Subcutaneous Fat and Lean Tissue Components in Rajput and Scheduled Caste Adolescents of a Part of Sirmour District, Himachal Pradesh

Rajan Gaur, Madhuri Mourya and Payal Kang Singh

INTRODUCTION

Body fat and its distribution have received renewed attention by the anthropologists, human biologists, epidemiologists and the medical professionals. Much of this interest emanates from the association of body fat with increased risk of certain metabolic disturbances and chronic diseases such as diabetes mellitus, hypertension, some female carcinomas, coronary artery disease, sleep disorders and polycystic ovary syndrome (Ducimetiere and Richard, 1989; Gillum, 1987; Hartz, et al., 1983; Koutoubi and Huffman, 2005; Lapidus et al., 1988; Ogretmenoglu et al., 2005; Schapira et al., 1990; Selby et al., 1989; Soler et al., 1988; Vague et al., 1988; Williams et al., 1987). Excessive body fat or obesity is an increasing public health problem in many countries (Deitz, 1994). Several techniques are now available to investigate body composition directly or indirectly such as densitometry, roentgenogrammetry, total body potassium, computed tomography, magnetic resonance imaging, anthropometry, bioelectric impedance, dual energy X-ray absorptiometry (Byers, 1987; Borkan et al., 1985; Chumlea and Baumgartner, 1990; Cuerton et al., 1975; Guo et al., 1993; Khaled et al., 1987; Lohman, 1992; Lukaski,1987; Segal et al., 1988; Seidell et al., 1989; Siri, 1961; Wilson et al.,1990). Many of these techniques, such as densitomery, total body potassium, computer tomography, magnetic resonance imaging, require sophisticated and expensive equipment in a laboratory setting or are limited because of the difficult conditions and compliance by the subjects (Guo et al., 1993). However, anthropometry employing skinfolds continues to be preferred for large-scale surveys because of its non-invasiveness, economy and ease of making reliable estimates of fat and lean components of the body.

In addition to its epidemiological significance, studies of human body composition have proved useful to understand the nature of gender, ethnic and age variations in lean and fat tissue components. Several studies have described fatness and fat patterning among Indians employing skinfold thicknesses (Indech et al., 1991; Johnston, et al., 1991; Kansal et al., 1982; Kapoor and Tyagi, 2001; Pathmanathan and Prakash, 1994; Satwanti et al., 1978, 1980; Sidhu et al., 1975; Sidhu and Sidhu, 1987; Singal et al., 1988, 1993; Singh and Sidhu, 1987; Sood and Kapil, 1974; Talwar et al., 2001). Majority of these studies described aspects of body composition of either Indian adults or sports persons and only a few focused on adolescents. Except for a report on the Gaddi boys (Singh and Sidhu, 1987), very little information is available on subcutaneous tissue folds and body fat of populations of Himachal Pradesh. This communication presents data on the skinfold thickness at biceps, triceps, subscapular and suprailiac sites of adolescent Rajput and Scheduled Caste individuals from a part of the Sirmour District of Himachal Pradesh. The paper also investigates fat and lean mass in the context of age, gender and caste variations in the present sample of 544 adolescent boys and girls.

MATERIALS AND METHODS

Present investigation is based on a sample of 544 rural school-going children ranging in age from 11 to 17 years. The subjects included 269 Rajputs (141 girls and 128 boys) and 275 Scheduled Caste (135 girls and 140 boys) children. Data for the present investigation was collected from various schools in the vicinity of Renuka Lake of Sirmour District of Himachal Pradesh in September and October, 2005. The following government and private schools were visited for collecting anthropometric and other data: 1. Dr. Y.S.Parmar Memorial School, Dadahu; 2. Girls Government Middle School, Dadahu; 3. Government Model School, Chandani; 4. Government Senior Secondary School, Sangrah; 5. Government Middle School, Sangrah; 6. Government High School, Deed Panar and 7. Government

Model School, Khalakair. For the present work six anthropometric measurements, namely stature, weight, and biceps, triceps, sub-scapular and suprailiac skinfolds were taken following standard methods prescribed by Weiner and Lourie (1981). The skinfold measurements were taken with the help of a Swiss made GPM skinfold caliper. In addition to anthropometric measurements some general information about each subject was also recorded on a specially designed proforma.

The information about the dates of birth of the subjects was obtained from the school records. The age of each subject was converted into decimal age, following the decimal age calendar of Tanner and Whitehouse (1966) and the subjects were grouped into seven age groups of one year each using age mid-points. Table 1 shows the distribution of the present sample according to age, gender and caste.

Body composition was assessed by the anthropometric method using skinfolds. Body density was estimated from the sum of biceps, triceps, sub-scapular and suprailiac skinfolds and using it in the following equations of Durnin and Rehman (1967) for adolescent boys and girls:

D (girls) = 1.1369-0.0598 x $\log_{10}$ (sum of biceps + triceps + sub-scapular + suprailiac skinfolds)

D (boys) = 1.1533-0.0643 x $\log_{10}$ (sum of biceps + triceps + sub-scapular + suprailiac skinfolds)

Percent body fat was calculated from body density (D) with the help of the following equation of Siri (1961):

Body fat (%) = (4.95/D-4.5) x 100

Fat mass was calculated from weight and percentage of fat as follows:

Fat Mass (kg) = Percentage of Body Fat x Body Weight (kg)/100

Lean body mass or fat- free mass was calculated by subtracting the fat mass (kg) from the body weight (kg). Significance of gender and caste differences was evaluated with help of one-way ANOVA.

The present sample of Rajput and Scheduled Caste children is basically a rural sample from the Dadahu Sub-tehsil of Sirmour District of Himachal Pradesh. Sirmour District is one of the 12 districts of Himachal Pradesh. Geographically, the district is bounded by Shimla District in the north, Solan District in the northwest, Uttaranchal Pradesh in the east and Yamuna Nagar District of Haryana in the south. The District is predominantly mountainous with deep valleys lying between ranges of varying elevation. The population of the district was 458593 (241299 males and 217294 females) with 410923 people or roughly 90 % of the population of this district living in villages (Census of India, 2001). One of the major tourist attractions of the area is the famous Renuka Lake.

