DISCUSSION
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In the present study a total of 1100 children were studied for various anthropometric measurements and development of secondary sex characters. All these children belonged to well to do families having good awareness about health. So the environmental and dietary factors were optimal for growth of these children. Thus, the data collected could be used as norms for the Indian children belonging to this part of the country.

Total of 11 groups consisting of 100 children in each group, 50 males and 50 females (6-16 years) were studied. The parameters assessed were weight, height, sitting height, head circumference, chest circumference, mid arm circumference, skinfold thickness at triceps, subscapular and suprailliac areas, segmental measurements of upper and lower limbs and sexual developments. The parameters for the sake of convenience are discussed one by one as follows.

Weight

Body weight is the single most important measurement of body growth as it is composite of all other measurements of body and thus is an overall
measure of body size (Illingworth, 1964). In the present study the mean weight of the girls was more than that of boys at the age of 6 years. From 7th to 9th years the boys were heavier than girls. From 10th year to 13th year of age the girls were heavier than the boys and thereafter the boys gained more weight than girls (Table 4) and Figure 1). The growth spurt of weight in girls was recorded between 9-13 years and between 11 to 16 years in boys. This observations was in accord with Tanner (1976), Aggarwal et al. (1970), Vijaya Raghavan et al. (1971), ICMR (1972), Aggarwal et al. (1974), NCHS standards (Nelson, 1987), thereby indicating a growth spurt during these years.

In the present study the mean weight in both the sexes was significantly higher than that of ICMR study (1972) at all age groups (Fig. 18). The difference is because ICMR (1972) study included children from mixed socio-economic groups, whereas in the present study all the children belonged to the affluent group as per extended Kuppuswamy scale. The second valid explanation for this difference is that data presented by ICMR (1972) study were collected over an extended period i.e. from 1956 to 1965 and the increase in weight may be because of the secular trend towards increase in weight with each succeeding generation.
The increase in weight of both boys and girls in the present study correlates well with the western studies like NCHS (Nelson, 1987) and Tanner (1976) and also Indian studies done on upper socio-economic groups of children like Raghavan et al. (1971), Sikri (1972), Aggarwal et al. (1974) and Rath et al. (1978). Singh et al. (1972) & Bhandari et al. (1974) studied children from lower and mixed socio-economic groups and hence cannot be compared with the present study.

Standing Height

Standing height is a measure of linear growth and together with weight which is a measure of body mass, is an excellent index or parameter to know the extent of growth in a child. As is evident from Table 5 the mean height of girls at 10th, 11th and 12th birthday was more than the boys, particularly at 10th year at which the difference between the two was statistically significant. The linear spurt of girls started at the age of 9 years and continued till 13 years. The boys are significantly taller than girls after 14 years though the spurt started at 11 years and continued till 16 years but the difference was significant from 15-16 years. Similar findings
were observed by Tanner (1976), Aggarwal et al. (1970), ICMH (1972), Aggarwal et al. (1974), Raghavan et al. (1977), NCMS (Nelson, 1987) around the age of 9-13 years in girls and 11 to 16 years in boys.

The mean height observed in the present study was comparable with NCHS standards (Tanner, 1976) and Nelson, 1987). This may be because of the environmental factors like good nutrition, health awareness and better standards of living influencing the height. Raghavan et al. (1971), Sikri (1972) and Rath et al. (1978) studied height in upper socio-economic status children in preadolescence and adolescence and the results of their studies were comparable with the present study. The subjects of the study done by Aggarwal et al. (1974) were slightly less in height as compared with the present study though both the studies are done on upper socio-economic status children. This difference may be due to the geographical distribution.

ICMR (1972), Bhandari et al. (1974) and Singh et al. (1979) observed significantly lower mean values than the present study in boys and girls. This difference as already stated earlier may be because the sample belonged to poor or mixed socio-economic status.
Sitting Height

Sitting height of girls was more at 10 years of age as compared to boys in the present study (Table 6). But at the age of 15 and 16 years it was significantly higher in boys as compared to girls (Fig. 3). Thus the growth spurt in girls started earlier than boys and also it ended earlier. The spurt in sitting height as well as mean sitting height was comparable with British Children (Tanner, 1973; Rath et al., 1978). However, it was significantly lower when compared with ICMR (1972) and studies done by Bhandari et al. (1974), and Singh et al. (1979). This difference can well be explained on the basis of socio-economic status.

