Anthropometric Measurements and Undernutrition:
A Case on School Children of South Tripura, India

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ABSTRACT Tripura is one of the north-eastern state of India. Studies relating body development through anthropometric measurements relating to general health and well-being in this population are not available. The present investigation was aimed to assess the nutritional and growth status of children of South Tripura using anthropometric measurements. For the present study, 152 students in the age range of 6 to 10 years were selected at random from schools of south Tripura. The subjects were divided into five age groups. Different anthropometric characteristics, *viz.*, height, weight, mid upper arm circumference (MUAC) of the subjects were measured. The general physical status of children was assessed from height for age, weight for age, weight for height and BMI. Results showed that undernutrition prevailed among these children. The average height and weight among children were found to be lesser than the standard recommended by ICMR. The Mid Upper Arm Circumference MUAC of children were lower in both gender-groups when compared with World Health Organization(WHO) standards. The overall frequency of Chronic Energy Malnutrition in boys (BMI < 18.5 kg/m^2) was 97.4% and in girls the frequency was 100%. Based on the WHO classification, the prevalence of Chronic Energy Malnutrition among this population was high and the situation may be considered as serious.

INTRODUCTION

India has the dubious distinction of having the largest number of malnourished children in the world. Assessment of nutritional status is a vast subject (WHO 1995,1999). According to Jelliffe (1966), the study of nutritional status of any country is important for the mechanism of evolution and morphological character which brings about the change in the pattern of body development and its structure.

Malnutrition has been defined as a "Pathological state resulting from a relative or absolute deficiency or excess of one or more essential nutrients" (Jelliffe 1966). Malnutrition during infancy and early childhood is believed to have long-term repercussions on both physical growth and intellectual performance in later life (Stoch and Smythe 1967; Cravioto and De Licardie 1979). The physical growth of children is reflected by different anthropometric measurements especially weight and height. The physical dimensions of the body are much influenced by nutrition in growing period of school age. Poor health and nutritional status affect work capacity as well as cognitive functions. And it is the age group that is a dynamic period of growth and development as children undergo physical, mental, emotional and social changes. Hence, it is necessary to assess the nutritional status of this specific group (Bharati et al. 2005).

In a developing country like India, poverty undoubtedly constitutes a major factor for malnutrition in children, but lack of awareness of what constitutes a balanced diet is also a factor, which needs to be considered (Kumari 2005). No concerted efforts have been made to establish norms of height, weight and other anthropometric measurements for age and growth status of this age group in Tripura.

The main objective of the present study was therefore to determine the nutritional and growth status of 6 to 10 years old children attending schools of south Tripura by comparing various anthropometric measurements with national status and international standards.

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MATERIALS AND METHODS

Anthropometric measurements (height and weight) were taken of 152 primary school- going children of south Tripura. The distribution of study sample according to the age and sex is given in Table 1. They entered the study after giving informed consent. Most of this study's subjects belong to lower income groups. Simple random sampling design was adhered to in drawing the samples from classes I to V, only healthy students were selected for the study. The proportion of Bengali students was less in rural interiors of south Tripura, and majority of the students belonged to tribal communities. The selection of subjects was confined to rural areas of Belonia, south district of Tripura, in order to obtain children inhabiting in same area having similar dietary habits and socio-economic condition. The protocol and procedure employed was according to the human ethical guidelines of Helsinki Declaration (Touitou et al. 2004).

Table1: Distribution of study subjects according to age and gender from each classes

Age (years)	Boys	Girls	Total
6	11	11	22
7	15	15	30
8	15	15	30
9	15	15	30
10	20	20	40
Total	76	76	152

Data regarding general information and awareness about balanced diet was collected by personally interviewing the subjects. Three anthropometric parameters of the subjects were taken under standardized condition. The height was measured to the nearest 0.5 cm without shoes using anthropometer and weight was re-

corded using a mechanical beam balance, and was recorded to the nearest 0.1 Kg. The body mass index (BMI) of a subject was determined by dividing the weight (kg) by the squared value of height (meter); [BMI = weight / height^2]. Mid upper arm circumference (MUAC) was recorded with the help of flexible non-stretchable steel measuring tape to the nearest 0.1 cm, using standard technique (Lee and Nieman 2003).The height and weight measurements were compared with ICMR standard and MUAC with WHO standard, two separate standards were used as ICMR reference standards for MUAC were not available for the subjects concerned. For assessing the nutritional status of subjects, weight deficit for age, height deficit for age and MUAC deficit for age have been calculated. The subjects were divided in four groups: of malnutrition besides normal, viz., grade–I , grade-II and grade-III malnutrition. The classification for weight deficit for age, height deficit for age, weight deficit for height was followed from the classification used by Gomez et al. (1965), Waterlow (1972) and Waterlow et al. (1977) respectively, Subjects were also categorized as severe, moderate and mild to normal undernutrition on the basis of their BMI as described by WHO (1963).