RESULTS

Table 2 presents the descriptive statistics of height, weight, biceps skinfold, triceps skinfold, sub-scapular skinfold, suprailiac skinfold, percent fat, fat mass and fat-free mass (lean mass) of Rajput and Scheduled Caste adolescents according to age, sex and caste.

It is clear from the table that the children in the present sample show a gradual increase in mean height from 11 to 17 years. Over the age range considered here, in boys, the height increased from 136.9 to 148.7 cm among the Rajputs and 135.1 to 162.9 cm among the Scheduled Castes. In case of girls, the increase in mean height was from 137.5 to 147.7 cm in the Rajputs and from 132.5 to 156.2 cm in the Scheduled Castes. The mean weight of the

Table 1: Distribution of the present sample from the Sirmour area (H. P.) in different age categories according to caste and sex

S. No.	*Age Group (Years)*	*Number of Individuals*				*Sexes Combined*		*Caste and Sex Combined*
		Rajputs		*Scheduled Castes*				
		Males	*Females*	*Males*	*Females*	*Rajputs*	*Scheduled Castes*	
1	11	18	20	20	21	38	41	79
2	12	17	22	19	17	39	36	75
3	13	19	20	21	20	39	41	80
4	14	18	19	19	24	37	43	80
5	15	18	20	22	18	38	40	78
6	16	18	21	18	17	39	35	74
7	17	20	19	21	18	39	39	78
8	11-17	128	141	140	135	269	275	544

Table 2: Mean ± standard deviation of Height, Weight, Biceps, Triceps, Subscapular and Suprailiac Skinfolds, % Fat, Fat Mass and Fat-free Mass of 11-17 year old Rajput and Scheduled Caste boys and girls according to age.

S. No.	Age Grp. (yrs)	N		Height (cm)		Weight (kg)		Biceps Skinfold (mm)		Triceps Skinfold (mm)	
		Raj.	S.C.	Raj.	S.C.	Raj.	S.C.	Raj.	S.C.	Raj.	S.C.
MALES											
1	11	18	20	136.9 ± 5.20	135.1± 7.41	29.8±5.16	27.5± 8.47	2.8 ± 0.32	2.9 ± 0.38	4.2± 0.69	4.3 ± 0.74
2	12	17	19	139.3 ± 6.19	137.8± 8.40	30.4±5.11	29.4± 4.63	2.7 ± 0.27	3.1 ± 0.45	3.9± 0.59	4.8 ± 1.00
3	13	19	21	142.6 ± 10.33	144.0± 8.55	33.4±5.35	35.3± 6.78	2.3 ± 0.28	3.6 ± 1.08	4.3± 0.61	5.8 ± 2.36
4	14	18	19	146.8 ± 7.97	149.8± 10.20	35.8±4.05	39.4± 7.53	3.1 ± 0.29	3.4 ± 0.77	4.7± 0.63	5.3 ± 1.69
5	15	18	22	155.2 ± 5.32	153.5± 7.77	42.7±5.87	41.0± 6.57	3.1 ± 0.21	3.1 ± 0.44	4.8± 0.47	4.9 ± 0.96
6	16	18	18	154.4 ± 9.53	154.0± 11.87	43.5±6.82	42.5± 9.29	3.1 ± 0.30	3.3 ± 0.60	4.9± 0.65	5.3 ± 1.30
7	17	20	21	163.7 ± 8.25	162.9± 8.19	50.0±8.51	50.6± 7.75	3.5 ± 0.62	3.2 ± 0.54	5.6± 1.35	5.0 ± 1.17
8	11-17	128	140	148.7 ± 11.92	148.3± 12.68	38.2±9.27	38.0± 10.38	3.0 ± 0.42	3.2 ± 0.67	4.6± 0.92	5.1 ± 1.46
FEMALES											
1	11	20	21	137.5 ± 5.84	132.5± 7.41	28.6±4.28	26.8± 5.31	3.2 ± 0.56	3.8 ± 0.74	5.1±	6.3 ± 1.61
2	12	22	17	140.0 ± 5.65	138.8± 9.67	30.1±2.98	32.3± 6.75	3.4 ± 0.67	4.2 ± 1.07	5.5± 1.47	7.2 ± 2.34
3	13	20	20	142.6 ± 7.04	142.8± 7.58	32.6±6.06	34.7± 7.19	3.4 ± 0.41	4.1 ± 1.35	5.4± 0.89	7.1 ± 2.94
4	14	19	24	148.9 ± 8.87	147.3± 8.71	38.8±7.54	38.7± 5.04	3.6 ± 1.02	4.4 ± 1.24	5.9± 2.23	7.6 ± 2.71
5	15	20	18	152.1 ± 7.27	149.9± 5.86	39.1±5.22	40.7± 6.82	3.6 ± 0.70	4.4 ± 1.03	5.9± 1.51	7.7 ± 2.25
6	16	21	17	154.3 ± 3.73	152.8± 7.06	44.7±4.50	41.3± 7.89	3.9 ± 0.52	3.9 ± 1.03	6.5± 1.13	6.5 ± 2.25
7	17	19	18	155.7 ± 6.19	156.2± 4.59	45.8±5.67	43.5± 6.03	4.1 ± 0.95	4.5 ± 1.28	6.9± 2.07	7.8 ± 2.80
8	11-17	141	135	147.7 ± 9.16	145.6± 10.75	37.3±8.36	36.7± 8.35	3.6 ± 0.78	4.1 ± 1.13	5.9± 1.63	7.2 ± 2.46

