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Physical Growth and Nutritional Status of the Shabar Tribal Adolescents of Orissa, India: a Cross-sectional Study

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ABSTRACT

The aim of the study is to assess the growth and nutritional status of adolescents of the Shabar tribe of Orissa, India. There are no studies on the growth pattern of the Shabar tribe, one of the largest tribal communities of Orissa. Studies of other tribes have shown poor health status of their members. This cross-sectional study was carried out on 328 adolescents (149 boys and 179 girls), aged 10 to 18 years from Khurda and Cuttack districts of Orissa. Anthropometric measurements were taken to assess growth and nutritional status. Means, standard deviation and percentile curves were used to examine the pattern of growth, while *t*-test and 50th percentile values were used to compare the nutritional status with other studies. Values of <5th percentile of body mass index (BMI) for age were considered as indicators of under-nutrition. Most of the body measurements showed high rates of increase between 14 to 15 years among boys and 12 to 13 years among girls, which correspond to the adolescent growth spurt. The Shabar adolescents were significantly ($p<0.01$) shorter and lighter than the NCHS (National Center for Health Statistics) 50th percentile curves. There was high prevalence of chronic under-nutrition (<5th percentile of BMI for age). It is noted that the nutritional status of the Shabar children is generally better than that of other tribes. These findings may be attributed to various nutritional programmes for children. However, poor socio-economic status of this tribe remains an important factor for the high prevalence of chronic under-nutrition and poor growth pattern. In-depth studies are necessary for identifying other factors that lead to growth retardation and under-nutrition among the adolescents of the Shabar population.

INTRODUCTION

Adolescence is a time of rapid growth and often designated as a transitional stage between childhood and adulthood along with increased need for specific nutrients and energy (Malina & Bouchard, 1991). The onset of adolescent growth spurt differs according to sex, that is, in general, adolescent spurt among girls is earlier than boys (Koziel, Hauspie & Susanne, 1995). Deficiency of required nutrients may lead to chronic under-nutrition, which is identified with reduced lean body mass, low muscular strength and working capacity (WHO, 1995). It has also been identified as one of the key determinants for future low birth weight (LBW) infants in the case of girls

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(Elizabeth, 2001) and also adult diseases (Barkey *et al.*, 2000).

Studies have been conducted in different regions of India among the urban affluent (Chugh & Puri, 2001; Ramachandran *et al.*, 2002), rural (Rao, Joshi & Kanade, 2000; Venkaiah *et al.*, 2002) and urban-rural difference in growth pattern (Adak *et al.*, 2002). These studies indicate changes in the pattern of growth and nutritional status that are basically attributed to their living conditions, food consumption and access to medical facilities. The disadvantaged groups tend to have high rates of growth retardation and prevalence of chronic under-nutrition during the adolescent period. In this context, Indian tribal communities are the most socially disadvantaged and deprived, characterised by poverty, illiteracy, unsafe drinking water and unhygienic living conditions, leading to poor health conditions (Rath, 2004). There are limited studies on tribal adolescent growth (Reddy & Rao, 2000; Mitra *et al.*, 2002) and nutritional status (Rao *et al.*, 2006). The majority of these studies have shown growth retardation and under-nutrition. There are no studies on the growth pattern of the Shabar tribe, one of the largest tribal communities of Orissa. This study aimed to investigate the pattern of growth and the nutritional status of Shabar adolescents.

SUBJECTS AND METHODS

This cross-sectional study was carried out in 9 settlements of Bhubaneswar and its adjacent areas of Khurda and Cuttack district of Orissa.

Sample size and sample selection

The sample consisted of 328 adolescents (149 boys and 179 girls) of the Shabar tribe, aged 10 to 18 years. The sample represented all adolescents from 473 families who agreed to participate in the study. Statistical sampling of individuals was not feasible because of obvious operational difficulties in the field. Each study participant was asked to give consent before taking anthropometric measurements. The study was approved by the Ethical Committee of the Indian Statistical Institute, Kolkata.