The obtained data were analyzed using the Micro Soft Excel software, and are presented in table as mean ± SE.

RESULTS AND DISCUSSION

The mean and standard error of three different anthropometric parameters of each age group of boys and girls have been presented in Table 2. It was found that the mean height increases with age irrespective of the gender variation.

On an average, the boys were 109.91 cm tall at the age of six years and 134.54 cm at the age

Table 2: Mean± SE of anthropometric measurements of school children (N=152)

S. No.	Age	Gender	Height (cm)	Weight (kg)	BMI(kg/m^2)	MUAC (cm)
1	6	Boys	109.91** ± 1.19	15.41** ± 0.64	12.72 ± 0.434	14.36 ± 0.174
		Girls	108.09** ± 1.289	15.04** ± 0.455	12.85 ± 0.16	14.56 ± 0.257
2	7	Boys	115.0** ± 0.98	17.57** ± 0.35	13.28 ± 0.184	15.41 ± 0.197
		Girls	114.89** ± 0.731	17.47** ± 0.482	13.19 ± 0.229	15.37 ± 0.222
3	8	Boys	120.79** ± 1.126	19.8** ± 0.47	13.54 ± 0.142	15.93 ± 0.177
		Girls	120.37** ± 1.067	19.33** ± 0.422	13.33 ± 0.223	15.48 ± 0.167
4	9	Boys	122.98** ± 1.38	21.3** ± 0.647	14.03 ± 0.196	16.11 ± 0.242
		Girls	124.1** ± 0.834	20.4** ± 0.631	13.21 ± 0.278	15.69 ± 0.212
5	10	Boys	134.54** ± 1.038	26.5** ± 0.884	14.59 ± 0.351	17.32 ± 0.397
		Girls	135.52* ± 1.08	24.65** ± 0.734	13.39 ± 0.249	16.66 ± 0.177

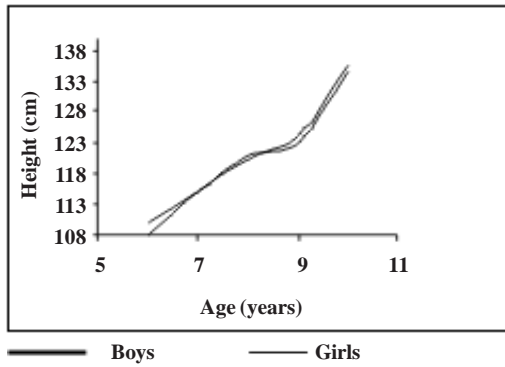(**P<0.01,*P<0.02 with respect to ICMR standard)

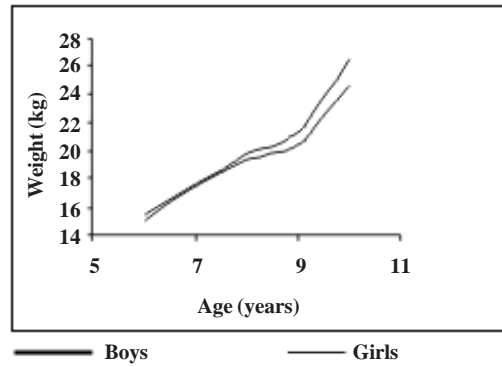**Fig. 1A. Comparison of mean height of boys and girls**

Fig. 1B. Comparison of mean weight of boys and girls

of ten years whereas the average height of girls was 108.09 cm at the age of six years and 135.52 cm at the age of ten years. These results showed that the height of boys under the age of seven and eight years increased slightly better than girls in the same age group. But height of girls from nine years onwards was better than the boys of the same age group (Fig.1A).

Between ages of 6- 8 years, there is very little, if any, difference between males and females in terms of height. However, after the age of about 9 or 10 years, female takes the lead and with the onset of puberty the girls may outgrowth her male counterparts as much as 2 inches ≈5.08 (Shaver 1981). Similar trend was noted from the present study.

The mean height of the children, when compared with ICMR standard, significant difference (P<0.01) was found in all age groups for both the sexes (Table 2). Easwaran and Devdas have also reported similar results (Devadas and Easwaran 1981).

