntarily were also included. Eventually the sample size of the present study consists of 6 to 18 year-old 1523 participants (Table 1) including:

Limbu (756 individuals): 377 boys, 379 girls

Mech (767 individuals): 365 boys, 402 girls

Distribution of the participants by sex also coincided with the sampling procedure based on population size (boys 49%, girls 51%). The participants represented randomly selected 1447 households from Limbu (718) and Mech (729) communities. In the present study, age groups were taken at every two-year interval in below 10 years and every three-year interval among the boys and girls above 10 years of age [38, 39]. However, in the present study, early adolescent age range was little wider (10 to 15 years) than that reported earlier by UNICEF [38, 39] and was divided into two age groups of equal size (10 to 12 years and 13 to 15 years), considering the importance of puberty. However, maturity related data were not available in the present study.

Anthropometric measurements

The participants were apparently healthy, were not suffering from any chronic diseases within three months before study and did not have any physical handicap. Age of the participants was documented from official records including birth registration certificate and immunisation card. Anthropometric measurements were recorded following standard international protocols [40, 41]. In this study, height (cm, to nearest 0.1 cm) was measured using a standard Martin anthropometer. Measurements were taken by one of the co-authors (PB). Technical errors of measurements (TEMs) were found to be within reference values [42]. Test-retest reliability was

TABLE 1. Distribution of 6 to 18 year-old boys and girls (n = 1523) by age groups and community.

AGE GROUPS (YEARS)	LIMBU		MECH	
	BOYS	GIRLS	BOYS	GIRLS
6 to 7	63	59	64	64
8 to 9	65	64	53	58
10 to 12	105	93	97	95
13 to 15	76	83	86	106
16 to 18	68	80	65	79
Total	377	379	365	402

computed using intra-class correlation coefficients (ICC, repeated measures) with 95% CI [43]; in all cases ICC values were > 0.85 [44]. Based on standard cut-off values of Z-scores of height-for-age, stunting or low height-for-age was defined as < −2SD of HAZ (Z-score for height-for-age). Children and adolescents were grouped into stunted (low height-for-age) and non-stunted based on the HAZ [2, 45]. Height-for-age Z-scores (HAZ) were calculated using the WHO Anthro and WHO AnthroPlus software (WHO, 2006, 2007).

Ethical consideration

Ethical clearance was obtained from the appropriate institutional committee before commencement of the study (see acknowledgement). Written as well as verbal informed consent was obtained from the community leaders, the respective chief of the *Panchayat* (a local statutory body) and also from the parents and guardians of the children. Verbal assent was taken from the participants before recording the measurements. Participant names were replaced by folio numbers. After data collection and analysis, participants' parents/caregivers were given a basic report on their child's nutritional status.

Normalisation of anthropometric data and comparison with growth reference data

Normalisation of anthropometric data of height of the participants was done to compare the data with WHO growth reference data [2, 46]. The LMS methodology [26, 28] was applied to normalise height-for-age in boys and girls. The LMS Chartmaker Pro (Version 2.4; Tim Cole and Huiqi Pan, copyright 1997–2008, Medical Research Council, UK) software package was used to process data. Outliers in the LMS data plots were eliminated by visual scrutiny. Centiles in terms of age and sex-specific cubic spline curves were estimated. To produce a model with the best possible fit, estimation was done with maximum penalised likelihood beginning from initial values (L=3, M=5, S=3 equivalent degree of freedom or edf with original age). The edf values L=2, M=3, and S=2 were selected with rescaled age to attain significant change in deviance (D) values and also to improve the fitting of L, M, and S curves. Maximum possible data smoothing was reached when the Z-score and Q-Q Plot (Worm Plot) distributions ceased to exhibit unrealistic outliers. The estimated percentiles for the height data were exported to a Microsoft© Excel spreadsheet to generate graphs and those were compared with the corresponding WHO growth reference data by age and sex [2]. Comparisons were done using anthropometric values at mid-year age in the WHO growth reference [2, 45, 46] for height. The normalised data of height of children and adolescents by age and sex were also compared with median height of the growth reference data of the Indian Council of Medical Research [36]. Student's t-test was used to find significant difference of mean values between sex and between two communities. Odds ratio and Chi-square test with Yates' correction were run to observe the degree of difference of frequency of stunting in boys and girls from two communities by age groups. All statistical analyses were done using the SPSS (Version 13.00, Chicago IL, USA) program. All analyses were run using a 5% significance level (α= 0.05).

