MIXED LONGITUDINAL ANALYSIS ON WEIGHT AND HEIGHT

The height and weight data from Chittoor district for adolescent school going boys and girls have been analysed according to methods described for mixed longitudinal study by Tanner (1951). It must be mentioned here that these school children belonged to middle and the lower middle socio-economic status. The growth data on these children offers a pattern of growth in an average Indian adolescent. Ideally one should have performed such studies on moderately well off children to establish optimal growth pattern for the community. This could not be achieved since very few families in this district chosen for study belonged to upper socio-economic group. Further, the children from such families were generally sent out of town to English medium schools.

The means for height and weight in the present material demonstrated that these are significantly lesser in both boys and girls for the corresponding age than the values reported for well off Hyderabad children (Vijayaraghavan, 1969). Further it was demonstrated that the Indian boys upto 14 years and girls upto 12 years of age correspond with the American counterparts (Vijayaraghavan et al., 1971). The means observed for urban boys and girls and rural girls in the present study were identical to
the Delhi children's observations for socio-economic groups II and III. While the rural boys were nearer Delhi children of the socio-economic group IV (Tripathi et al., 1976). The data of the present study are also in agreement with those for the children of Tamilnadu, Madhya Pradesh and Poona (Table A).

In a study on well-to-do British children Tanner et al. (1966) recorded peak weight velocity at 12.9 and 14.3 years in girls and boys respectively. The peak weight velocities being 6.0 and 6.3 kg/year in girls and boys respectively. In the present study the rural boys had a peak weight velocity of 3.2 kg/year between 16-17 years while rural and urban girls showed velocities of 4.1 and 3.4 kg/year during 11-12 years of age. The urban boys showed peak weight velocity of 3.3 kg/year around 13-14 years of age. The peak weight gains in adolescents observed in the present study are lower than the values reported by Tanner et al. (1966) on cross sectional yearly increments. The age periods for peak weight gain in urban boys and rural and urban girls are fairly comparable to their British counterparts while the rural boys lagged behind by 2-3 years.

(Similar to the data for weight, the height also showed lesser values as compared to other reported studies. The observations of the present study corresponded nearer to those observed
for socio-economic group III for Delhi children. (The height for corresponding age and sex was significantly lesser in the present study as compared to the height obtained for corresponding age and sex in Western and Indian well off children (Table B). Among the available Western studies, the peak height velocity cm per year has been reported as follows:

<table>
<thead>
<tr>
<th>Studies</th>
<th>Peak height velocity</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Boys</td>
</tr>
<tr>
<td>Tanner et al. (1966)</td>
<td>7.3</td>
</tr>
<tr>
<td>Marubini et al (1971)</td>
<td>-</td>
</tr>
<tr>
<td>Toeman and Bilsel (1974)</td>
<td>-</td>
</tr>
<tr>
<td>Present study</td>
<td>Rural</td>
</tr>
<tr>
<td></td>
<td>Urban</td>
</tr>
</tbody>
</table>

The girls of the present study obtained peak height velocity approximately one year prior to menarche. The peak height velocity ranged for rural and urban children between 5.4 - 6.8 cm/year. These values are nearer to the peak height velocity of the British children. West European children on an average reached peak height velocity in girls and boys at 13 and 14 years, respectively and North American children were advanced by about 6 months. In the present study, the rural children had peak height velocity at 13th year of age while the urban boys and girls had at 13 and 14 years of age, respectively.
These observations are different to the established patterns for the well to do children (Tables A and B). Nelson (1975) described that on an average girls surpass boys in weight in the thirteenth year. (Holt, McIntosh and Barnett (1951) mentioned that there is greater relative increase in weight (almost double the weight) during adolescence than in height both in girls as well as in boys.)

Frisch and Revelle (1969, 70) demonstrated that there is good relationship between gain in weight and the onset of puberty. They further suggested that girls will be around 47.0 kg at the time of menarche, irrespective of the achievement in height. However, in the present study in rural and urban girls the weight was 30.2 and 32.0 kg respectively just prior to menarche. Even in other Indian studies on moderately well-to-do girls, the average weight just prior to menarche has been around 40.0 kg (Table A). Since the material of the present study came from middle and lower middle socio-economic groups, therefore, the pattern of growth for weight and height did not appear to observe the established patterns reported by earlier workers (Tables A and B). This is more true for the rural children where weight as well as height were almost identical upto 14-15 years of age. Thus, showing that the initiation of pubescence in girls was delayed. (This is most likely due to the poor- socio-economic status, possible mild undernutrition, sub-clinical illnesses and lack of exercise in the girls.)
For the remaining measurements in this study, the cross-sectional data have been presented by taking means of all the observations for the age.

The data on standing height analysed as mixed longitudinal study has been discussed above. In general it could be said that there is increase in standing suprasternal height, sitting vertex height, sitting suprasternal height and horizontal span corresponding to the general body growth. This growth is more evident during early and middle adolescent periods.

CROSS-SECTIONAL ANALYSIS

Heights: In the present study the sitting and standing suprasternal height values did not differ between rural and urban children. For sitting and the sitting suprasternal heights, the urban boys showed better values between 12-14 years of age as compared to the rural boys, while the rural girls are always ahead of the urban girls for this parameter. The data on trochanteric height also did not demonstrate any significant difference for rural and urban girls. In the early part of adolescence, girls are having better values than the boys. However, by 16-17 years the boys overtake girls. This is in agreement with the Iowa studies reported in Table D. The available data in literature for sitting height from some Indian and the Iowa studies reveal that the observations for both the sexes in the present study are much lower than the values observed in these studies (Table D).
Neck and head dimensions: The present observations on neck circumference cannot be commented since no one has studied this measurement in Indian children earlier. It can only be said that the boys had more neck-circumference than the girls.