S. No.	Subscapular Skinfold (mm)		Suprailiac Skinfold (mm)		Percent Fat (%)		Fat Mass (kg)		Fat-Free Mass (lean mass) (kg)	
	Raj.	S.C.	Raj.	S.C.	Raj.	S.C.	Raj.	S.C.	Raj.	S.C.
1	4.8± 1.02	5.0 ± 1.45	4.5 ± 1.17	3.8± 1.93	10.1± 2.08	9.8± 2.41	3.0± 0.82	2.7 ± 1.30	27.8± 4.56	24.7 ± 7.46
2	4.6± 0.94	4.7 ± 0.83	4.7 ± 0.99	3.6± 0.87	9.8± 1.91	10.1± 1.73	3.0± 0.91	3.0 ± 0.76	27.4± 4.30	26.4 ± 4.07
3	5.1± 0.80	5.6 ± 1.91	5.0 ± 1.18	4.7± 2.40	10.9± 1.38	12.0± 3.66	3.7± 0.91	4.4 ± 2.02	29.7± 4.57	30.9 ± 5.31
4	5.3± 0.73	5.3 ± 1.03	5.5 ± 1.43	3.9± 1.60	11.8± 1.60	11.2± 2.63	4.3± 0.90	4.5 ± 1.99	31.5± 3.30	34.9 ± 5.96
5	5.9± 0.83	5.3 ± 0.96	6.2 ± 1.41	4.3± 1.33	12.7± 1.16	11.1± 1.70	5.4± 0.93	4.6 ± 1.09	37.3± 5.09	36.4 ± 5.76
6	5.9± 0.85	6.0 ± 1.63	6.1 ± 1.81	5.1± 1.26	12.7± 1.43	12.4± 2.28	5.5± 0.84	5.4 ± 1.78	38.1± 6.23	37.2 ± 7.82
7	7.4± 1.99	7.2 ± 1.54	7.3 ± 1.35	5.0± 1.51	14.6± 2.48	12.8± 2.17	7.5± 2.41	6.6 ± 1.67	42.6± 6.37	44.0 ± 6.48
8	5.6± 1.41	5.6 ± 1.56	5.7 ± 1.63	4.4± 1.68	11.9± 2.36	11.4± 2.61	4.7± 1.96	4.5 ± 1.97	33.5± 7.50	33.6 ± 8.72
1	6.4± 1.81	5.6 ± 2.17	7.6 ± 3.08	5.6± 3.08	18.3± 2.91	17.6± 3.27	5.3± 1.49	4.8 ± 1.95	23.3± 3.07	21.9 ± 3.53
2	6.2± 1.38	6.7 ± 1.80	7.6 ± 3.08	8.1± 2.35	18.8± 2.41	20.3± 2.58	5.7± 0.99	6.6 ± 1.98	24.5± 2.39	25.7 ± 5.03
3	6.6± 1.83	7.4 ± 3.18	7.3 ± 2.75	7.5± 3.33	18.6± 2.51	19.8± 4.05	6.1± 1.60	7.0 ± 2.41	26.5± 4.71	27.7 ± 5.38
4	7.2± 2.69	7.4 ± 2.76	7.8 ± 2.24	7.1± 3.80	19.2± 3.60	20.1± 3.45	8.1± 2.88	7.8 ± 1.85	30.5± 5.20	30.9 ± 3.94
5	7.9± 2.29	8.4 ± 2.65	8.7 ± 2.36	7.9± 2.76	20.2± 2.79	21.1± 2.90	7.9± 1.80	8.8 ± 2.43	31.2± 3.98	32.0 ± 4.58
6	9.6± 2.62	7.4 ± 1.33	11.7 ± 3.27	6.4± 2.45	22.5± 2.45	19.3± 2.21	10.0± 1.47	8.1 ± 2.08	34.7± 3.78	33.3 ± 6.05
7	9.0± 2.56	7.2 ± 2.51	9.3 ± 3.36	7.6± 2.61	21.3± 3.36	20.4± 3.10	9.8± 2.19	8.8 ± 1.46	36.0± 4.36	34.7 ± 5.51
8	7.5± 2.49	7.1 ±2.53	8.6 ± 3.18	7.1± 3.06	19.8± 3.18	19.8± 3.28	7.5± 2.55	7.4 ± 2.39	29.8± 6.17	29.3 ± 6.36

children in the present sample increased with increase in age from 11 to 17 years. In case of boys the weight increased from 29.8 kg to 50.0 kg among the Rajputs and from 27.5 kg to 50.6 kg among the Scheduled Castes. Among the girls, the mean weight increased from 28.6 kg to 45.8 kg in the Rajputs and from 26.8 to 43.5 kg in the Scheduled Castes.

As can be seen in Table 2, no clear age trend was noticed in mean biceps skinfold in the boys and girls of the present sample, though the fold thickness was clearly more at 17 years than at 11 years. In case of the triceps skinfold, the Rajput as well as Scheduled Caste girls, by and large, displayed an increase in mean values with increase in age from 5.1mm at 11 years to 6.9 mm at 17 years among the Rajputs and from 6.3 mm at 11 years to 7.8 mm at 17 years among the Scheduled Castes. Though the mean triceps skinfold at 17 years in case of the boys was more than at 11 years, the overall trend presented a fluctuating age pattern. The age trend in the growth of sub-scapular skinfold in case of boys also presented a fluctuating pattern, though from 11 to 17 years there was an overall gain of 2.8 mm in the Rajputs and 2.2 mm in the Scheduled castes. The same was true for the sub-scapular skinfold of the girls in the present sample in which the net gain was 3.2 mm in the Rajputs and 1.6 mm in the Scheduled Castes. Though, overall, the suprailiac skinfold increased from 11 to 17 years in Rajput as well as Scheduled Caste boys of the present sample, the increase was not regular over the age range. The girls in the present sample showed a growth pattern of suprailiac skinfold similar to that of the boys with a net gain of 2.8 mm in Rajputs and 1.2 mm in Scheduled castes from 11 to 17 years.

Table 2 and Figure 1A show that, among the Rajput and Scheduled Caste boys of the present sample, the fat percentage, by and large, increased with age from 11 to 17 years, the increase being more among the Rajput boys than among the Scheduled Caste boys. Like the Sirmour boys, fat percentage in the Sirmour girls also showed an overall trend of increase with age from 11 to 17 years, but the variations were more than the boys. The fat mass showed a gradual increase with increase in age among the Sirmour boys and girls; the variations were more among the girls (Table 2, Fig. 1B). The fat-free mass in the Rajput and Scheduled Caste children of the present sample, on the average, showed an increasing trend from 11 to 17 years in boys as well as girls (Fig.1C).

Sex Differences: The sex differences were evaluated with the help of a one-way ANOVA analysis, the results of which are presented in Tables 3 and 4.

