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Interrelationship between Subischial Leg Length and Height in 4 and 5-Year-old Limbu Children from Darjeeling, West Bengal

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ABSTRACT Short leg length is an indicator of nutritional stress and growth impairment in children. The objective of the present study was to observe interrelationships between subischial leg length (SLL) and height in preschool children. The present cross-sectional study was carried out during 2010-2014 among 4 and 5-year-old children (100 boys, 100 girls) of Limbu community in Darjeeling district of West Bengal. Anthropometric measurements were height and sitting height; derived variable was SLL. Age and anthropometric characteristics did not show any significant sex difference. Prevalence of stunting (low height-for-age) was remarkable in the sample (boys 19%, girls 18%). SLL was negatively associated with stunting. Linear regression model, after adjusting for age and sex, showed SLL had significantly positive relationship with height ($p<0.05$) in children.

INTRODUCTION

Height and body dimensions, upper and lower limbs have differential timing and tempo of growth (Bogin 1999). Legs grow faster in childhood and mature earlier than height in adolescence (Datta Banik et al. 2017; Hermanussen 2016). Nutritional status of children is an indicator of household socioeconomic status and living conditions (Cuanalo et al. 2014). Poor housing, socioeconomic status, and diet may affect health, physical growth and development in children (Bogin 2012; Bogin and Varela-Silva 2010). Therefore, short leg length is responsive to undernutrition, infection and other adverse life conditions during growing age of children that has long-term negative consequences on health and nutrition (Bogin and Varela-Silva 2010). Previous studies among Limbus from Darjeeling district in West Bengal reported poor household socioeconomic status, low macronutrient intake rates and remarkable prevalence of low height-for-age (stunting) in children and adolescents (Bhattacharjee 2015; Datta Banik et al. 2016).

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Objective

In this background, objective of the present study was to observe interrelationships between subischial leg length (SLL) and height in preschool children from Limbu community in Darjeeling, West Bengal.

METHODOLOGY

In the present cross-sectional study, participants were 4 and 5-year-old preschool children from Limbu community in Darjeeling district of West Bengal, India. The present study was part of a research project (2010-2012) and a doctoral thesis (2009-2015) (Bhattacharjee 2015) (see Acknowledgements). Nutritional status of preschool children was used as a correlate of household socioeconomic status in the research project. Ethical approval was given by the institutional committee of Vidyasagar University. Prior approval for field work and data collection was obtained from the community leader (an elected representative) of the statutory body of village council (*Gram Panchayat*). Parents and / or caregivers of the children signed the informed consent form and gave permission to record anthropometric measurements. The participant children gave their verbal assent. At least one parent or family member was present at the time of recording anthropometric measurements.

Sampling design has been elaborately described in previous reports (Bhattacharjee 2015; Datta Banik et al. 2016). Limbu settlements were identified, based on the available information in the local government offices in different subdivisions of Darjeeling district namely, Darjeeling Sadar, Kurseong, Kalimpong (presently a separate district), and Siliguri. The present study was carried out in 85 out of 102 settlements from this region and preschool children were identified through household demographic survey. Limbu community people were identified based on "Scheduled Tribe" certificate issued by the Government. Few children below 4 years of age agreed to participate. Therefore, in the present study, participants were children between 4.0 and 5.99 years of age (100 boys and 100 girls, 50 each in 4 and 5 years of age by sex). Total number of children in this age group from the region was 218 and response rate was approximately 92 percent.

Anthropometric measurements were recorded by a trained researcher (see Acknowledgements). The measurement procedure followed international protocol (Lohman et al. 1988). Height (cm) and sitting height (cm) were measured to the nearest 0.1 cm, using a stadiometer (Seca, Model no. 872, Germany) that has been used and reported earlier (Datta Banik and Das 2015). To measure sitting height, the participant was in a sitting position on an anthropometric box (40 cm tall). In such a sitting position when lower legs of the child were hanging, a small support (an adjustable wooden stool) was given below so that thigh and lower leg remained at 90-degree angle. Sitting height was estimated deducting 40 cm from the measured height from floor to vertex while the participant was sitting on the box. Subischial leg length or SLL (cm) was calculated deducting sitting height from standing height. Height-for-age z-scores were calculated and the NHANES III comprehensive reference was used to define stunting, as having a z-score value of height-for-age equal or below -1.650 (Frisancho 2008).

Descriptive statistics (mean and standard deviation values) of anthropometric parameters and sex differences (Student's t-test and p-values) were calculated using the SPSS statistical software (version 15.0). Normality tests for the anthropometric characteristics were done following assumption of Shapiro-Wilk test ($p< 0.05$). Parametric and non-parametric correlation coefficients (Pearson's r and Spearman's rho, respectively) and linear regression model were used to estimate interrelationships between height, SLL, and stunting (yes = 1, no = 0). Level of significance was set at $\alpha = 0.05$ in all analyses.

