Introduction

Variability in growth pattern among children from different races, ethnicity, and geographical regions is well-established.\(^1\) Hence, the use of reference standards derived from the native population is always recommended for assessment of growth and nutritional parameters in children.\(^2\) Among the several reference population data available for use, those derived from large sample from various Indian cities are largely used for assessment of Indian children.\(^3\) However, wide variations in environmental and sociocultural milieu across the regions of the country even render the use of a single “national” growth standard arguable. With distinct geographical and demographic conditions prevalent in the regions of Himalayan foothills, it seems questionable to assess the children from these areas using the standards based upon growth pattern of children from major central cities of the country. To answer this question, we compared the growth parameters of apparently healthy children, attending our out-patient clinic, with corresponding median values for age from national reference data.

Materials and Methods

This observational analytical study was conducted...
between October 2014 and March 2015 at an Outpatient Children Clinic of Teaching Institute in Himalayan Foothill Region of North India after approval from Institute Ethics Committee. The weight and height of apparently healthy children, aged 5–18, presenting with transient minor illnesses, attending our clinic were included. Those with medical (chronic illness, clinically overt nutritional deficiencies, genetic disorders, etc.) and sociodemographic factors (low socioeconomic status, institutionalized children from orphanages, etc.), which can potentially affect growth, were excluded. Age was recorded in number of completed years. The expected value for age that is median value for the corresponding age from the recommended national reference data was also recorded. The association between observed and expected values was assessed using linear regression method. The predicted values were assessed using linear regression equations, so obtained. Finally, the disagreement between the predicted and observed values was evaluated to find the appropriateness of the use of reference data. The variables were recorded as mean (standard deviation [SD]), and $P < 0.05$ was considered as statistically significant. Data were recorded using Microsoft Excel Sheets and analyzed using SPSS version 16.

### Results

A total of 565 children were screened, of which, data from 205 boys (mean, SD age 10.51, 3.55 years) and 200 girls (10.26, 3.81 years) were finally evaluated. The mean (SD) observed and expected weight of boys was 29.55 (10.59) and 31.77 (11.54) kg, the corresponding figures for girls were 27.59 (10.59) and 29.83 (11.42) kg. The mean (SD) observed and expected height of boys was 138.97 (19.81) and 136.34 (20.33) cm, the corresponding figures for girls were 136.10 (18.71) and 133.51 (18.94) cm. The linear regression relations of observed and expected values are shown in Figure 1. The regression equation from data for weight were $y = 3.24 + 0.83x$ for boys and $y = 1.63 + 0.87x$ for girls and that for height were $y = 5.78 + 0.97x$ for boys and $y = 1.93 + 1.00x$ for girls. The predicted values for corresponding observed value, using the regression equations are presented in Table 1.

### Discussion

Our observations suggest that there is a considerable difference between growth parameters of apparently healthy children from widely prevalent national reference data. Children are observed to be lighter, especially in older

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**Figure 1:** Scatter diagram showing regression analysis between observed (Y-axis) and expected (X-axis) values. (a) Weight among boys, (b) weight among girls, (c) height among boys, (d) height among girls
age groups and taller, especially in younger age groups, when compared with corresponding median values from reference data.

Though considerable similarity was observed between the growth patterns of affluent children from various countries,[4] there are several observations that identify inappropriateness of using western reference data while interpreting the growth patterns of children from general population at large.[5] The resultant misinterpretation might lead to inappropriately higher proportion of children being diagnosed as undernourished.[6] Apart from ethnicity and nutritional status, numerous other factors like socioeconomic development, literacy rate, perinatal health, etc., are implicated to be affecting growth pattern of children in the region.[7] Children from other similar geographical foothill areas have been observed to have distinct growth patterns from those residing in urban areas.[8] In a study on 220 adolescent females from Shimla, another Himalayan region city, undernutrition was found to be widely prevalent however in contrast to height deficits; increase in weight deficits were observed to be greater.[9] This observation was similar to our findings where predicted weight of children was observed to be lower than the expected values. Though children in our sample were found to be taller than the expected values, the difference fades away with increasing age, resulting in no significant difference in the final height of children.

Our study has certain limitations as the sample size is relatively small and is from the children attending the hospital services hence, not truly a community derived. Hence, our observations must be interpreted with due caution when extrapolated on the population of any other region. However, since we have only included apparently healthy children presenting with minor transient illnesses, the sample is a fair representation of the general population. Moreover, our institute is situated in suburban area with the majority of the population belonging to middle and lower middle socioeconomic status that holds a reasonable similarity with the general demographic characteristics of Uttarakhand State. The observation certainly appears valid enough to provide an indication toward inappropriateness of interpreting the growth parameters of the children of this region in the background of index national reference.

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Nil.

**Conflicts of interest**

There are no conflicts of interest.

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**Table 1: Predicted values of parameters corresponding to expected values, using the observed regression equations**

| Expected (50th centile) | Predicted (girls) | Predicted (boys) |
|-------------------------|-------------------|------------------|
| Weight (kg)             |                   |                  |
| 20                      | 19.08             | 19.84            |
| 35                      | 32.18             | 32.29            |
| 50                      | 45.28             | 44.74            |
| Height (cm)             |                   |                  |
| 100                     | 102.13            | 103.18           |
| 125                     | 127.18            | 127.53           |
| 150                     | 152.23            | 151.88           |