Table 3 shows the F-values of sex differences of various measurements of Rajput children of Sirmour area. It is clear from the table that the sex differences in the four fat folds were significant ($P \leq 0.05$) at all ages. The Rajput girls displayed thicker mean fat folds in all age groups considered

Table 3: Results of one-way ANOVA showing F-values (along with degrees of freedom) for sex differences between Rajput girls and boys of Sirmour area

Age Group (years)	*Height*	*Weight*	*Biceps skinfold*	*Triceps skinfold*	*Subsca-pular skinfold*	*Supra-iliac skinfold*	*Percent fat*	*Fat Mass*	*Lean Mass*
11	0.12 (1, 36)	0.64 (1, 36)	6.96* (1, 36)	6.99* (1, 36)	10.95* (1, 36)	16.99* (1, 36)	97.20* (1, 36)	31.99* (1, 36)	7.76* (1, 36)
12	0.14 (1, 37)	0.05 (1, 37)	18.28* (1, 37)	18.38* (1, 37)	17.36* (1, 37)	31.27* (1, 37)	156.94* (1, 37)	71.03* (1, 37)	7.24* (1, 37)
13	0.01 (1, 37)	0.19 (1, 37)	18.75* (1, 37)	18.66* (1, 37)	11.28* (1, 37)	10.89* (1, 37)	135.21* (1, 37)	33.34* (1, 37)	4.698* (1, 37)
14	5.99* (1, 35)	7.91* (1, 35)	5.22* (1, 35)	5.21* (1, 35)	7.75* (1, 35)	7.61* (1, 35)	63.94* (1, 35)	29.68* (1, 35)	1.57* (1, 35)
15	2.21 (1, 36)	3.96* (1, 36)	9.64* (1, 36)	9.69* (1, 36)	12.72* (1, 36)	15.14* (1, 36)	111.68* (1, 36)	28.31* (1, 36)	17.04* (1, 36)
16	0.01 (1, 37)	0.41 (1, 37)	30.35* (1, 37)	30.33* (1, 37)	32.49* (1, 37)	41.48* (1, 37)	222.44* (1, 37)	135.25* (1, 37)	4.38* (1, 37)
17	11.63* (1, 37)	3.31 (1, 37)	5.10* (1, 37)	5.12* (1, 37)	5.07* (1, 37)	5.50* (1, 37)	50.38* (1, 37)	9.94* (1, 37)	13.97* (1, 37)
11-17	0.62 (1, 267)	0.58 (1, 267)	56.00* (1, 267)	57.00* (1, 267)	60.00* (1, 267)	89.77* (1, 267)	534.0* (1, 267)	104.97* (1, 267)	19.47* (1, 267)

*Significant difference ($P \leq 0.05$)

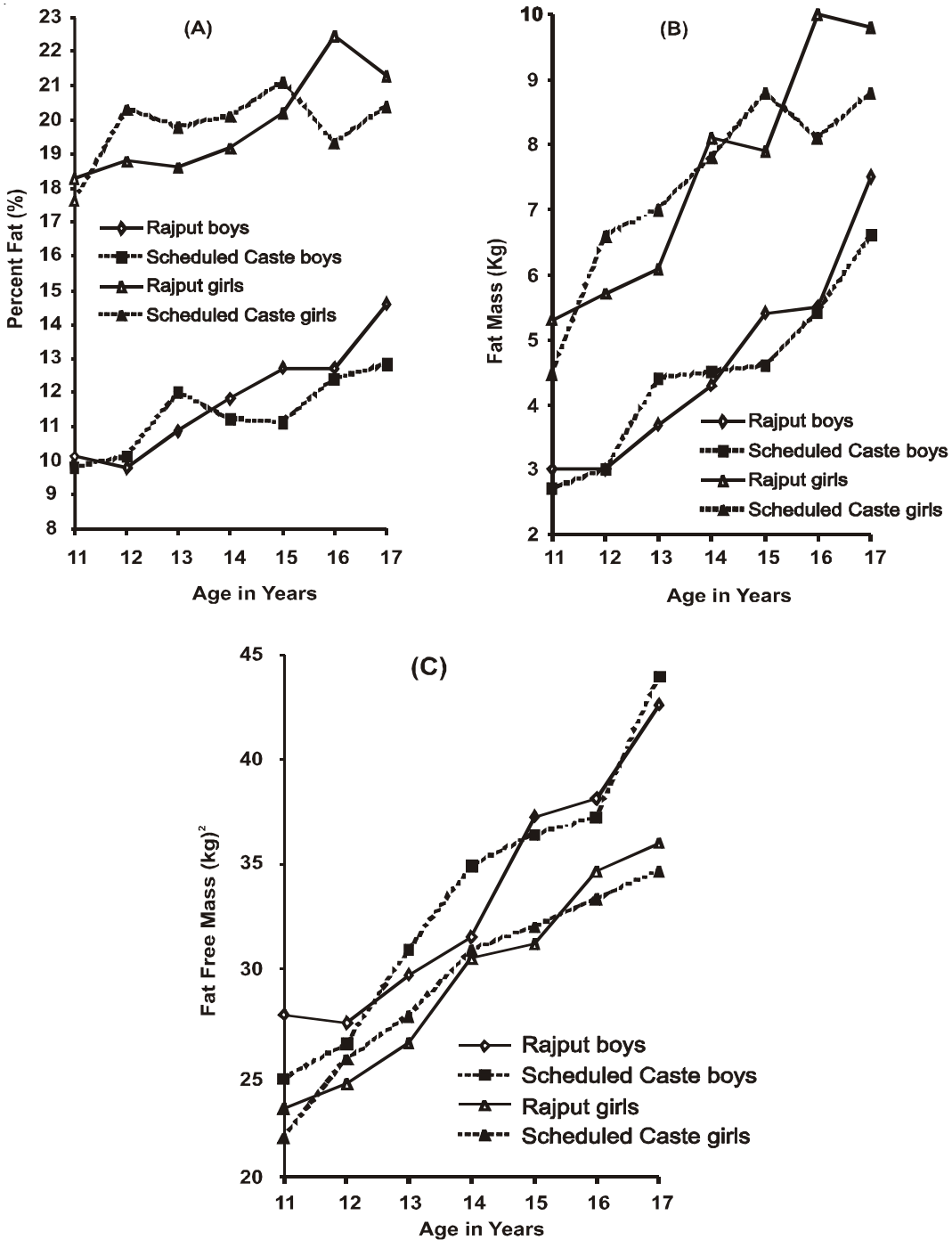

Fig. 1. Age trends in mean percent fat (A), fat mass (B) and fat-free mass (C) among adolescent Rajput and Scheduled Caste boys and girls of Sirmour District (H.P.)

here. The percentage fat and fat mass were also significantly higher (P≤0.05) in the Rajput girls as compared to the Rajput boys. However, mean lean mass was significantly less (P≤0.05) in the girls as compared to the boys.