RESULTS

Descriptive statistics of height by age group, sex and community is presented in Table 2. Height increment between 6 and 18 years of age in boys and girls is observed as usual pattern. Highest standard deviation (SD) value is recorded in the age group 10 to 12 years. Mech boys and girls are found to be taller than their Limbu age-peers with significant difference ($p< 0.05$) at below 9 years and also at 16-18 years of age. Table 3 shows mean and SD of height-for-age Z-scores (HAZ) of Limbu and Mech boys and girls. No significant sex difference is observed in mean values of HAZ of participants from either community. However, difference of mean values of

TABLE 2. Descriptive statistics of height (cm) in Limbu and Mech children and adolescents.

AGE GROUP (YEARS)	LIMBU (BOYS)		LIMBU (GIRLS)		SEX DIFFERENCE (LIMBU)	MECH (BOYS)		MECH (GIRLS)		SEX DIFFERENCE (MECH)	MEAN DIFFERENCE BY COMMUNITY (BOYS)	MEAN DIFFERENCE BY COMMUNITY (GIRLS)
	Mean	SD	Mean	SD	t-value	Mean	SD	Mean	SD	t-value	t-value	t-value
6 to 7	108.17	6.43	107.68	7.25	0.40	115.48	7.41	113.31	6.57	1.75	-5.93*	-4.52*
8 to 9	120.26	7.82	119.91	7.56	0.26	123.10	6.88	123.61	6.45	-0.40	-2.07*	-2.89*
10 to 12	133.46	10.66	134.95	8.90	-1.07	138.05	10.30	137.07	8.32	0.72	-3.11*	-1.68
13 to 15	153.49	8.27	148.64	6.19	4.21*	155.25	10.37	149.77	6.16	4.54*	-1.19	-1.25
16 to 18	159.04	5.85	149.27	4.50	11.47*	164.34	8.96	153.04	5.66	9.20*	-4.06*	-4.66*

*SD: Standard deviation; * p< 0.05*

TABLE 3. Descriptive statistics of height-for-age Z-score (HAZ) in Limbu and Mech children.

AGE GROUP (YEARS)	LIMBU (BOYS)		LIMBU (GIRLS)		SEX DIFFERENCE (LIMBU)	MECH (BOYS)		MECH (GIRLS)		SEX DIFFERENCE (MECH)	MEAN DIFFERENCE BY COMMUNITY (BOYS)	MEAN DIFFERENCE BY COMMUNITY (GIRLS)
	Mean	SD	Mean	SD	t-value	Mean	SD	Mean	SD	t-value	t-value	t-value
6 to 7	-2.38	±1.21	-2.05	±1.14	-1.54	-1.00	±1.34	-1.06	±1.10	0.23	-6.08**	-4.93**
8 to 9	-1.97	±1.17	-1.99	±1.08	0.09	-1.48	±1.03	-1.30	±0.90	-1.00	-2.38*	-3.83**
10 to 12	-1.79	±1.25	-1.96	±1.05	1.03	-1.24	±1.09	-1.59	±1.00	2.27	-3.30**	-2.50*
13 to 15	-1.33	±0.95	-1.73	±0.99	2.58*	-1.13	±1.22	-1.52	±0.91	2.51	-1.13	-1.51
16 to 18	-1.94	±0.79	-1.95	±0.72	0.12	-1.26	±1.29	-1.37	±0.88	0.59	-3.67**	-4.58**

*SD: Standard deviation; * p< 0.05*

HAZ is observed between Limbu and Mech communities in all age groups except at 13 to 15 years. A general trend of decline of mean HAZ is observed in either sex of Limbu and Mech children with their advancement of age. The results also indicate that Limbu children of either sex seem to be more stunted (low height-for-age) than Mech age-peers with significant difference (p< 0.05) except at 13 to 15 years.

Prevalence of stunting (low height-for-age) in children and adolescents was higher in Limbu boys and girls than their Mech age-peers (Table 4). In general, there is a declining trend of the frequency of stunting is observed from the age group 6 to 7 years to 16 to 18 years. However, in Limbu children and adolescents, a very high prevalence of stunting (≥ 40%) is recorded in the age group of 16 to 18 years. From the results it is observed that Limbu boys and girls are suffering from higher degree of undernutrition in terms of low height-for-age compared to their age-peers from Mech community. Odds ratio with 95% confidence intervals and Chi-square test values of the prevalence of stunting by age groups are presented in Table 4. Higher frequency of stunting in girls than boys with significant difference (p< 0.05) was observed in the age group 13 to 15 years among Limbus and in the age group 10 to 12 years among Mech participants.