The three head dimensions studied showed a definite trend of continuous increase both for boys as well as girls. This is in agreement with the observations of Tanner (1962) and Singh (1969). The West European girls in age groups of menarche showed final head widths of 146.0, 145.4 and 144.0 mm which were significantly different. The head lengths, on the other hand were 183.9, 184.2 and 183.9 mm (Goldstein, 1939; Shuttleworth, 1939), showing that the means in the present study are lesser for head length and breadth as compared to the British and Punjabi children (Singh, 1969). Comparatively the growth in the head dimensions was found to occur in the earlier part of adolescence for urban children as compared to the rural counterparts.

Bi-acromial and chest measurements: Data on chest circumference from Iowa study demonstrate that boys always had higher mean values. On the contrary Varanasi data reveals that the girls had higher means and it is only at 17 years of age that the means for chest circumference in boys and girls become equal. The data of the present study for mesosternal chest girth correspond to the chest circumference data reported from Varanasi (Table C). From the data of present study, it is
apparent that all the indices like bi-acromial breadth, chest depth, chest breadth, axillary chest girth and mesosternal chest girth are taking part in adolescent growth. The chest depth measurement did not differ much between rural and urban boys and girls. The bi-acromial and chest breadths in general showed higher means for boys as compared to the girls. These observations are in agreement with those of Tanner (1962). This was also true for axillary chest girth in urban males, while rural children showed higher means for girls. (However the boys overtook the girls in the final phase of adolescence.)

Similar to the observations on axillary chest girth were the findings for mesosternal chest girth in the present study. Throughout adolescence, the lesser axillary and mesosternal chest girths in urban girls could be due to better exercise and figure consciousness. (In this respect observations of this study support the findings of Iowa study which also showed persistently lower chest circumference for girls as compared to the boys. As girls approach late adolescent age, an increase in the meso-ster nal chest girth is observed. This could be due to the development of breasts in girls. In view of this, girls are nearer to their male counterparts with regard to this measurement. Hence there is no significant difference between boys and girls towards the later years of adolescence.) On the contrary in the case of axillary chest girth boys are significantly ahead of girls after 17 years of age. These marked changes due to sex difference
account for the shape differentiation in boys and girls. These are in line with the expected findings that males have broad and wide shoulders and females approach the males in the mesosternal chest circumference (Tanner, 1962).

**Trunk and hip measurements**: These measurements also showed growth during adolescence. Pelvic and hip breadth values were initially higher for girls but ultimately the means were equal for both the sexes and also no difference was found between urban and rural children. Trunk waist girth was found to be always higher in urban boys than the girls. On the contrary during adolescence the rural girl showed higher means than her male counterpart, in the early part of adolescence. Thereafter the means were higher for boys. However, the rural girl always had higher hip girth than the urban counterpart. Hip girth was found to be more in girls than in boys. Further the rural girl showed a trend for higher girth during 13-19 years of age. This is possibly due to the urban girls being figure conscious and exercise oriented as discussed for the chest measurements.

**Measurements of upper extremity**: It is evident from the observations that the arm span also has responded to the adolescent spurt of growth. In general boys demonstrate a significant growth throughout the period of adolescence except at 13th year of age when rural girls significantly excel their male counterparts. Boys have better values even in the growth of total upper
extremity length as compared to girls and urban boys are ahead of rural boys. Similar trends were revealed in the growth pattern of the rest of the upper extremity measurements namely, total arm length, lower arm length, hand length and breadth. Thus the growth of all the upper extremity measurements seems to be faster in adolescent boys compared to their female counterparts, which is a normal phenomenon of growth. Tanner (1973) mentioned that from birth onwards males have longer forearms than females with respect to the length of their upper arms or to total body height. This is mainly due to sex difference. Further the adolescent boys of the present study are found to have more or less the same mean values for hand length as for the Punjabi boys reported by Singh (1970). However, the hand breadth is more for the adolescent boys of the present study than their Punjabi counterparts during adolescence. This could be due to racial differences and exercise. Since the boys of the present study belonged mostly to middle and lower middle income groups, they had to do active work with hands both at home and in the fields.

Measurements of the lower extremity: A similar pattern as is evident for the upper extremity measurements was observed for the lower extremity, where boys are found to achieve better growth than girls during adolescence in the growth of ilio-cristal, ilio-spinal, trochanteric, tibial and sphyrion heights. Foot length and breadth have also demonstrated a similar trend.
Menarche: In the present study, the mean age of menarche was found to be 13.68 and 13.55 years in rural and urban girls respectively. This finding is in agreement with the mean age of menarche in various countries reported by Tanner (1968) from the data on the European and Indian studies. The all India study of I.C.M.R. (1972) gave the mean age of menarche in Indian girls as 13.8 years which is almost alike the finding of the present study.

Menarche and growth in height: In the present study, the early-menarche girls had greater height as compared to the girls who had menarche after 14 years during 10-18 years of age. At 19th year, the late maturing girls approached and crossed over the early maturers (Figure VI). Initially, the difference in height is greater by 10.0 cm. However, this difference in these two groups tended to decrease with increase in age and both had more or less the same height at maturity. This finding is in agreement to the findings of earlier investigators (cf. Tanner, 1968).