Table 4 displays the F-values of ANOVA analysis for sex differences of different measurements of Scheduled Caste subjects of the Sirmour area. As in the case of Rajputs, the sex differences among Scheduled Castes were also, on the whole, significant (P≤0.05), with girls registering higher mean fat folds than the boys. Similarly the mean percent fat and mean fat mass were also significantly higher (P≤0.05) among the Scheduled Caste girls. The mean lean mass was, however, significantly less (P≤0.05) among the girls, as is evident from the F-values.

Caste Differences: Caste differences between the Rajputs and the Scheduled Caste subjects were analysed using one-way ANOVA analysis and the results are presented in Tables 5 and 6.

As can be seen in Table 5, among the Sirmour boys, the mean biceps and triceps skinfolds showed significant differences (P≤0.05) at 12 and 13 years only. Caste differences were not significant for sub-scapular skinfold. Suprailiac skinfold was the only skinfold that displayed significant differences (P≤0.05) in a majority of the age groups between Scheduled Caste and Rajput boys, with Rajput boys recording higher mean values.

It is clear from Table 6 that, from 11 to 15 years, the differences in mean biceps and triceps skinfolds between Rajput and Scheduled Caste girls of the present sample were significant (P≤0.05); Scheduled Caste girls registered higher mean values at most ages. The suprailiac and subscapular skinfolds differed significantly in a couple of age groups only and overall the caste differences in these two skinfolds were not significant.

It also clear from Tables 5 and 6 that, on the average, the caste differences in percent fat, fat-mass and fat free mass were not significant in Sirmour boys as well girls. By and large, in boys as well girls, the differences in mean stature and weight between Scheduled Caste and Rajput subjects of the present sample from Sirmour area were also not significant (Tables 5 and 6).

Thus, with the exception of triceps and biceps skinfolds in girls and suprailiac skinfold in boys, the caste differences in a majority of the skinfolds and calculated percent fat, fat mass, and fat-free mass were not significant.

DISCUSSION

Figure 2 (A-D) shows plots of mean heights and weights of 11 to17 year old Scheduled Caste and Rajput individuals on NCHS percentiles. Rajput as well as Scheduled Caste boys and girls were, on average, placed below the 10th percentiles of the NCHS reference in height as well as weight, indicating comparatively poor growth status. The

Table 4: Results of one-way ANOVA showing F-values (along with degrees of freedom) for sex differences between Scheduled Caste girls and boys of Sirmour area

Age Group (years)	*Height*	*Weight*	*Biceps skinfold*	*Triceps skinfold*	*Subsca-pular skinfold*	*Supra-iliac skinfold*	*Percent fat*	*Fat Mass*	*Lean Mass*
11	1.28 (1, 39)	0.09 (1, 39)	24.89* (1, 39)	24.92* (1, 39)	1.06 (1, 39)	4.80* (1, 39)	74.10* (1, 39)	16.28* (1, 39)	2.34* (1, 39)
12	0.02 (1, 34)	2.22 (1, 34)	11.16* (1, 34)	17.09* (1, 34)	19.23* (1, 34)	61.13* (1, 34)	194.19* (1, 34)	54.44* (1, 34)	0.26 (1, 34)
13	0.19 (1, 39)	0.07 (1, 39)	2.4 (1, 39)	2.41 (1, 39)	5.13* (1, 39)	9.21* (1, 39)	42.02* (1, 39)	14.28* (1, 39)	3.62* (1, 39)
14	0.73 (1, 41)	0.1 (1, 41)	9.90* (1, 41)	9.95* (1, 41)	9.20* (1, 41)	11.57* (1, 41)	86.37* (1, 41)	31.63* (1, 41)	6.73* (1, 41)
15	2.63 (1, 38)	0.01 (1, 38)	29.19* (1, 38)	29.18* (1, 38)	26.48* (1, 38)	27.99* (1, 38)	183.41* (1, 38)	51.94* (1, 38)	6.96* (1, 38)
16	0.14 (1, 33)	0.17 (1, 33)	3.5 1, 33)	3.56 (1, 33)	7.14* (1, 33)	4.19* (1, 33)	82.87* (1, 33)	16.99* (1, 33)	2.7 (1, 33)
17	6.76* (1, 37)	9.97* (1, 37)	16.77* (1, 37)	16.87* (1, 37)	0.01 (1, 37)	14.99* (1, 37)	80.57* (1, 37)	20.01* (1, 37)	23.30* (1, 37)
11-17	3.49 (1, 273)	1.4 (1, 273)	75.24* (1, 273)	75.24* (1, 273)	36.65* (1, 273)	86.89* (1, 273)	553.64* (1, 273)	121.87* (1, 273)	21.33* (1, 273)

*Significant difference (P≤0.05)

Table 5: Results of a one-way ANOVA showing F-values (along with degrees of freedom) for caste differences between Rajput and Scheduled Caste boys of Sirmour area