Head Circumference

Head circumference being an important part of body growth, in the present study, showed a gradual increase in size from 6-16 years. Also the head circumference of boys is significantly larger than the girls at all age groups (Table 7). This is in agreement with the study done by Roche et al. (1987) [Since NCMS has made standards for head circumference only till the age group of 36 months, Roche et al. (1987) made standards for American children from 0-18 years].
Head circumference of the present study are higher than that reported by ICMR (1972) and Bhandari et al. (1975) and the reason for this is well understood. Apart from the socio-economic status, the lower values of head circumference in both the sexes of studies done by ICMR (1972) and Bhandari et al. (1975) may be because of prevalence of low birth weight in their study sample and ethnic differences.

The present study is not comparable with Tanner (1976) and Roche et al. (1987) who revealed higher values for head circumference in western children. This may be due to racial differences socio-economic levels and environmental factors.

The pubescent spurt of head circumference as seen both in males and females (Table 7) and this is because of the changes in the scalp thickness than the cranial thickness. A similar spurt was observed by ICMR (1972), Aggarwal et al. (1974). This spurt was larger in girls than boys was observed by Eichorn and Bayley (1962).

Chest Circumference

In the present study the chest circumference increased progressively with age. The boys had a higher chest circumference at all ages but the difference was not statistically significant except between 11-14 years and also at 9 years (Table 8).
The chest circumference also showed a pubertal growth spurt in both the sexes (Fig. 5). The growth spurt of chest circumference of present study corresponds with the pubescent growth spurts observed by ICMR (1972), Aggarwal et al. (1974) and Tanner (1976). Aggarwal et al. (1974) observed a higher mean values in chest circumference in girls than the boys.

The mean values of chest circumference in the present study corresponded with the values of Rath et al. (1978) but were higher than the ICMR (1972) and Bhandari et al. (1975) values. The reasons for this is already discussed earlier is the difference in socio-economic levels.

**Mid Arm Circumference**

Mid arm circumference is an indicator of nutritional status and in the present study increased in both sexes with age. The maximum increase being 9-13 in girls and 12th to 16th years in boys when the pubescent growth spurt occurred. The difference was statistically significant only at age groups 15 and 16 years (Table 9, Fig. 6). Inspite of the lower values of ICMR (1972) than the present study, the growth spurt in mid arm circumference are between the two are well comparable. Similarly Aggarwal et al. (1974) and Rath et al. (1978) also showed an adolescent growth spurt of mid arm circumference in both sexes.
The mean values of mid arm circumference of the present study and the study done by Rath et al. (1978) are comparable. The results of the present study of mid arm circumference are higher and not in accord with ICMR (1972) and Bhandari et al. (1975). This is because the sample is drawn from lower mixed socio-economic status.

**Triceps Skinfold Thickness**

Skinfold thickness have been shown to be useful indicators of body fat and hence of caloric reserves (Raghavan et al. 1974). In the present study the girls had a higher values for triceps skinfold thickness than the boys and the difference was statistically significant in all age groups except 6, 7 and 15 years of age (Table 10). This observation of triceps skinfold thickness of the present study when compared with Hammond (1955) were found to be lower for all ages. This may be because of the racial and environmental factors.

The mean values of the present study were higher than the Sood et al. (1984) in rural boys. This is because our study was done in upper socio-economic status who are more nourished than their rural counterparts.
Subscapular Skinfold

Tanner and Whitehouse (1975) demonstrated considerable difference in growth curves between limb and body fat and, therefore, recommended that to have an idea of body fat the triceps skinfold must be included with one more skinfold thickness from trunk, i.e. subscapular skinfold. In the present study the mean subscapular skinfold thickness gradually increases from 6-16 years in girls but in boys the values are at the lowest at 8 years and then it rose with slight plateau up to 12 years. In girls there is a steady rise from 7-11 years and thereafter subscapular skin fold thickness again decrease from 11-12 and again there is a steady rise from 12-16 years (Table 11). The present study is in accord with Tanner and Whitehouse (1975) with only slight difference that in their study, the subscapular skinfold thickness was lowest at 7 years in boys and then it rose with a steady plateau from 11-12 years, whereas in girls the lowest values was 6-7 and thereafter it increased gradually. The present study's observations of subscapular skinfold thickness are lower in girls as compared to Hammond (1955). On the other hand the studies conducted by Hammond (1955) and Sood et al. (1984) on boys for subscapular skinfold thickness was comparable with present study. In the study
Hammond (1955) and Sood et al. (1984) the observations on boys subscapular skin fold thickness was comparable with present study.