Age estimation

It is a general experience of field workers that exact age assessment in the rural area especially from the tribal communities is very difficult due to ignorance, illiteracy and lack of any written records. The ages were ascertained from the *Anganwadi* (a village level organization of Indian Council of Medical Research working specifically on mother and child health). Ages of most of the adolescents were also estimated and cross-checked from the reference to the events remembered, such as some important festivals, visits of some eminent personalities, storm, flood and horoscopes. The age was further confirmed by other family members especially mothers, or other literate members. The age of each study adolescent was recorded in complete years.

Anthropometric measurements

Anthropometric measurements reported here include height (cm), weight (kg), sitting height (cm), circumference (cm) of chest, mid-upper arm, waist, hip, calf and also skinfold thicknesses (mm) of biceps, triceps, subscapular, suprailliac and abdominal sites. The measurements were taken according to the techniques in Weiner and Lourie (1981). A portable weighing machine (Edryl India), anthropometer and tape (GPM, Swiss made) and Harpenden skinfold caliper (British Indicator Ltd.) were used for the measurements.

Data analysis

Descriptive statistics including means, standard deviation and percentile were calculated and *t*-tests were estimated for each age class and sex. The 5th percentile of BMI for age and sex was used to categorise under-nutrition using the National Center for Health Statistics (NCHS) reference (WHO, 1995; Frisancho, 1990). The present adolescents were compared with Indian Council of Medical Research (ICMR, 1972) data owing to the absence of a more recent national data, as well as muscle area (cm^2) and arm fat area (cm^2) were calculated standard equations (Frisancho, 1990). The data was analysed using SPSS 11.0 version.

RESULTS AND DISCUSSION

The means and standard deviations of weight, height, different circumferences and skinfold measurements for both boys and girls are shown in Tables 1 and 2. In both sexes the distance curves of height and weight showed a gradual increase with age. The maximum weight difference between two successive age groups (6.7 kg) was observed in boys aged 14 to 15 years, and in girls aged (4.6 kg) during 12 to 13 years. The curves then gradually stabilised with increasing age. The highest increase in height (7.60 cm) was also found between 14 to 15 years among boys, and between 12 to 13 years among girls (5.03 cm). The rapid

Table 1. Mean and standard deviation for anthropometric measurements by age and sex

Age group (Yrs.)		*Weight (kg)*		*Height (cm)*		*Sitting height (cm)*		*Chest circumference (cm)*		*MUAC (cm)*	
	n	*X*	*SD*	*X*	*SD*	*X*	*SD*	*X*	*SD*	*X*	*SD*
Boys											
10	23	24.2	2.8	129.7	4.8	63.7	2.9	61.0	2.9	16.8	1.2
11	13	26.9	3.4	137.0	6.6	67.0	4.5	63.0	3.4	17.3	1.2
12	18	27.8	5.6	138.3	9.8	68.2	4.7	63.9	4.5	18.0	3.7
13	14	30.8	5.8	140.7	9.5	69.3	6.1	65.1	4.4	18.2	1.8
14	19	35.8	6.8	148.3	6.6	72.7	3.6	70.6	5.3	20.1	2.3
15	21	42.5	5.2	155.9	6.4	75.8	3.7	74.6	4.4	21.7	1.8
16	18	44.2	6.1	156.5	7.2	76.5	5.0	76.7	5.5	22.2	2.0
17	12	45.7	6.2	157.5	8.4	78.7	5.8	77.6	6.4	23.2	3.1
18	11	46.8	6.4	159.2	9.7	80.9	6.1	78.3	3.0	23.7	0.7
Girls											
10	25	25.9	4.6	131.6	6.7	65.3	3.7	61.5	5.0	17.8	2.1
11	25	27.8	5.7	137.7	9.9	66.1	4.6	63.0	5.6	17.8	1.9
12	19	30.3	4.1	138.9	4.4	68.5	2.3	65.5	4.3	18.6	1.6
13	17	35.0	5.3	144.0	6.7	71.7	4.3	67.5	9.2	20.1	2.1
14	17	37.2	5.4	144.5	5.4	71.9	2.8	73.7	4.8	21.3	2.0
15	19	38.4	4.8	146.1	4.8	72.5	5.3	73.9	3.8	21.5	2.0
16	18	38.5	4.0	146.9	5.7	71.7	4.3	74.1	2.8	21.7	1.7
17	19	40.6	5.0	147.8	4.9	72.2	4.4	75.3	5.3	22.4	2.2
18	20	40.8	6.0	148.3	5.4	74.2	2.9	77.7	5.4	22.9	1.7