Age	*Ht*	*Wt*	*Bsf*	*Tsf*	*Ssf*	*Supilsf*	*%fat*	*Fat mass*	*Lean mass*
11	0.76 (1, 36)	1.04 (1, 36)	0.49 (1, 36)	0.48 (1, 36)	0.28 (1, 36)	1.56 (1, 36)	0.09 (1, 36)	0.63 (1, 36)	0.95 (1, 36)
12	0.38 (1, 34)	0.38 (1, 34)	6.30* (1, 34)	7.45* (1, 34)	0.18 (1, 34)	11.66* (1, 34)	0.27 (1, 34)	0.02 (1, 34)	0.47 (1, 34)
13	0.23 (1, 38)	0.93 (1, 38)	5.40* (1, 38)	6.39* (1, 38)	1.19 (1, 38)	0.22 (1, 38)	1.5 (1, 38)	1.92 (1, 38)	0.56 (1, 38)
14	0.97 (1, 35)	3.15 (1, 35)	2.2 (1, 35)	2.29 (1, 35)	0.01 (1, 35)	10.16* (1, 35)	0.74 (1, 35)	0.25 (1, 35)	4.2* (1, 35)
15	0.62 (1, 38)	0.7 (1, 38)	0.18 (1, 38)	0.19 (1, 38)	4.66* (1, 38)	18.38* (1, 38)	10.80* (1, 38)	6.75* (1, 38)	0.23 (1, 38)
16	0.01 (1, 34)	0.14 (1, 34)	0.44 (1, 34)	1.92 (1, 34)	0.08 (1, 34)	3.82* (1, 34)	0.52 (1, 34)	0.05 (1, 34)	0.15 (1, 34)
17	0.93 (1, 39)	0.55 (1, 39)	2.47 (1, 39)	2.46 (1, 39)	0.04 (1, 39)	28.0* (1, 39)	6.20* (1, 39)	1.98 (1, 39)	0.56 (1, 39)
11-17	0.06 (1, 266)	0.01 (1, 266)	2.02* (1, 266)	2.29* (1, 266)	0.01 (1, 266)	40.22* (1, 266)	2.5 (1, 266)	0.76 (1, 266)	0.01 (1, 266)

*Significant difference (P≤ 0.05)

Table 6: Results of a one-way ANOVA showing F-values (along with degrees of freedom) for caste differences between Rajput and Scheduled Caste girls of Sirmour area

Age Group (years)	*Height*	*Weight*	*Biceps skinfold*	*Triceps skinfold*	*Subsca-pular skinfold*	*Supra-iliac skinfold*	*Percent fat*	*Fat Mass*	*Lean Mass*
11	5.90* (1, 39)	1.41 (1, 39)	7.96* (1, 39)	7.97* (1, 39)	1.59 (1, 39)	4.61* (1, 39)	0.44 (1, 39)	0.63 (1, 39)	1.72 (1, 39)
12	0.26 (1, 37)	1.79 (1, 37)	7.80* (1, 37)	7.80* (1, 37)	1.02 (1, 37)	0.15 (1, 37)	3.48 (1, 37)	3.85* (1, 37)	0.97 (1, 37)
13	0.01 (1, 38)	1.02 (1, 38)	6.40* (1, 38)	6.47* (1, 38)	1.02 (1, 38)	0.04 (1, 38)	1.47 (1, 38)	1.96 (1, 38)	0.58 (1, 38)
14	4.85* (1, 41)	1.99 (1, 41)	4.54* (1, 41)	4.41* (1, 41)	0.63 (1, 41)	0.44 (1, 41)	0.68 (1, 41)	0.16 (1, 41)	3.04 (1, 41)
15	1.03 (1, 36)	0.71 (1, 36)	8.58* (1, 36)	8.64* (1, 36)	0.34 (1, 36)	1.01 (1, 36)	1.05 (1, 36)	1.43 (1, 36)	0.35 (1, 36)
16	0.7 (1, 36)	2.77 (1, 36)	0.01 (1, 36)	0.01 (1, 36)	9.97* (1, 36)	13.34* (1, 36)	16.77* (1, 36)	11.56* (1, 36)	0.78 (1, 36)
17	0.75 (1, 35)	1.42 (1, 35)	1.17 (1, 35)	1.18 (1, 35)	4.76* (1, 35)	2.86 (1, 35)	0.7 (1, 35)	2.47 (1, 35)	0.66 (1, 35)
11-17	2.1 (1, 274)	0.41 (1, 274)	24.70* (1, 274)	27.00* (1, 274)	1.81 (1, 274)	2.09 (1, 274)	0.1 (1, 274)	0.3 (1, 274)	0.46 (1, 274)

*Significant difference (P≤0.05)

NCHS reference standards were based on the American population. It is well known that growth performance of populations from poor and developing countries, such as India, is generally poor as compared to that of developed countries (Eveleth and Tanner, 1990).

The mean triceps and sub-scapular skinfolds of the present sample from Sirmour area has been compared with those of other populations from within and outside India (Figure 3 A to D). The triceps skinfold of the Sirmour girls and boys has been compared with that of American Whites (Ryan et al., 1990), well-to-do Indians (Vijayaraghavan et al., 1974), Low-income Indians (Vijayaraghavan et al., 1974), Well-to-do Chandigarh boys and girls (Johnston, et al., 1991), Manipuris (Gaur and Singh, 1995), Haryanvi Jat girls (Talwar et al., 2001) and Gaddi Rajput boys (Singh and Sidhu, 1987). The mean triceps skinfolds of Sirmour girls are distinctly less than that of the other populations, except the Haryanavi Jat girls who show thinner triceps skinfolds at 12 – 14 years than the Scheduled Caste girls of the present Sample (Fig. 3A). By and large, the mean triceps skinfolds of the boys in the present sample were less than that of all other populations under comparison (Fig. 3B).