Suprailiac Skinfold

Waaler (1983) recommended the measurement of suprailliac skinfold in addition to triceps and subscapular skinfold as there was considerable difference between body and limb fat. In present study the suprailliac skinfold values were less than triceps and subscapular skinfold at almost all age groups. The mean values were slightly higher in cases of girls as compared to boys and the difference was statistically significant from 6-16 years (Table 12) which well explainable on the characteristic fat distribution in the girls.

When the present study was compared with the British study (Hammond, 1955), it was found that suprailliac skinfold thickness was lower than the British children. Present study results of suprailliac skin fold thickness of boys from 6-16 years of age was more than Sood et al. (1984) who conducted study on rural boys.
Segmental Measurements of Proportions

The growth trends of Punjabi affluent group of children found in present study follows the "general law of developmental direction" as mentioned by Jackson (1914) and which was termed by Kingsbury (1924 and 1926) as cephalic caudal differential growth.

The crown heel : Crown rump ratio decreases with age although the stature increases as a whole. The lower extremely grows faster throughout the period of growth in relation to stature, whereas the relationship of upper extremity to stature records only small fluctuations. It has been further noticed that there were very small fluctuations in crural index and brachial index. Leg length index and hand length index, fore arm index between 6-16 years in both sexes. Donge et al. (1979) also observed that lower extremity of boys from age group 9-10 years grew relatively faster than stature while in case of girls it grew relatively faster in relation to stature between age group 5-6 years. Thus the various segments of human body keep growing at different rates at different times at different stages of growth and development hence emphasizing the importance of studying the body proportions or body segments.
Rate of growth calculated from the average values of various measurements in the present study had been found to be invariably higher for all the body dimensions during the pubertal growth spurt i.e. 9-13 years in case of females and 11-16 years in case of males.

In the present study, it is observed that those parts of the body which grow at the least rate e.g. head, reach mature dimensions earliest and those which grow at the fastest rate e.g. extremities reach maturity the last. Such correlations between variability of various dimensions and rate of growth had also been observed by Boas (1897) and Schultz (1926).

The findings of hand length and foot length and their positive and significant correlations with crown heel length, head circumference and weight is one of the marked feature of the present study. The correlation and regression equations have been derived (as discussed in the Observations) and it is obvious from these equations that given the value of hand length or foot length a fair estimate of crown heel length, head circumference and of weight can be made in children. The knowledge may be of practical use in medico-legal investigations and in anthropometry as often only a limb or its part
may be available from which the stature and other values can be calculated. Sexena (1984) studied hand length, hand breadth and sole length and their possible correlation with stature in adult male Nigerian medical students. James et al. (1979) reported a positive linear correlation between foot length and occipito frontal circumference, crown heel length and crown rump length in neonates of gestational age 26-46 weeks.

Secondary Sex Characters

The adolescent growth is remarkable not only on account of the dramatic physical events but equally characteristic sexual development that takes place simultaneously. The sexual development transforms an unmature child to mature adult capable of procreation.

1. Females: Sexual growth can be objectively and accurately measured by following the development of secondary sex characters such as breast, pubic hair and axillary hair. The maturity of internal sex organs is marked by onset of menarche which provides landmark in females. In the present study the secondary sex characters were noted to follow a general pattern as discussed in the following paragraphs.
Breast Development: As shown in Table 28B the median age for attainment of stage 2 of breast development in present study was 10.39 years and median age for stage 4 was 13.29.

Marshall and Tanner (1969) observed that mean age for completion of breast development was 4.18 years and mean age for attainment of stage 2 of breast development in their study was 11.15 years i.e. on an average 0.76 years later than the girls of present study but complete maturation occurred earlier. This may be because our study is a cross-sectional one.

Kaul et al. (1983) observed that stage 2 of breast development was at a median age of 10.99 years and stage 5 at 17.37 years i.e. it took on an average 6.38 years to complete sexual development. The median for stage 5 is not observed in our study thus the comparison cannot be made.

Indirabai and Vijay Laxami (1973) reported mean age of appearance of breast development was 10.25 years in South Indian girls and Bhargava (1980) reported mean age 9.2 for Delhi school girls and Raynolds and Wines (1948) 10.8 years for American girls.

Pubic Hair

As shown in Table 28B the stage 2 of pubic hair development appeared at a median age of 10.39 years.
The median age for stage 5 was not observed till the age of 16 years in the present study, thus showing that pubic hair development continues even after the age of 16 years in girls.

In the study conducted by Marshall and Tanner, the mean age of stage 2 was 11.69 years and it took 2.72 years for those girls to reach stage 5.

In the study conducted by ICMR (1972), the mean age of appearance of pubic hair in M.P. urban girls was 12.23 years and all Indian (pooled) figure was 12.72 years. But the stage of appearance of pubic hair were not accounted for that study and hence a comparison is not possible.