n = Sample; X= Mean; SD= Standard deviation.

Table 2. Mean and standard deviation for anthropometric measurements by age and sex

Age group (Yrs.)		*Waist circumference (cm)*		*Hip circumference (cm)*		*Calf circumference (cm)*		*Biceps skinfold (mm)*		*Triceps skinfold (mm)*		*Subscapular skinfold (mm)*		*Suprailliac skinfold (mm)*		*Abdominal skinfold (mm)*	
	n	*X*	*SD*	*X*	*SD*	*X*	*SD*	*X*	*SD*	*X*	*SD*	*X*	*SD*	*X*	*SD*	*X*	*SD*
Boys																	
10	23	52.7	4.9	60.3	3.1	24.2	1.3	3.0	0.5	6.0	1.4	5.9	1.1	5.3	1.6	6.1	1.6
11	13	54.1	2.5	63.0	3.6	25.2	1.3	2.9	0.4	5.9	1.6	5.9	0.8	5.3	0.9	6.1	1.5
12	18	54.8	3.3	63.3	6.0	25.4	2.3	2.9	0.4	5.0	1.2	6.0	0.9	5.0	1.0	5.6	1.0
13	14	56.7	5.3	66.2	5.8	27.9	1.1	3.3	0.7	5.5	1.2	5.9	0.9	5.7	1.3	6.5	1.6
14	19	58.4	4.0	71.1	4.8	28.1	2.3	3.2	0.6	5.6	1.8	7.0	1.6	5.7	1.5	7.1	2.4
15	21	61.6	3.6	75.3	3.4	28.8	1.8	3.1	0.4	5.0	0.7	7.7	1.5	5.7	0.8	6.1	1.3
16	18	64.0	3.2	76.0	4.3	29.7	2.7	3.1	0.5	5.5	1.2	8.4	1.9	6.3	2.2	7.5	2.4
17	12	64.0	6.7	76.8	5.9	30.5	2.9	3.3	0.9	5.8	2.0	8.7	2.3	6.2	1.6	7.1	1.5
18	11	64.1	5.1	77.7	4.2	30.6	1.3	2.8	0.4	4.8	0.9	8.5	1.3	6.0	1.1	6.8	0.8
Girls																	
10	25	52.9	3.6	64.7	5.8	24.8	2.1	3.4	0.7	7.1	1.7	7.8	2.2	7.1	1.8	9.3	3.6
11	25	53.7	3.9	65.0	6.0	24.8	2.3	3.7	0.6	7.4	1.5	7.7	2.1	7.5	2.7	9.1	2.7
12	19	55.0	4.1	67.5	4.1	27.0	4.0	3.4	0.8	7.2	2.5	8.5	2.2	7.8	3.1	9.4	3.1
13	17	57.0	5.3	73.2	5.5	27.2	2.1	4.3	1.3	9.6	3.3	9.9	2.7	9.7	3.5	10.6	4.0
14	17	57.7	5.9	75.9	4.3	28.4	2.1	4.4	1.1	10.1	2.4	12.7	3.0	11.3	3.6	12.2	4.7
15	19	59.1	4.0	76.4	4.1	28.7	2.3	4.7	1.6	9.9	2.9	11.2	2.8	10.0	3.1	14.8	3.6
16	18	60.0	3.9	76.8	3.7	28.9	1.7	4.3	1.4	10.0	3.4	11.6	4.0	9.5	3.5	13.8	3.3
17	19	60.0	6.6	78.3	6.9	29.7	2.3	4.3	1.5	10.4	3.1	12.9	4.2	11.4	4.1	12.8	4.0
18	20	60.2	5.2	78.8	4.4	29.7	1.8	4.0	1.3	9.6	2.4	12.0	3.0	11.0	4.5	14.4	5.4

n = Sample; X= Mean; SD= Standard deviation.