The mean sub-scapular skinfold of Rajput and

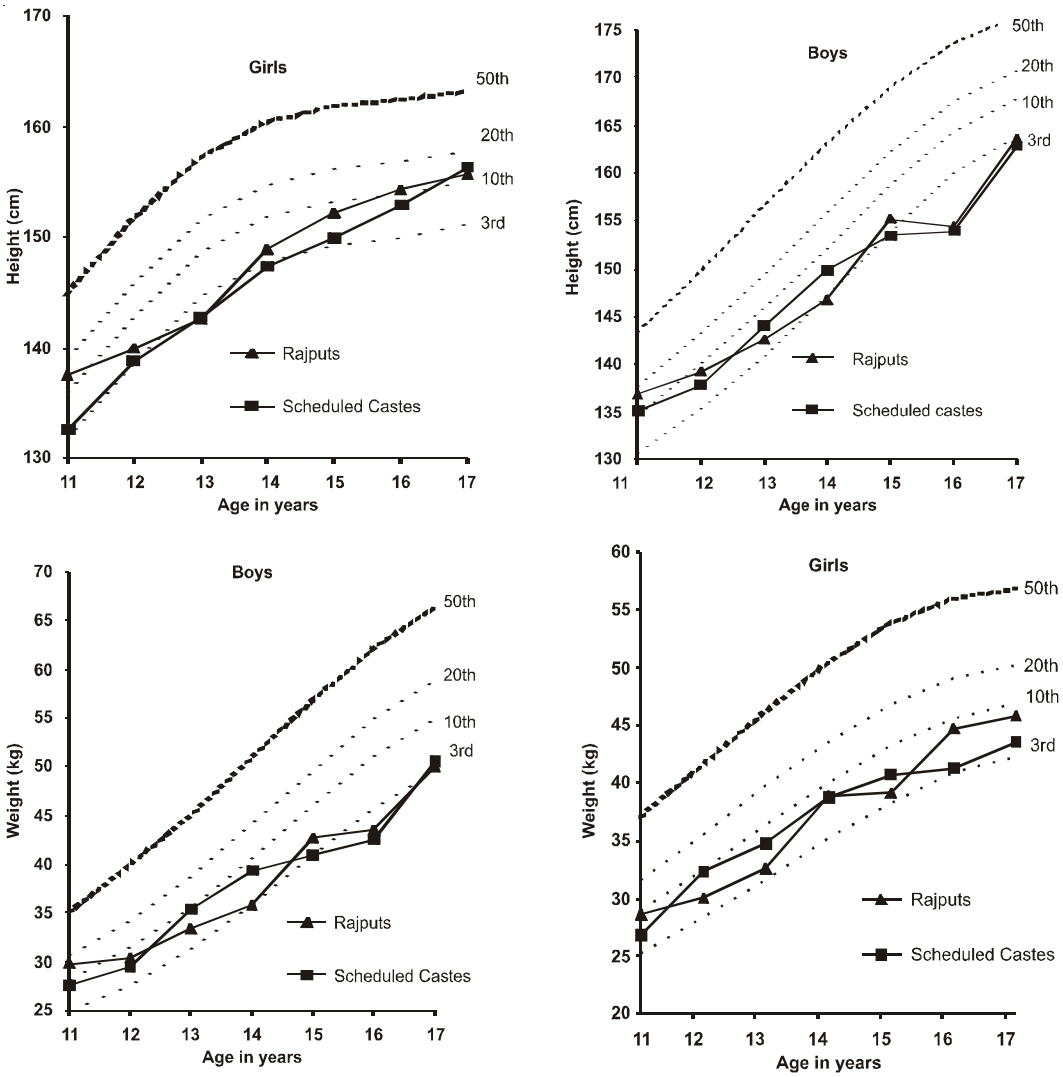

Fig. 2. Mean heights and weights of Rajput and Scheduled Caste boys and girls of Sirmour Area (H.P.) plotted on NCHS percentiles.

Scheduled Caste boys and girls in the present sample is compared with that of Americans (Ryan et al., 1990), Well-to-do boys and girls from Chandigarh (Johnston et al., 1991), Manipuris (Talwar and Singh, 1995), Haryanavi Jat girls (Talwar et al., 2001) and Gaddi Rajput boys (Singh and Sidhu, 1987). Except for the Jat girls, the sub-scapular skinfold of Sirmour girls in the present sample was less than that of the other populations (Fig. 3C). On the average, the mean sub-scapular skinfolds of the boys from Sirmour area were thinner than that of other populations (Fig. 3D).

These comparisons reveal that, on the whole, the subcutaneous fat reserves of the Sirmour boys as well as girls were less than that of the other populations from within and outside India. The quantum of difference was much more with the Americans, well-to-do Indians and Chandigarh samples, which are samples from well-to-do populations. The Sirmour sample is a low-income rural sample. Thus one of the reason for low fat reserves among the present sample