Figures 2A and 2B shows comparison between mean height of boys and girls with ICMR standard. It was observed in the present study that the mean weight of the children increased with age in both the sexes (Table 2). The average weight of boys at the age of 6 years was 15.41 kg and 26.5 kg at the age of 10 years. There was a substantial gain of 11.09 kg in their weight during a span of 5 years. In case of girls, the mean value of weight was 15.04 kg at the age of 6 years and 24.65 kg at the age of 10 years. It was thus, adding on 9.61 kg to the weight only during the same 5 year period. This finding showed that the boys, in the age group of 6-10 years, weighed more than the girls through the ascending age unlike height. The analysis revealed that from 6 years onwards, the average weight was found to be lesser than the respective standard weight (ICMR) for both the sexes and the differences were significant (P<0.01) (Table 2). These differences might be due to the variation of economic condition and
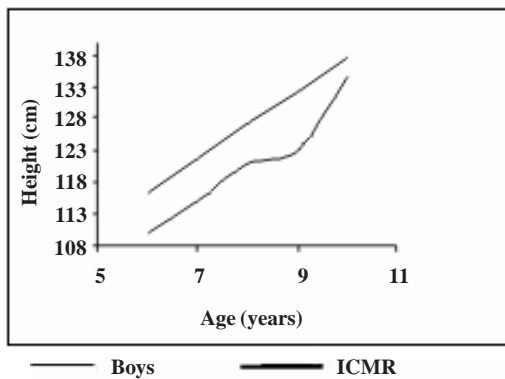

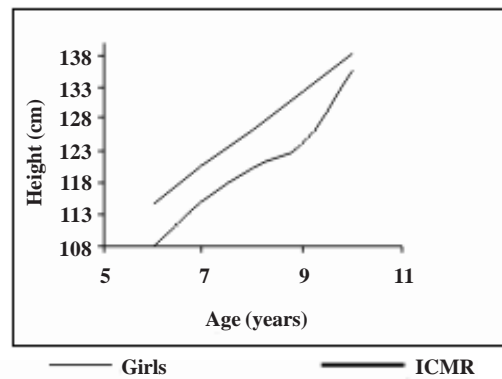**Fig. 2A. Comparison of height of boys and ICMR reference**

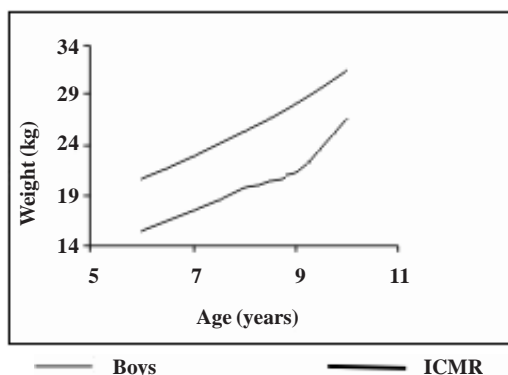**Fig. 2B. Comparison of height of girls and ICMR reference**

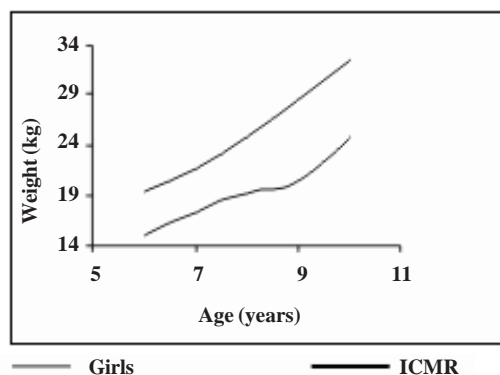**Fig. 3A. Comparison of weight of boys and ICMR reference**

Fig. 3B. Comparison of weight of girls and ICMR reference

food habits in children. Figures 3A and 3B showed variation of mean weight of boys and girls with ICMR standard.

The frequency and percentage of different grades of malnutrition of the children, which were determined using Gomez classification of weight-for-age, have been presented in Table 3. Among the studied population 94.73% boys and 92.11% girls are found to be underweight.

It was observed from the results that 50.00% boys and 44.73% girls had high prevalence of stunting according to Waterlow index for height-for-age. Based on weight-for-height classification of Waterlow et al. (1977) the percentage of overall malnutrition in boys was 68.42% and in girls it was higher (72.36%) than the boys. The occurrence of grade-I malnutrition was the most frequent among the boys and girls when above three criteria were considered.