Table 3. Test of significance of differences in various anthropometric measurements between the Shabar boys and girls

Age in yrs.	*Weight*	*Height*	*Sitting height*	*Chest circum-ference*	*MUAC*	*Waist circum-ference*	*Hip circum-ference*	*Calf circum-ference*	*Biceps skinfold*	*Triceps skinfold*	*Sub-scapular skinfold*	*Supra illiac skinfold*	*Abdominal skinfold*
10	-1.51	-1.12	-1.58	-0.40	-1.86	-1.44	-3.19**	-1.18	-1.91	-2.35**	-3.70**	-3.96**	-4.60**
11	-0.80	-0.23	0.60	-0.01	-0.92	0.15	-0.98	0.65	-4.26**	-2.93**	-3.23**	-3.40**	-4.12**
12	-1.39	-0.25	-0.26	-1.09	0.08	-0.05	-2.52*	-1.42	-2.69*	-3.89**	-4.86**	-4.51**	-6.01**
13	-2.12*	-1.04	-1.30	-0.89	-2.65*	0.00	-3.39**	0.84	-3.07**	-4.92**	-6.10**	-4.47**	-5.15**
14	-0.65	1.84	-0.24	-1.18	-1.72	-0.79	-3.20**	-0.40	-4.61**	-6.53**	-7.92**	-7.09**	-8.83**
15	2.60*	5.44**	2.09*	1.76	0.42	2.11*	-1.81	0.78	-5.58**	-9.04**	-4.84**	-7.41**	-11.09**
16	3.36**	5.37**	2.99*	1.77	0.82	3.39**	0.16	1.08	-3.78**	-5.83**	-3.06**	-3.39**	-5.14**
17	2.52*	4.00**	2.06*	1.15	0.83	1.73	-0.79	1.24	-2.54**	-5.19**	-3.16**	-5.03**	-5.39**
18	2.61*	4.12**	2.79*	0.38	1.69	2.79*	0.68	1.02	-2.91**	-6.74**	-3.95**	-4.44**	-5.75**

* $p<0.05$, ** $p<0.01$

increase in weight and height in the age group of 14 to 15 years for boys and 12 to 13 years for girls indicates the adolescent growth spurt. The distance curves of sitting height also showed a gradual increase with increasing age in both sexes. The maximum increase in sitting height was 3.15 cm for boys aged 14 to 15 years and 3.21 cm for girls between 12 and 13 years. This finding also reflects the adolescent growth spurt. The increase in mid-upper arm circumference is gradual in both sexes. Similar trends were also observed in waist, hip and calf circumferences among boys and girls. However, the skinfold thickness showed a fluctuating growth pattern in both sexes.

Table 3 shows the mean differences in various anthropometric measurements between boys and girls. It is interesting to note that before 14 years of age, girls are heavier, taller, and have a higher sitting height compared to boys, but after 14 years of age, boys are heavier and taller and the differences are significant ($p<0.05$). Similarly, almost the same trend is observed in the case of mid-upper arm circumference, waist circumference and calf circumference measurements. In the case of hip circumferences however, girls have higher values than boys. Skinfold thickness measurements are significantly ($p< 0.01$) higher among girls than boys in all the ages except among the 10-year-olds, where girls have a higher value but the difference is not significant.