After normalisation of data on height using LMS methods in boys and girls of the present study are compared with WHO growth reference data for the similar age (WHO, 2007). The results show 50th centile curve (median) of height of the Limbu and Mech boys and girls are consistently below the reference median height-for-age curves of WHO. The graphs showing distribution of 5th to 95th centile curves are available from the corresponding author. The height-for-age curves of Limbu boys and girls at 5th, 25th, 50th, 85th and 95th percentiles are also below height-for-age curves of their Mech age-peers. The height-for-age centile curves for the boys and girls at 95th percentile are even below the 85th percentile curve of WHO. It appears that height-for-age as a growth and nutritional status indicator of the boys and girls of

TABLE 4. Prevalence of stunting (low height-for-age) among Limbu and Mech children and adolescents.

AGE GROUP (YEARS)	LIMBU				MECH			
	Boys (%)	Girls (%)	Odds ratio (95% CI)#	Chi-square test with Yates' correction (p-value)	Boys (%)	Girls (%)	Odds ratio (95% CI)	Chi-square test with Yates' correction (p-value)
6 to 7	60.30	57.30	1.13 (0.64 – 1.98)	0.08 (0.78)	21.90	20.30	1.13 (0.57 – 2.22)	0.03 (0.86)
8 to 9	53.80	46.90	1.32 (0.76 – 2.30)	0.72 (0.40)	32.10	20.70	1.77 (0.93 – 3.35)	2.57 (0.11)
10 to 12	42.90	49.50	0.75 (0.43 – 1.32)	0.72 (0.40)	22.70	36.80	0.51 (0.27 – 0.94)	4.02 (0.04)*
13 to 15	19.70	32.50	0.51 (0.27 – 0.97)	3.70 (0.05)*	20.90	24.50	0.80 (0.41 – 1.54)	0.25 (0.62)
16 to 18	45.60	40.00	1.27 (0.73 – 2.24)	0.51 (0.48)	15.40	20.30	0.71 (0.34 – 1.47)	0.55 (0.46)

*# CI: Confidence intervals; * p< 0.05*

either community does not reach the global standard of WHO (Figures 1 and 2).

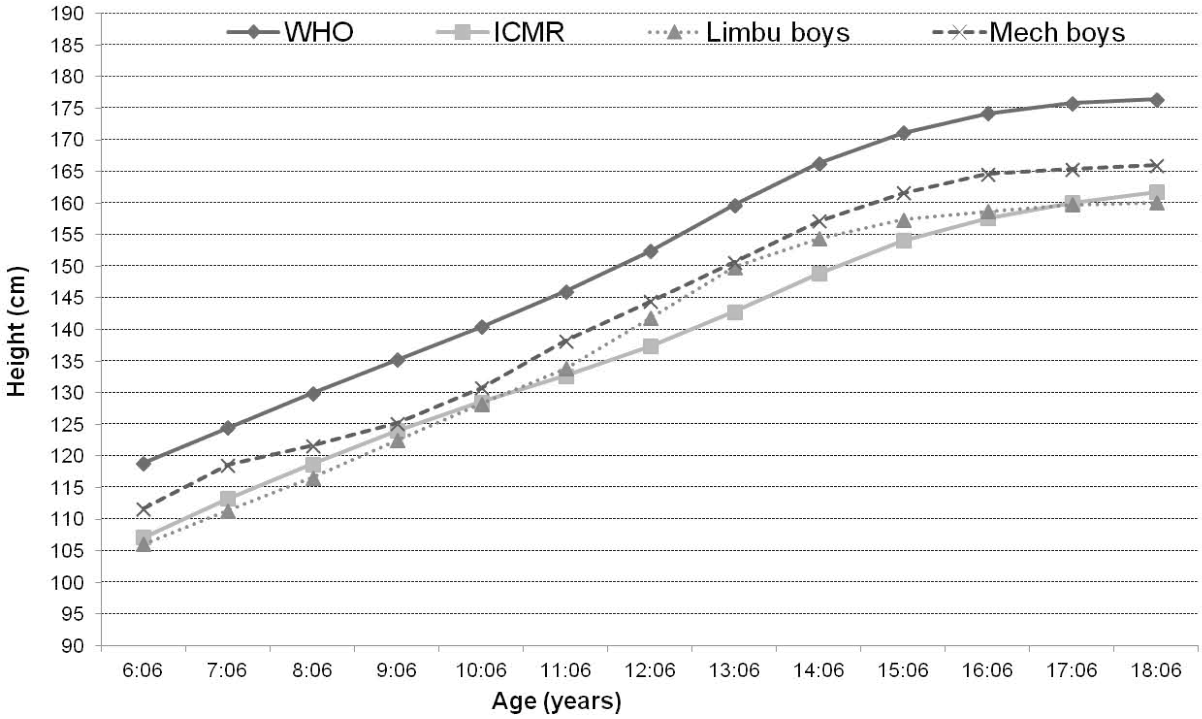
Data of the median (50th percentile) height (after normalisation) of Limbu and Mech boys and girls are also compared with that of Indian Council of Medical Research (ICMR, 2009) data on growth of children in India. The data of ICMR represent children from 16 States of rural India. The comparison was made between data of the study participants in their mid-year age and that of the available information based on chronological age (6 to 18 years) from ICMR. Limbu and Mech boys and girls appear to be taller with respect to their median (50th percentile) height when compared with the median height of ICMR (2009) data of children from rural India (Figures 1 and 2).