RESULTS

Mean values of age (boys 5.15 years, girls 5.17 years) and anthropometric characteristics in Limbu children (100 boys, 100 girls) did not show any sex difference (Table 1). Boys were marginally taller, had higher mean value of sitting height (SH) than girls. However, mean value of subischial leg length (SLL) was marginally higher among girl children.

Prevalence of low height-for-age or stunting (boys 19%, girls 18%) was remarkable in the sample. Mean values of height, height-for-age z-score, and sitting height were lower among stunted boys and girls in comparison with not stunted peers showing significant differences ($p< 0.0001$) (Table 2). Mean values of SLL among stunted children (boys 44.24 ± 3.05 cm, girls 45.80 ± 1.94 cm) were significantly ($p< 0.001$) lower (t

Table 1: Descriptive statistics of age and anthropometric characteristics in Limbu boys (n=100) and girls (n=100)

Variables	*Boys*	*Girls*		
	Mean (SD)	*Mean (SD)*	*t*	*p-value*
Age (years)	5.15 (0.57)	5.17 (0.52)	-0.27	0.79
Height (cm)	105.67 (6.08)	105.17 (4.56)	0.65	0.52
Height for age z-score	-0.83 (1.05)	-0.74 (0.92)	-0.62	0.54
Sitting height (cm)	58.36 (3.12)	57.60 (2.41)	1.94	0.05
Subischial leg length (cm)	47.30 (3.49)	47.58 (2.78)	-0.61	0.54

SD: Standard deviation

Table 2: Descriptive statistics of age and anthropometric characteristics among stunted and not-stunted Limbu boys (n=100) and girls (n=100)

Variables	*Boys*			*Girls*		
	Stunted (19) Mean (SD	*NS (81) Mean (SD)*	*t*	*Stunted (18) Mean (SD)*	*NS (82) Mean (SD)*	*t*
Height (cm)	99.06 (4.86)	107.21 (5.25)	6.17*	100.61 (2.87)	106.18 (4.24)	5.30*
Height for age z-score	-2.35 (0.56)	-0.47 (0.78)	9.87*	-2.09 (0.40)	-0.44 (0.72)	9.41*
Sitting height (cm)	54.83 (2.40)	59.19 (2.67)	6.53*	54.81 (1.95)	58.21 (2.05)	6.43*
SLL (cm)	44.24 (3.05)	48.02 (3.19)	4.69*	45.80 (1.94)	47.97 (2.79)	3.13*

NS: Not stunted; SD: Standard deviation; SLL: Subischial leg length (cm); * p-value< 0.0001

values in boys = 4.69 and girls = 3.13) than normally growing children (boys 48.02 ± 3.19 cm, girls 47.97 ± 2.79 cm). Correlation coefficients between SLL and height (Pearson's r = 0.93 in boys and 0.89 in girls) were significant ($p < 0.001$). Non-parametric correlation coefficients between SLL and stunting (yes = 1, no = 0) (Spearman's rho = -0.45 in boys and -0.30 in girls) were significant ($p < 0.001$) that showed inverse association.

Linear regression model to find the interrelationship between SLL and height, after adjusting for age and sex in Limbu children is presented in Table 3. ANOVA p-value was < 0.05 in the model, indicating statistically significant interrelationships between variables at 95.0 percent confidence level. The regression model predicting height by SLL accounted for 84.0 percent of total variability explained by adjusted R^2. Height as a response variable also showed 84.0 percent of variability around the mean in the fitted models to be explained by the R-squared statistic. Height was found to be significantly related ($p < 0.0001$) to sex (boys = 1, girls = 2) and SLL in children. It was observed that for one cm higher SLL, there was a chance of 1.50 cm taller height in children, holding other predictors in the model constant. Durbin-Watson (DW) statistic (2.08) indicated no autocorrelation in the model. Relatively high tolerance (>0.72) and low variance inflation factor (<1.5) meant no multicollinearity between independent variables. The residuals were normally distributed with no patterns (Shapiro-Wilk test, $p > 0.05$).