Similar trends were also observed among Kamar tribal boys and girls from Central India (Mitra *et al*., 2002). In general, girls had earlier maturation than boys and attained the adolescent spurt earlier. Sex

Table 4. Comparison of height (cm) of Shabar adolescent with other Indian adolescents

Age (Yrs.)	*Present Study*		*Indian (rural) (ICMR, 1972)*		*Sugalis (AP) (Reddy and Rao, 2000)*		*Kamar (CG) (Mitra et al., 2002)*	
	n	*Mean*	*n*	*Mean*	*n*	*Mean*	*n*	*Mean*
Boys								
10	23	129.7	1668	128.1	33	130.8	24	127.2
11	13	137.0	1572	132.4	38	132.6	20	129.4
12	18	138.3	1605	137.4	33	136.6	26	132.6
13	14	140.7	1393	143.5	35	141.4	23	137.2
14	19	148.3	1216	148.3	38	149.6	29	140.5
15	21	155.9	1086	153.1	30	154.2	24	144.7
16	18	156.5	971	157.5	39	158.1	22	151.8
17	12	157.5	812	160.4	18	159.4	19	155.9
18	11	159.2	885	162.0	43	161.4	21	157.5
Girls								
10	25	131.6	1254	126.7	27	129.1	21	121.5
11	25	137.7	984	131.2	42	134.9	20	127.0
12	19	138.9	967	136.7	28	138.0	29	130.6
13	17	144.0	808	141.5	22	142.7	26	133.8
14	17	144.5	656	145.3	29	146.6	21	140.4
15	19	146.1	598	147.7	12	148.9	21	145.0
16	18	146.9	509	149.6	32	150.5	19	147.9
17	19	147.8	440	150.1	21	151.0	20	150.1
18	20	148.3	365	150.0	20	151.2	22	151.7

Table 5. Comparison of weight (kg) of Shabar adolescents with other Indian adolescents

Age (Yrs.)	*Present Study*		*Indian (rural) (ICMR, 1972)*		*Sugalis (AP) (Reddy & Rao, 2000)*		*Kamar (CG) (Mitra et al., 2002)*	
	n	*Mean*	*n*	*Mean*	*n*	*Mean*	*n*	*Mean*
Boys								
10	23	24.2	1668	23.1	33	25.6	24	20.0
11	13	26.9	1572	25.1	38	26.5	20	22.8
12	18	27.8	1605	27.8	33	28.3	26	24.9
13	14	30.8	1393	31.0	35	31.6	23	25.7
14	19	35.8	1216	33.7	38	36.5	29	26.9
15	21	42.5	1086	37.1	30	41.3	24	31.0
16	18	44.2	971	41.2	39	43.6	22	34.1
17	12	45.7	812	43.9	18	44.5	19	37.2
18	11	46.8	885	45.8	43	45.2	21	40.9
Girls								
10	25	25.9	1254	22.5	27	25.1	21	20.5
11	25	27.8	984	24.5	42	28.5	20	22.2
12	19	30.3	967	27.3	28	29.4	29	23.6
13	17	35.0	808	30.6	22	34.6	26	25.4
14	17	37.2	656	33.5	29	35.8	21	27.3
15	19	38.4	598	35.4	12	40.4	21	29.8
16	18	38.5	509	37.9	32	40.6	19	31.8
17	19	40.6	440	39.3	21	41.7	20	34.0
18	20	40.8	365	39.6	20	42.5	22	36.1

differences among Shabar adolescents are pronounced for weight, height, sitting height, and waist circumference. These findings reflect the sexual physiological differentiation mechanism (Gultekin, Akin & Ozer, 2005).

The 50th percentile of weight and height for boys (Figures 1 & 2) and girls (Figures 3 & 4) were compared with the 50th percentile standard for Indian children (ICMR, 1972) and 50th percentile for American children (Frisancho, 1990). The 50th percentile of weight for Shabar boys was above that for Indian boys except among the 14-year-olds. A similar trend was observed among girls up to 13 years. Subsequently, the weights were below the Indian standard. For both sexes, the average weights were well below the median values for children in United States for all the ages. In the case of height, Shabar boys were taller up to 12 years of age compared to Indian boys, while the girls were taller up to 13 years of age, after which they fell below the Indian standard. The average height of the Shabar adolescents of both sexes is well below the median reference values for children in United States. Similar weight and height deficits were reported in other tribal adolescents in India when compared to the NCHS 50th percentile (Reddy & Rao, 2000; Mitra *et al*., 2002; Rao *et al.*, 2006).