The mean values of MUAC of children of both sexes increased with age (Table 2). For boys at the age of 6 years, it was 14.36 cm and 17.32 cm at the age of 10 years. In case of girls, the

mean value was 14.56 cm at the age of 6 years and 16.66 cm at the age of 11 years. There was no significant difference of MUAC between boys and girls in different age groups. MUAC of children of different age groups when compared with WHO standard recorded lower MUAC without any difference between the two gender groups (Figs.4A and 4B).

The mean values of BMI ranged from 12.72 to 14.59 in boys and 12.85 to 13.39 in girls (Table 2). The distribution of different categories of chronic energy deficiency (CED) on the basis of BMI has been shown in Table 3, the following results certainly indicate their poor socio-economic status and poor nutritional status as well. A very high frequency of CED- III was recorded in both sexes (98.68 % among boys and 100 % among girls) followed by CED-II.

The CED is a chronic imbalance between energy intake and expenditure. The high level of energy expenditure is required for physical activities and playing. This impact of imbalance is seen on both sexes. Since BMI is a result of

Table 3: Classification of grades of malnutrition according to Gomez (weight-for-age), Waterlow (height-for-age), Waterlow et al. (weight for height) and WHO (BMI) classification for school children

| Types of malnutrition	N	Normal		Grade I (mild)		Grade-II (moderate)		Grade-III (severe)		Total malnourished	
		No.	%	No.	%	No.	%	No.	%	No.	%
Boys											
Weight-for-age	76	04	5.26	44	57.89	27	35.53	01	1.32	72	94.73
Height-for-age	76	38	50	30	39.47	07	9.21	01	1.32	38	50.00
Weight-for-height	76	24	31.57	44	57.89	06	7.89	02	2.63	52	68.42
BMI	76	01	1.32	-	-	01	1.32	74	97.37	75	98.68
Girls											
Weight-for-age	76	06	7.89	34	44.74	34	44.74	02	2.63	70	92.11
Height-for-age	76	42	55.26	30	39.47	04	5.26	-	-	34	44.73
Weight-for-height	76	21	27.63	40	52.63	14	18.42	01	1.32	55	72.36
BMI	76	-	-	-	-	-	-	76	100	76	100
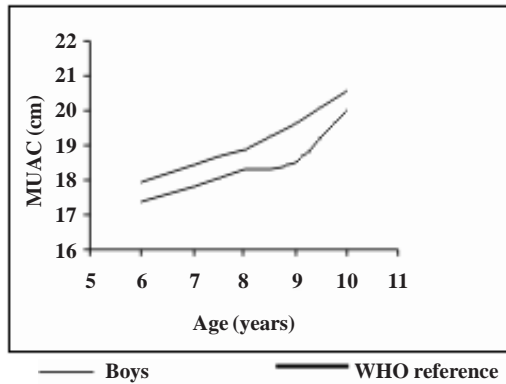
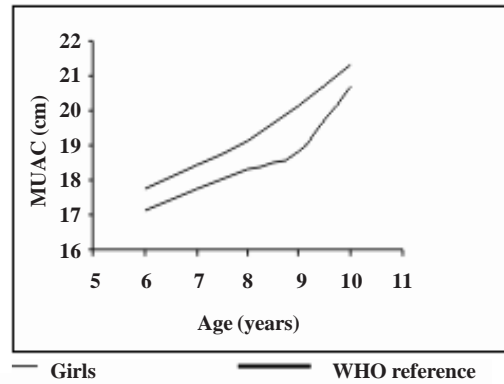**Fig. 4A. Comparison of MUAC of boys and WHO reference**

Fig. 4B. Comparison of MUAC of girls and WHO reference

complex interaction between nutritional intake, health status and physical activity pattern, the lesser intake of fat and protein might be affected in gaining weight and height among the children which attributed to their low socio-economic status.

The results show that the magnitude and severity of CED a great problem to be tackled seriously. In rural areas of south Tripura, the chronic energy deficiency is a primary significance rather than overweight.

CONCLUSION

From the study it appears that a large number of boys and girls of south Tripura suffer from malnutrition. The nutritional status of children is lower than the ICMR standard in terms of height and weight and WHO standard in terms of BMI and MUAC. The growth of boys and girls is slower than that of the national reference (ICMR).

Looking at the results of the study, it can be concluded that there is a need to implement intervention programme effectively to improve the nutritional status of school age children of rural areas of Belonia, south Tripura. This study suggests further evaluation involving more boys and girls with a specific nutrition programme in schools.

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