DISCUSSION

Stunting is related to the prolonged nutritional stress faced in early life, infancy and childhood [2]. The UNICEF [39] reported that India has very high number of stunted children in the World. The present study supports the idea that much of growth failure is explained by low height-for-age; stunting appears to be established early and the subsequent decline with advancement of age was found. The study shows high prevalence of stunting in children and adolescents from Limbu and Mech communities. Overall frequency of stunting among 6 to 18 year-old boys (33%) and girls (34.7%) was remarkably high. Prevalence of stunting was higher in Limbus (boys 43.5%, girls 44.6%) than Mech (boys 22.2%, girls 25.4%). However, there was a tendency of decline in prevalence of stunting with advancement of age among children and adolescents (except Mech girls) when the participants were categorised in three age groups. Below 9 years, rate of stunting was highest: among boys (Limbu 57%, Mech 26.5%) and Limbu girls (52.0%). In this age group, rate of stunting was 20.5% in Mech girls. Between 10 and 13 years, rate of stunting declined in boys (Limbu 39.2%, Mech 22.6%) and Limbu girls (43.7%). In this age group, Mech girls had highest rate of stunting (33.6%). In the age group of 14 to 18 years, frequency of stunting declined further in boys (Limbu 33.6%, Mech 17.7%) and girls (Limbu 38.7%, Mech 21.9%).

Other studies from West Bengal State also reported remarkably higher prevalence of stunting in children and adolescents (Table 5). A cross-sectional study reported an extreme level of stunting was 51.7% and 48.4% in boys and girls respectively from the families with low socioeconomic status in Barasat and Madhyamgram regions near Kolkata, West Bengal [5]. Majority of Santal (a scheduled tribe) children (> 60%) aged 6-10 years were found to be stunted in a study from Birbhum district of the State [20]. Stunting (26.1%) was also observed among 1 to 14 year-old children from Lodha community (a scheduled tribe) in Paschim Medinipur district in south West Bengal [18]. Around 50% of 2-13 year-old children were reported to be stunted among Kora-Mudi tribal community from Paschim Medinipur [19]. A study

FIGURE 1. Comparison of median height of Limbu and Mech boys with growth reference data (ICMR, 2009; WHO, 2007).