The mean height and weight of adolescent boys and girls of the present study were compared with rural Indian adolescents (ICMR, 1972), Sugalis tribal adolescents of Andhra Pradesh (Reddy & Rao, 2000), and the Kamar tribal adolescents

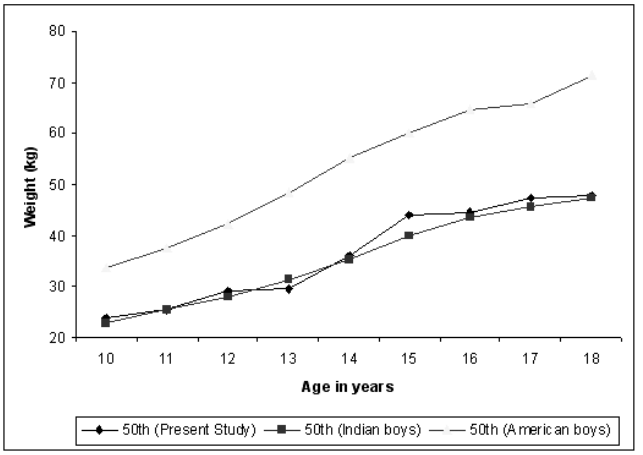

Figure 1. Percentile distribution of weight (kg) among boys

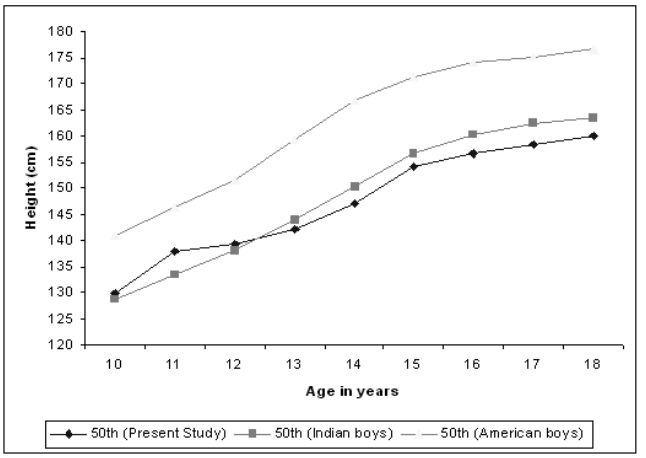

Figure 2. Percentile distribution of height (cm) among boys

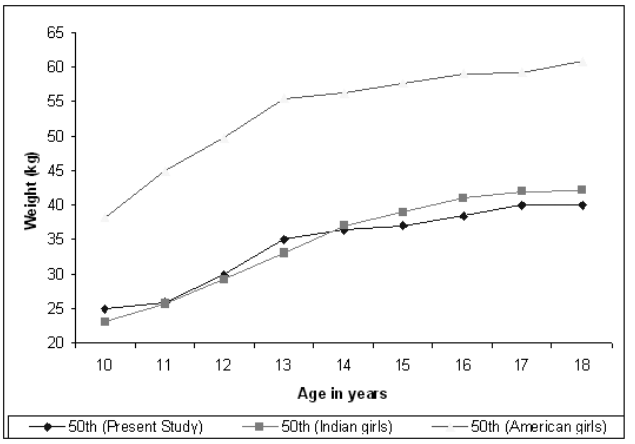

Figure 3. Percentile distribution of weight (kg) among girls

Table 6. Nutritional status of Shabar adolescent on the basis of BMI for age

Age in years	*< 5th percentile BMI age (Under-nutrition) (%)*	*≥ 5th to <85th percentile BMI age (Normal)* (%)
Boys		
10	60.8	39.1
11	69.2	30.8
12	77.8	22.2
13	57.1	42.9
14	57.9	42.1
15	33.3	66.7
16	44.4	55.6
17	25.0	75.0
18	63.6	36.4
Total	54.4	45.6
Girls		
10	36.0	64.0
11	60.0	40.0
12	36.8	63.2
13	11.8	88.2
14	29.4	70.6
15	31.6	68.4
16	27.8	72.2
17	36.8	63.2
18	40.0	60.0
Total	35.8	64.3