DISCUSSION

It was evident from the results of the present study that SLL had significantly positive interrelationship with height. It was presumed that in Limbu community, where low household socioeconomic status, poor housing conditions including toilet use and water supply had been reported (Bhattacharjee 2015), the children might have suffered from undernutrition due to unfavorable living conditions. High prevalence of stunting (boys 43.5%, girls 44.6%) was also reported in 6 to 18-year-old children and adolescents of Limbu community from Darjeeling in West Bengal (Datta Banik et al. 2016). As it was

Table 3: Linear regression model for subischial leg length as predictor for height in Limbu boys (n=100) and girls (n=100)

Predictors	*Regression coefficient*	*SEE*	*t*	*p-value*	*95% confidence interval*	
					Lower bound	*Upper bound*
(Constant)	32.60	2.35	13.88	**<0.0001**	27.97	37.23
Age (years)	0.57	0.34	1.67	0.10	-0.10	1.25
Sex	-0.91	0.31	-2.99	**<0.0001**	-1.52	-0.31
Subischial leg length (cm)	1.50	0.06	25.36	**<0.0001**	1.38	1.62

Sex: Boys = 1; Girls = 2; SEE= Standard error of estimate

mentioned in the methods section that the present study was related to the previous study among Limbu children and adolescents (Bhattacharjee 2015), we may presume that the 4 to 5-year-old Limbu preschool children were also having similar household living conditions.

Physical growth in preschool children is rapid (Bogin 1999). During this growth phase, if children face disadvantaged environmental conditions determined by poor socioeconomic status, housing condition, and inadequate diet, growth of legs might be affected. This fact is reflected from the results of the present study showing a negative relationship between stunting and SLL. A previous study (Datta Banik et al. 2016) reported that height of Limbu children and adolescents from this region of Darjeeling district was below the height-for-age percentiles of the WHO growth reference curve (de Onis et al. 2007). Prevalence of stunting among preschool children of the present study (4 and 5-year-old) was remarkable (boys 19%, girls 18%) but was lower in comparison with the frequencies observed in 6 to 7-year-old (boys 60.3%, girls 57.6%) and 8 to 9-year-old (boys 53.8%, girls 46.9%) Limbu children from the same region as reported earlier (Bhattacharjee 2015; Datta Banik et al. 2016). Limbu children and adolescents representing better household socioeconomic status (monthly per capita income and expenditure, housing patterns, and working mother) were taller than their peers having poor household socioeconomic backgrounds (Bhattacharjee 2015). Limbu adolescents also had poor dietary habits, lower macronutrient (carbohydrate, protein, lipid) consumption rates (Bhattacharjee et al. 2020) than recommended dietary allowance for the age (Gopalan et al. 1996; ICMR 2009).

A previous study among 2 to 6-year-old Nepali-speaking preschool children (133 boys, 135 girls) from Darjeeling district, reported high prevalence of BMI-based thinness (chronic energy deficiency); more girls (47.4%) were undernourished than boys (43.0%) (Das and Datta Banik 2011). High degree undernutrition was reported among preschoolers from different districts in West Bengal, such as: 2 to 6-year-old children in Purulia district (thinness 65.3%; Das and Bose 2009a), (stunting 37.0%, underweight 48.4%, wasting 21.5%; Das and Bose 2009b), (stunting 39.2%, underweight 51.2%, wasting 26.6%; Das and Bose 2009c); Hooghly district (stunting 26.6%, underweight 63.3%, wasting 50.0%; Mondal and Bose 2009; Mondal et al. 2009), and 3 to 5-year old children in Nadia district (thinness 50.7%; Biswas et al. 2009). Another study carried out among preschool children (463 boys, 335 girls) of 2 to 5 years of age in North 24 Parganas district of West Bengal, reported prevalence of BMI-based thinness higher in boys (48.2%) than girls (46.4%) (Bisai and Manna 2010). High prevalence of stunting (49.6%), underweight (52.9%), and wasting (22.7%) were also reported in a study among children aged 2 to 13 years (59 boys and 60 girls) from Kora-Mudi community in Paschim Medinipur district of West Bengal (Bisai and Mallick 2011). Limbu children showed relatively lower prevalence of stunting in comparison with the results obtained in the previous studies among preschoolers from other districts in West Bengal.

Stunting and lower SLL reflect the effects of unfavorable living conditions in infancy and early childhood that might have long-term negative influences on health and nutrition in adolescence and adulthood (Bogin 2012; Bogin and Varela-Silva 2010). It may be presumed that poor socioeconomic status, housing conditions, and inadequate diet in Limbu children and adolescents were persistent problems as reported earlier (Bhattacharjee 2015).

CONCLUSION

Height showed positive correlation with SLL and low height-for-age (stunting) had inverse association with SLL among Limbu preschool boys and girls. The present report contributes additional information to the earlier proposition that leg length is an indicator of physical growth in children that might be associated with environmental factors including household socioeconomic backgrounds, health and nutrition.

RECOMMENDATIONS

The reports showing poor nutritional status of children and adolescents from the region call for the implementation of intervention programs.

LIMITATIONS

Association between household socioeconomic backgrounds, dietary habits, health, and nutritional status of children that are not being reported here will be explored in future studies.

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