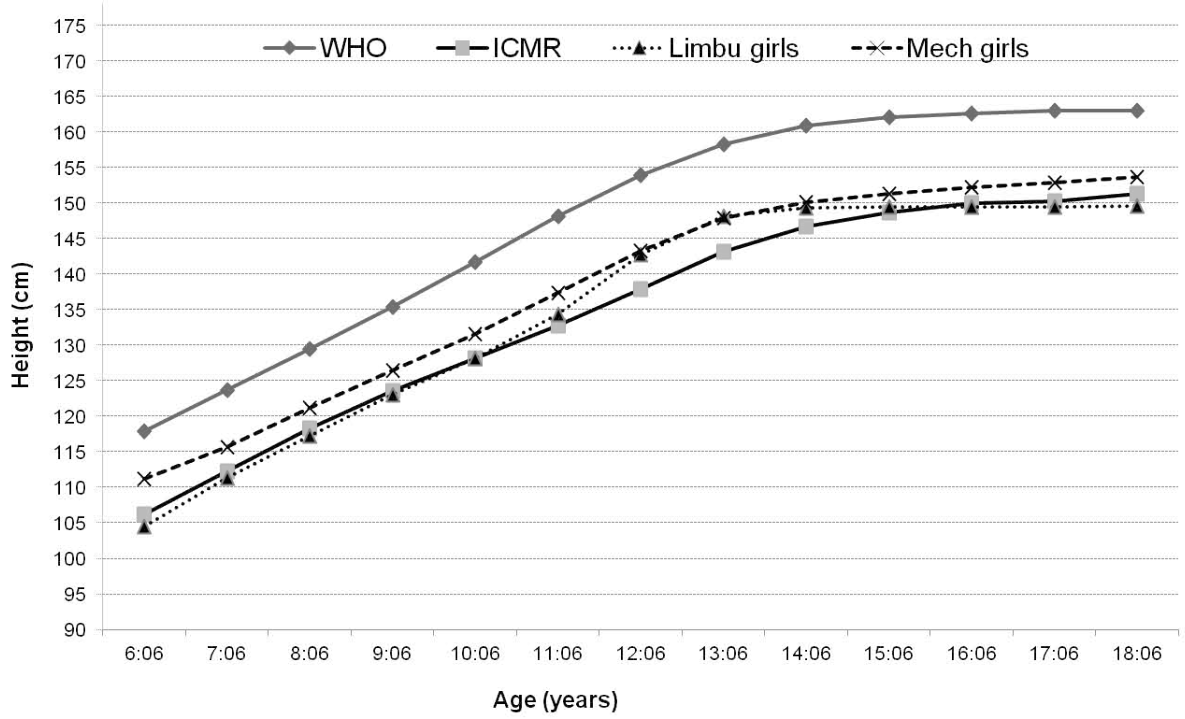


WHO: World Health Organization; ICMR: Indian Council of Medical Research

from Purba Medinipur district in south West Bengal also reported that 9 to 13 year-old Bengalee children of both sexes were suffering from stunting (14.6%) [6]. A study from semi-urban population of Hooghly district reported high prevalence of stunting (27%) among 11 to 18 year-old adolescent girls [10]. In Puruliya district of southwestern part of West Bengal, frequency of stunting was also high among 5 to 12 year old Santal boys (22%) and girls (14%) [21]. From the northern region in West Bengal, studies also reported high prevalence of stunting. Among 5 to 12 year-old children from Darjeeling district, boys had higher frequency of stunting (37%) than girls (34.59%) [8]. From the same region, higher rate of stunting was also observed in children and adolescents aged 10 to 17 years (boys 43%, girls 50%) [8, 9]. Therefore, reports by these authors [9] from Darjeeling region show a tendency of rise in the prevalence of stunting with advancement of age in children and adolescents between 5 and 17 years of age. Our results however, do not conform to these earlier reports from this region. In spite of high prevalence of stunting in Mech and Limbu boys and girls, there was a tendency of decline in the frequency with the advancement of age from 6 to 18 years. Another study from rural blocks of Darjeeling district reported majority of 11 to 19 year-old boys (55.4%) were stunted and that was higher than girls (25%) of same age group [47].

Reports from other states in India also showed conspicuously high prevalence of stunting in children and adolescents. High prevalence of stunting was recorded in 6 to 10 year-old Santal children (boys 58%, girls 66%) from Ghatshila in Jharkhand State [20]. A study on growth and nutritional status of 3 to 10 year-old children from two communities, e.g. Mishing (a scheduled tribe) and Kaibarta (a scheduled caste of Hindus) of Assam State in northeast India [17] recorded higher prevalence of stunting in boys (Mishing 26.84%, Kaibarta 33.33%) than girls (Mishing 21.31%, Kaibarta 18.06%). In Tripura, another north-eastern state, rural boys aged 8 to 15 years were also found to experience high degree stunting (28%) than urban age-peers (8%) [11]. In Aligarh of Uttar Pradesh State in northern India, 6 to 12 year-old girls showed higher prevalence of stunting (76%) than boys (62%) [12]. Prevalence of stunting was also reported to be high in 10 to 19 year-old boys (73%) and girls (45%) from Ahmedabad in Gujarat State of western India [13]. Another study among adolescents aged 10 to 18 years from urban slum areas in Nashik, Maharashtra, western India showed median height-for-age was about 10 cm lower than reference data (WHO and other Indian studies representing affluent urban juveniles and adolescents) [48]. In that study, prevalence of stunting recorded was higher among boys (WHO: 13%-59%; Indian reference: 13%-41%) than girls (WHO: 14%-44%; Indian reference: 4%-13%). From South India, prevalence of stunting was