Chi square value- 11.42 ($p < 0.01$, between boys and girls)

of Chhattisgarh (Mitra *et al*., 2002) (Tables 4 & 5). The mean heights of the Shabar boys, compared with rural Indian boys, indicate that they were taller up to 12 years and for girls up to 13 years, after which the Shabar adolescents were shorter. The average heights of the Shabar children were similar to that of the Sugalis tribe for both sexes. On the other hand, the boys in this study were taller compared to the Kamar tribal adolescents. Similarly, the Shabar girls were taller than the Kumar girls up to the age of 15, after which they were shorter.

The Shabar boys and girls had higher weights in all the ages compared to rural Indian adolescents and the Kamars. The weights of the Shabar adolescents were similar to the Sugalis tribe of Andhra Pradesh.

When BMI for age was used, under-nutrition ($<5^{th}$ percentile) was found in 54.4% in boys and 35.8% among girls, the difference being significantly different ($p<0.01$). The highest percentage of under-nutrition was observed among 12-year-old boys (77.8%) and 11-year-old girls (60.0%).

The arm muscle and arm fat areas of the Shabar boys and girls are shown in Figures 5 and 6. In the case of arm muscle area, the curves of the boys, compared to girls, had lower values up to 14 years and then it increased rapidly and significantly. On the other hand, the mean values of arm fat area were higher among the Shabar girls than boys in all age groups. The differences are minimal till 12 years of age but become substantial subsequently.

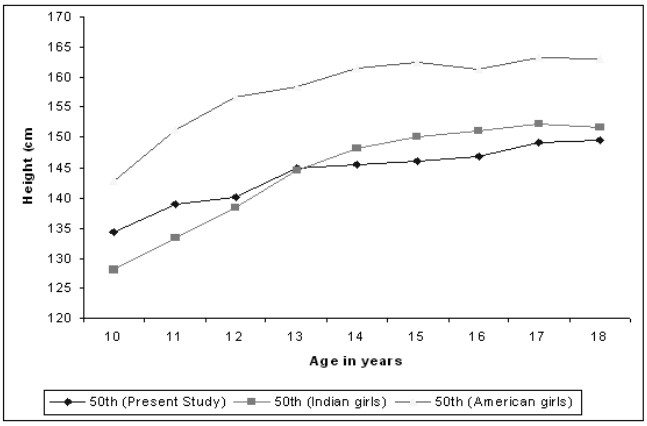

Figure 4. Percentile distribution of height (cm) among girls

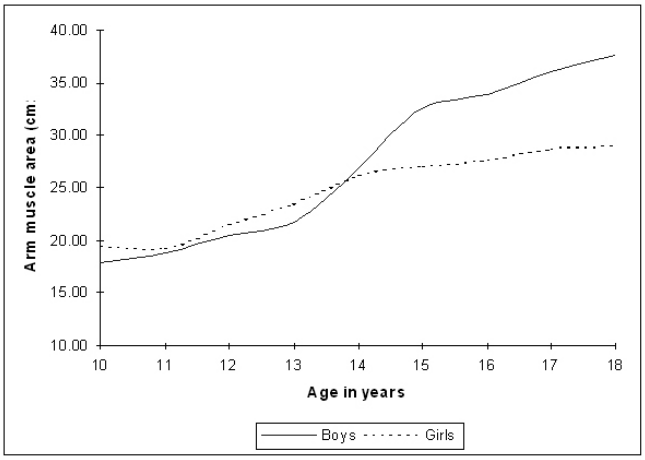

Figure 5. Distribution of arm muscle area (cm^2)