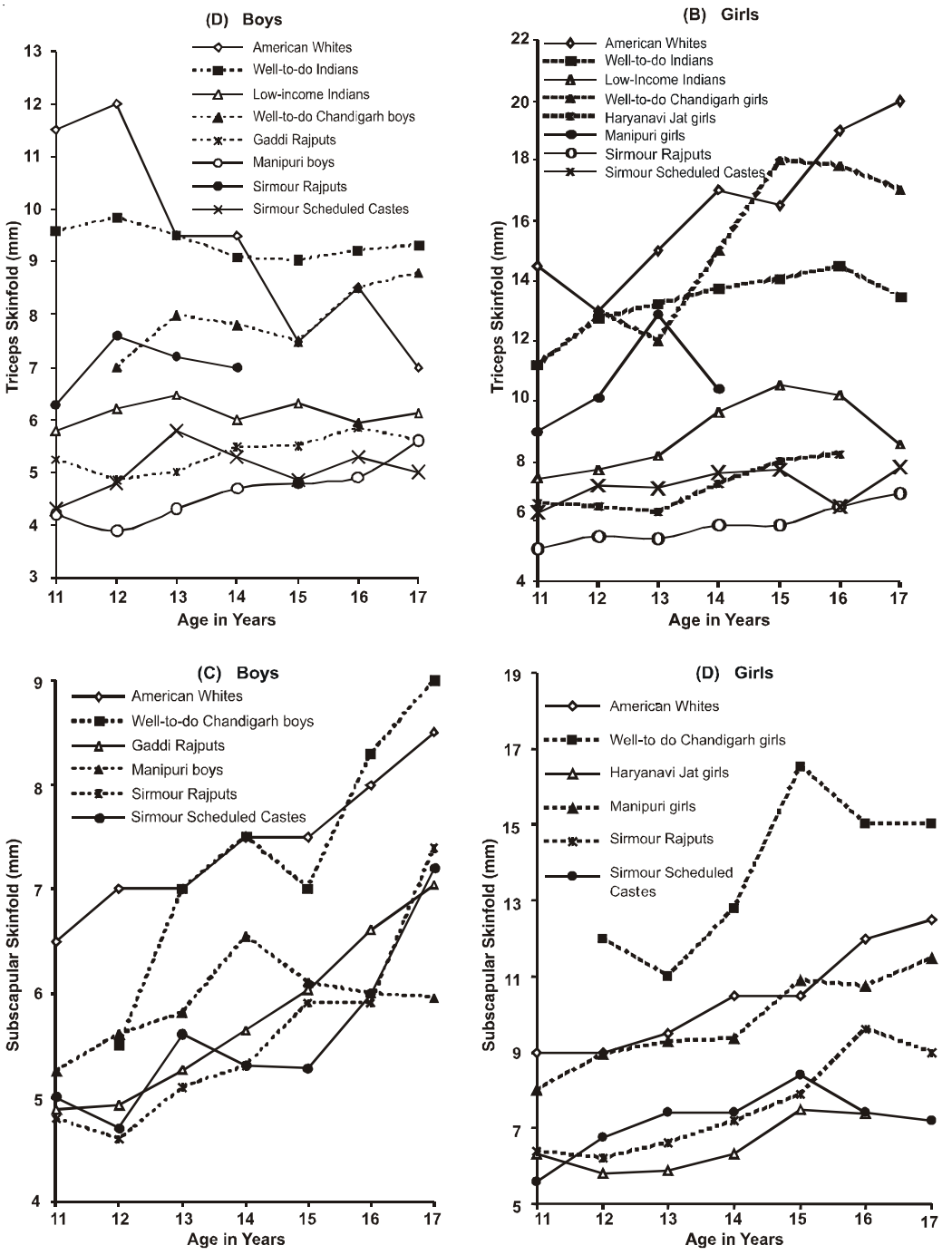

Fig. 3. Comparisons of means of triceps (A and B) and subscapular (C and D) skinfolds of Sirmour children with that of other populations.

could be socioeconomic. Majority of the samples with which the present sample has been compared are from populations inhabiting the plains. The Sirmour sample is from a moderate altitude mountainous area requiring routine strenuous activities during their daily life, which could explain their low fat reserves. Apart from these, ethnic differences could also be partly responsible. It seems that a combination of factors namely, geographic, socioeconomic and ethnic, might be responsible for the low subcutaneous fat reserves among the present sample.

There were significant gender differences in skinfold thicknesses, with girls having thicker fat folds. The percent body fat and fat mass was also significantly higher in the girls of the present sample. Generally, girls have more body fat than boys (Holliday, 1986). The average male has 12% of his body weight as fat while the average female has 25% (Holliday, 1986). Present results are thus consistent with the more fatty nature of the female as compared to the male. Similar results were reported by a number of other workers (Forbes, 1987; Frisancho, 1981; Gultekin et al., 2005; Johnston et al., 1974,1991; Nelson and Barondness, 1997; Pathmanathan and Prakash, 1994; Ryan et al., 1990).

The caste differences in the thickness of various skinfolds as well in the percent fat and fat mass between the Rajputs and the Scheduled Castes boys and girls from the Sirmour area were, by and large, not significant. The Rajputs of this area are high caste land owners and enjoy a comparatively better socioeconomic status than the Scheduled Castes. Therefore, one would expect the Rajputs to show better growth performance and greater subcutaneous fat reserves than the Scheduled Castes. But that was not the case as the differences in subcutaneous fat between Rajputs and Scheduled Castes were statistically not significant. The present sample is from a mountainous area of moderate altitude where both these caste groups have been living for generations. They were equally exposed for a long period of time to the tough conditions of a mountainous region, which probably played a major role in shaping their body constitution and physique. Apparently, despite socioeconomic differences, the influence of prolonged adaptation to a set of environmental determinants was probably overriding. Singh and Singh (1991) did not find much difference in physique between Brahmins and Rajputs of Chamba, a hilly area of moderate altitude of Himachal Pradesh. Similarly, Singh and Bhasin (1990) also noted resemblances in body physique among Brahmin, Rajput and Scheduled Caste boys from a part of Jammu and Kashmir. Gaur and Sharma (2004) also noted similarity in physique and constitution between Brahmins and Scheduled Castes of Bhimtal area of Uttaranchal. It may thus be concluded that populations exposed to same environmental situations over a prolonged period of time tend to develop similarity in body constitution. Investigations on larger samples from environmentally unique areas are necessary to further explore the issue.

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KEYWORDS Anthropometric Measurements. Adolescent Boys and Girls. Body Constitution. Environmental Situations

ABSTRACT Subcutaneous fat and lean tissue components of a cross-sectional sample of 544 adolescent boys and girls of a part of the Sirmour District of Himachal Pradesh are described. The sample consisted of 269 Rajputs (128 boys and 141 girls) and 275 Scheduled Castes (140 boys and 135 girls) ranging in age from 11 to 17 years. Body composition was assessed by the anthropometric method using skinfolds. Anthropometric measurements, namely stature, weight, biceps, triceps, sub-scapular and suprailiac skinfolds, were taken using standard instruments and procedures. Body density was estimated from the sum of biceps, triceps, sub-scapular and suprailiac skinfolds using the equations of Durnin and Rehman (1967) for adolescent boys and girls. Percent body fat was calculated from body density. One-way ANOVA was used to evaluate the significance of gender and caste differences. On the average, the percent fat and fat mass increased from 11 to 17 years in girls as well boys, with girls showing more variations. The mean percent fat and fat mass were significantly higher ($P \leq 0.05$) in the Sirmour girls as compared to the boys, while the mean lean mass was significantly less ($P \leq 0.05$) in the girls. With the exception of triceps and biceps skinfolds in girls and suprailiac skinfold in boys, the caste differences in a majority of the skinfolds and calculated percent fat, fat mass and fat-free mass were not significant. It may be concluded that people exposed to same environmental situations over a prolonged period of time tend to develop similarity in body constitution.

Authors' Address: **Rajan Gaur, Madhuri Mourya and Payal Kang Singh,** Department of Anthropology, Panjab University, Chandigarh 160 014, INDIA