FIGURE 2. Comparison of median height of Limbu and Mech girls with growth reference data (ICMR, 2009; WHO, 2007)



WHO: World Health Organization; ICMR: Indian Council of Medical Research

28% among 10 to 18 year-old girls from a slum of Nalgonda town in the state of Andhra Pradesh [14].

Some studies from neighbouring Asian countries also reported stunting in children and adolescents. A study among Pakistani 6 to 12 year-old school going children revealed that out of 1915 children, 300 (16.5%) were stunted [49]. Prevalence of stunting (8.4%) was also reported from Malaysian children [50]. Frequency of stunting was relatively low (3.7%) among studied children (n= 3147, mean age 82 months) from Tehran, Iran. It was higher among girls (4.4%) than among boys (2.8%) [51].

The Indian Council of Medical Research (ICMR) carried out a nationwide cross-sectional survey during 1956 to 1965 to develop growth reference charts for children and adolescents from India [52]. However, selected participants had lower socioeconomic backgrounds. The results from the present study show the boys and girls from Limbu and Mech communities were taller with respect to their median (50th percentile) height in comparison with the median height of ICMR 2009 data representing rural India [36]. The participants in the present study also represented two communities from rural areas of Darjeeling and Alipurduar regions in West Bengal, India; had relatively poor socioeconomic backgrounds [53]. We did not have data on genetic backgrounds of the people from Limbu and Mech communities. Data from any secondary sources were also not available. Therefore, in absence of data on genetical and environmental factors determining height, it was not possible to interpret the height difference between the participants of the present study and the ICMR reference [36]. High prevalence of low height-for-age among boys and girls was recorded in the present study. However, in absence of any nationally representative growth reference data from India, we compared height-for-age of the participants with WHO growth reference. This might be another reason behind of such high frequency stunting estimated among the participants in the present study.

In the present study, prevalence of stunting was higher among boys, particularly below 10 years of age. The results conform to the earlier reports from West Bengal and other Indian States [3.4, 5, 8, 16, 17, 18, 19, 21, 47, 48]. However, frequency of stunting was observed to be higher among girls in general, more particularly in the adolescent age groups.

Compared to the urban people, the rural inhabitants have lower education levels, higher mortality and fertility rates, higher poverty, and fewer modern amenities. Mostly the rural and tribal populations are socioeconomically disadvantaged compared to other populations and social groups in India [38, 39]. A recent study, in relation

TABLE 5. Prevalence of stunting in children and adolescents from different populations in India.