Kaul (1983) observed that median age for appearance of stage 2 was 11.48 years and for stage 5 was 16.77 years and it took on an average 5.29 years for complete maturation of pubic hair.

Indirabai and Vijay Laxami (1973), Bhargava (1980) and Renolds Wines (1948) reported mean age for appearance of pubic hair as 10.50 years in South Indian girls, 10.6 years in Delhi girls and 11.6 years in American girls respectively.

Other Sexual Characteristics

As shown in Table 30B the median age for
appearance of axillary hair was 11.83 years, for apocrine sweat glands 12.31 years and for menarche 13.72 years.

In the ICMR (1972) study, mean age for appearance of axillary hair and menarche were 11.43 years and 12.96 years respectively in Madhya Pradesh urban girls. The corresponding all India (pooled) figures were 12.63 years and 13.39 years for axillary hair and menarche respectively.

The study done by Kaul (1983) observed that mean age for appearance of axillary hair was 11.53, apocrine sweat glands 12.39 and menarche 13.57. The observations of this study were quite similar to the present study.

Indirabai and Vijayalaxmi (1973) reported that mean age of axillary hair was 13.36 years in South Indian girls. Aggarwal et al. (1947) reported that 39 per cent pubescence in girls appeared by the age of 9 years and 68 per cent by 10th year and 85 per cent by the age of 11 years. Median age of menarche was 12 years.

In Males: The sexual growth in males can be objectively and accurately measured by observing the development of secondary sex characters which are pubic hair, genital growth, axillary and facial hair, voice change, etc.
(a) Genital Growth: It can be seen from Table 3.9 that stage 2 of genital growth appeared at the median age of 9.54 years. The median age for genital growth of boys at stage 5 did not appear till the age of 16 years and thus showing that the growth continues beyond the age of 16 years.

Marshall and Tanner in their study observed that mean age for attainment of stage 2 of genital growth was 11.64 years and it took 3.05 years for the complete maturation of male genitalia.

Kaul (1983) observed that mean age for appearance of stage 2 was 9.83 years and stage 5 was 16.47 years and it took on an average 6.64 years for complete sexual development in boys. Singhi et al. (1982) observed median age for stage 2 of genital growth was 11.2 years and Bhargava (1979) observed stage 2 in Delhi boys at mean age of 10.7 years.

(b) Pubic Hair: The observations of present study was shown in Table 3.2B depicts that mean age for stage 2 of pubic hair was 10.65 year. The median age of pubic hair development did not appear by the age of 16 years and this shows that pubic hair development continues beyond the age of 16 years in boys.
In a study done by Marshall and Tanner the mean age of stage 2 was 13.44 and it took 1.74 years for their boys to reach stage 5. It may be because of study design, geographical ethnic and environmental factors.

In the study conducted by ICMR (1972) mean age of appearance of pubic hair on Madhya Pradesh urban boys was 13.59 years and rural boys was 14.19. The corresponding all India (pooled) figures were 14.00 year and 13.82 years respectively. These studies did not study the stage of appearance and hence a comparison cannot be made.

Bhargava (1979) and Singh et al. (1982) observed pubic hair stage 2 at mean ages of 10.5 years and 11.9 years, respectively.

Study done by Kaul (1983) observed almost similar findings as the present study. The median age for stage 2 was 10.96 years and stage 5 was 15.15 years.

Other Sexual Characteristics

In the present study as shown in Table 34B the mean age for appearance of voice change, facial hair, apocrine sweat gland function, breast development and axillary hair was in boys 12.82, 11.76, 13.34, 13.1 and 13.6 years respectively.
In the ICMR (1972) study mean age for appearance of axillary hair in urban boys of Madhya Pradesh was 12.94 years and 14.24 years for rural boys and that of voice change for urban and rural boys was 14.30 years and 16.89 years respectively. The corresponding all India (pooled) figures were 14.59 years and 14.25 years for axillary hair and 14.24 years and 14.30 years for voice change in urban and rural boys. This may be because of the ethnic, geographical and socio-economic grouping.

A study done by Kaul (1983) observed median age for axillary hair apocrine sweat gland function, breast development, voice change and facial hair was 13.41, 13.24, 13.40, 12.75, 12.96 years respectively. A similar study done by Singhi et al. (1982) observed that median age for axillary hair was 12.7 years and for facial hair appearance and voice change were 13.7 and 73.1 years respectively. Aggarwal et al. (1974) observed that pubescence in boys appeared to be by 9th year and 50 per cent was completed by the age of 13 years.