Figure 6. Distribution of arm fat area (cm^2)

CONCLUSION

The Shabar adolescents showed a high prevalence of growth retardation and chronic under-nutrition. It is noted that the nutritional status of these children is generally better than that of other tribes. These findings may be attributed to various childhood nutritional programmes through nutrition supplementation. These include the Integrated Child Development Services (ICDS) programme which has expanded steadily across the country during the 30 years of its existence with special emphasis on scheduled tribes. However, after puberty, the Shabar children do not appear to grow as well as children from other tribes. This fall in the growth parameters after puberty, compared to the Indian reference, is a matter of concern that should be addressed through dedicated nutritional interventions for these groups. The study provides valuable data on growth parameters that may be used as reference for monitoring interventions in the future. In depth studies are necessary for identifying the factors responsible for growth retardation and under-nutrition among the Shabar adolescents.

REFERENCES

Adak DK, Tiwari MK, Randhawa M, Bharati S & Bharati P (2000). Pattern of adolescent growth among the Brahmin girls - rural-urban variation. *Coll Anthropol* 26: 501- 507.

Barkey CS, Gardner JD, Frazier AL & Colditz A (2000). Relation of childhood diet and body size to menarche and adolescent growth in girls. *Am J Epidemiol* 152: 446-452.

Chugh T & Puri S (2001). Affluent adolescent girls of Delhi: eating and weight concerns. *Br J Nutr* 86: 535- 542.

Elizabeth KE (2001). A novel growth assessment chart for adolescents. *Indian Pediatr* 38: 1061- 1064.

Frisancho AR (1990). Anthropometric Standards for the Assessment of Growth and Nutritional Status. The University of Michigan Press, Michigan., USA.

Gultekin T, Akin G & Ozer BK (2005). Gender differences in fat patterning in children living in Ankara. *Anthropol Anz* 63: 427- 437.

Indian Council of Medical Research (ICMR)(1972). Growth and development of Indian infants and children. T.R.S. No 18, New Delhi, India.

Koziel SK, Hauspie R C & Susanne C (1995). Sex differences in height and sitting height in the Belgian population. *Int J Anthropol* 10: 241-247.

Malina RM & Bouchard C (1991). Growth, Maturation and Physical Activity. Human Kinetics, Champaign, USA.

Mitra M, Kumar PV, Ghosh R & Bharati P (2002). Growth pattern of the Kamars- a primitive tribe of Chhattisgarh, India. *Coll Anthropol* 26: 485- 499.

Ramachandran A, Snaehalatha C, Vinitha R, Thayyil M, Kumar CK, Sheeba L, Joseph S & Vijay V (2002). Prevalence of overweight in urban Indian adolescent schoolchildren. *Diabetes Res Clin Pract* 57: 185- 190.

Rao S, Joshi S & Kanade A (2000). Growth in some physical dimensions in relation to adolescent growth spurt among rural Indian children. *Ann Hum Biol* 27: 127-138.

Rao KM, Laxmaiah A, Venkaiah K, & Brahmam GN (2006). Diet and nutritional status of adolescent tribal population in nine states of India. *Asia Pac J Clin Nutr* 15: 64- 71.

Rath SS (2004). Indian tribes and their urgent and emerging health status: an over-view. In: *Tribal Health and Medicines.* Kalla AK & Joshi PC (eds). Concept Publishing Company, New Delhi, pp. 46-70.

Reddy PYB & Rao AP (2000). Growth pattern of the Sugalis - a tribal population of Andhra Pradesh, India. *Ann Hum Biol* 27: 67-81.

Venkaiah K, Damayanti K, Nayak MU & Vijayaraghavan K (2002). Diet and nutritional status of rural adolescents in India. *Eur J Clin Nutr* 56: 1119-1125.

Weiner JS & Lourie JA (1981). Pratical human Biology. Blackwell Scientific Public-ations, Oxford.

World Health Organization (WHO) (1995). Physical Status. The Use and Interpretation of Anthropometry. WHO Technical Report No. 854, Geneva.