PARTICIPANTS	SOCIAL GROUP	SEX	AGE (YEARS)	N	STUNTING (%)	STUDY LOCATION	REFERENCE	CITATION
Children	Mixed	Boy	1-12	788	51.70	Madhyamgram, West Bengal	Bose et al., 2008	5
		Girls	1-12	618	48.40			
Children	Mishing (tribe)	Boy	3-10	313	26.84	Assam, North eastern India	Basu et al., 2014	17
		Girls	3-10	291	21.31			
Children	Kaibarta (caste)	Boy	3-10	225	33.33			
		Girls	3-10	227	18.06			
Children	Santal (tribe)	Boys	6-10	65	58.47	Ghatshila, Jharkhand	Chakraborty et al., 2008	20
		Girls	6-10	58	65.52			
		Boys	6-10	42	61.91	Bolpur, Birbhum, West Bengal		
		Girls	6-10	63	68.26			
Children and Adolescents	Mixed	Boys	5-12	906	37.08	Darjeeling, West Bengal	Mondal and Sen, 2010	8
		Girls	5-12	964	34.59			
Children and Adolescents	Santal (tribe)	Boys	5-12	216	21.70	Puruliya, West Bengal	Dutta Chowdhury et al., 2008	21
		Girls	5-12	226	13.80			
Children and Adolescents	Mixed	Boys	6-12	184	62.00	Aligarh, Uttar Pradesh	Sultan, 2014	12
		Girls	6-12	166	75.90			
Children and Adolescents	Lodha (tribe)	Boys	1-14	68	26.5	West Midnapore district, West Bengal	Bisai et al., 2008	18
		Girls	1-14	97	25.8			
Children and Adolescents	Kora-Mudi (tribe)	Boys	2-13	59	55.90	Midnapore, West Bengal	Bisai and Mallick, 2011	19
		Girls	2-13	60	43.30			
Children and Adolescents	Tribes	Boys	8-15	258	7.60	West Tripura district (Urban), Tripura	Roy Sarkar et al., 2012	11
		Boys	8-15	365	27.90	West Tripura district (Rural), Tripura		
Adolescents	Mixed	Boys	10-17	376	43.10	Darjeeling, West Bengal	Mondal and Sen, 2010	9
		Girls	10-17	350	50.30			
Adolescents	Mixed (slum)	Girls	10-18	223	28.30	South India	Prashant and Shaw, 2009	14
Adolescents	Mixed	Boy	10-19	195	72.80	Ahmedabad, Gujarat	Prajapati et al., 2011	13
		Girls	10-19	206	44.70			
Adolescents	Mixed	Boys	11-19	258	55.40	Rural blocks of Darjeeling, West Bengal	Dey et al., 2011	47
		Girls	11-19	162	25.00			
Adolescents	Mixed	Girls	11-18	746	27.00	Semi-urban population, West Bengal	Pramanik et al., 2014	10

to the present context by one of the co-authors (PB) reported that Limbu and Mech community people had their distinct cultural practices, socioeconomic status, dietary habits, and activity patterns and other ways of life [53]. In general, Limbu community people had higher socioeconomic status (SES) than Mech. Household monthly income and per capita expenditure were higher in Limbu community people. Higher proportions of women in the households (mothers of the participants) among Limbus were working (80.29%) compared to the Mech community (74%). Literacy rate in men and women was higher among Limbus. Economy of Mech community was principally based on agriculture whereas Limbus were mostly involved in service and business that was also reflected from their household land ownership patterns. Limbu community people were mostly living in relatively higher altitude than

Mech. That was one of the main reasons behind the non-concrete house type and less amount of land ownership among Limbus. For the same reason, majority of Limbu households (83.20%) did not have sanitary toilet facilities whereas majority of Mech households had (65.58%). With respect to the household goods ownership as another indicator of SES, Limbu families had modern furniture, including refrigerator, and television, had motorcycle etc. [53]. In general, relatively higher prevalence of stunting observed among Limbu and Mech boys and girls was due to low socioeconomic status if compared with other regional studies mainly from urban sectors (Table 5).

The results of the present study showed in spite of having lower SES, Mech boys and girls were taller than Limbu peers by age and also had lower prevalence of low height-for-age (stunting). The reason behind of these facts might be interpreted in the light of genetical and environmental factors controlling for height. One of the major limitations of the present study was non-availability of such data. There was no secondary data source to evaluate such differential characteristics between these two communities. A recent study has reported genetic and phenotypic differences between two high-altitude Andean and one se-level population from Argentina [54]. The people of higher altitude had lower mean values of height, knee height, fore arm length than people who were living in the lower altitude and at sea levels. On the other hand, higher altitude people had higher respiratory rate, vital capacity, peak expiratory flow etc. In this context, this might be presumed that Limbu boys and girls having a population background of relatively higher altitude in the Himalayan mountain regions (as described in the Methods section) and also living in the relatively higher altitude than Mech people, were genetically short in height in spite of having higher socioeconomic background. Future research may shed some light in these aspects.

CONCLUDING REMARKS

In summary, it may be stated that in comparison with other studies from different districts in West Bengal State, our study reveals high prevalence of stunting especially among Limbu children and adolescents. However, a tendency of decline in the rate of stunting with advancement of age was observed in this cross-sectional study. In general, it is also observed that prevalence of stunting is remarkably high in children and adolescents in India. Moreover, children and adolescents from rural and tribal communities and also from families with relatively lower socioeconomic status are suffering from higher degree of undernutrition as determined by the prevalence of stunting in comparison with other social and economic groups in different states of India. Girls are found to be suffering from undernutrition more than boys. Therefore, immediate nutrition intervention programs are needed for better growth and development of children and adolescents in the state of West Bengal.

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Declaration of interest

The authors report no conflicts of interest.

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