The relationship of serum alkaline phosphatase levels to stages of pubic hair development

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The need to evaluate the significance of serum alkaline phosphatase (AP) values in children and adolescents occurs frequently now that automated multichannel blood analyzing equipment is so widely available. Serum AP is higher in children than in adults, and during adolescence it achieves adult levels.[1] The AP is osteoblastic in origin,[2] so it is not surprising that in children the AP level parallels the growth velocity,[1] as calculated by the change in height in 6 months. Tanner[3] has shown that secondary sex characteristics appear at different ages and take different lengths of time to develop to the adult state. Pubic hair growth, both in age of onset and duration of development, is the characteristic which most closely parallels the occurrence of the growth spurt and subsequent decline in growth velocity. We therefore set out to see if there is a relationship between the serum AP levels and the stages of pubic hair development in normal prepubertal and pubertal children, hoping this would aid the clinician in evaluating AP levels which are high by adult standards.

Method

We studied 200 patients, ages 8 to 18 years, who attended the Cleveland Clinic outpatient depart-

ment or who were admitted to the Cleveland Clinic Hospital between July 1974 and July 1975. Excluded from the study were patients who had disorders related to liver, kidney, or bone; inflammatory bowel disease; malignancy; endocrine disorders; or who were taking medication for seizures because of possible abnormal AP elevations in these conditions.[4, 5] Each patient was examined by one of the authors, his pubic hair development assessed by the criteria of Tanner,[3] and was assigned in Stages 1 to 5 as follows: Stage 1, no pubic hair; Stage 2, sparse, fine, downy hair with some pigmentation, mainly at the base of the penis or along the labia; Stage 3, coarser, longer hair in the same area, but spreading up over the pubis; Stage 4, adult type hair, but less extensive and not spread over onto the inner side of the thighs; Stage 5, adult hair distribution. Serum AP levels were determined in 20 boys and 20 girls in each of these pubertal groups; these values were then compared to their ages and public hair stage.

The total AP was estimated using the Technicon SMA-12 automated analyzer, which is based on the work of Morgenstern et al,[6] with p-nitrophenyl-phosphate as substrate, 2-amino-2-methyl-1-propanol as buffer, and values are given in international units (mU/ml). Normal adult values in this laboratory are 21–85 mU/ml serum.

Results

The AP values were plotted against the pubic hair stages (*Figs. 1 and 2*) and age of the patients (*Figs. 3 and 4*). Within any given stage there is a wide range of values, especially in Stages 1 to 3, but all are above the adult upper limit of 85 mU/ml. Only by Stage 4 do an appreciable number of levels fall within the adult range, and the girls' levels tend to be lower than in the corresponding stage in boys.

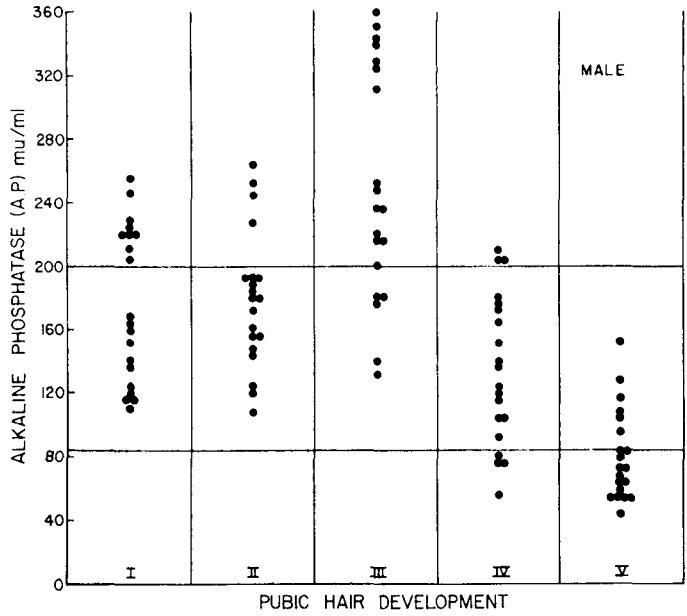
Some of the boys in Stage 3 have much higher AP levels, but although they are in the same developmental stage, their ages range from 12 to 16 years. They therefore cease to be a distinct group when their AP levels are plotted against age (*Fig. 3*). The range of AP values when plotted against age is also large and tends to fall with advancing years.

Discussion

The range of AP values within each stage of pubic hair development is as great as when they are plotted against age. However, there was a statistically significant drop in the values from Stage 3 to Stage 4, which coincides with the decrease in growth velocity in most patients.

In Stage 3 there is a group of seven boys who had much higher AP levels, ranging from 300 to 360 mU/ml. This group is too small to be evaluated statistically and may represent "rogue" values, a distinct group from the remainder, or the upper end of a genuine "rise" in mean AP values in this stage. The records of those boys were reviewed to see if these values could have been due to disease, but the complaints were as follows: lymphadenitis, headaches, maldescended testis, congenital heart disease, and adjustment reaction (three cases). The girls did not have this phenomenon, and their AP levels fell to adult values sooner than did the boys, which is in agreement with Clark and Beck.[1]

We suggest that in assessing the AP values in adolescents, the pubertal



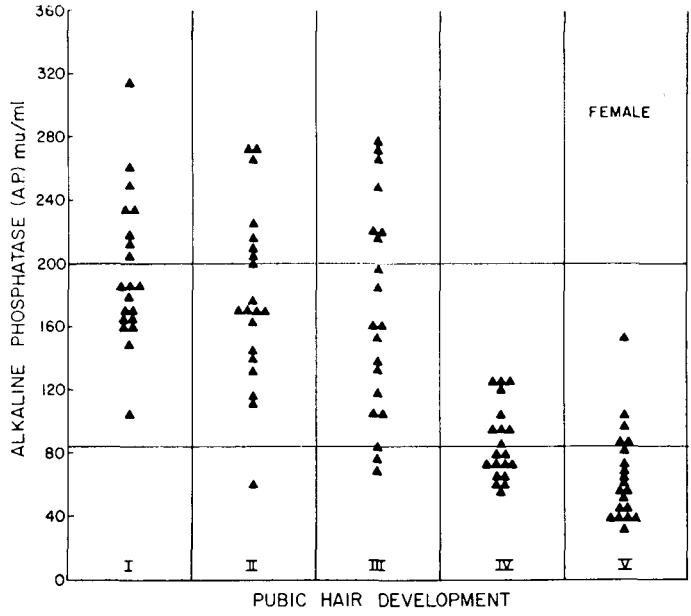
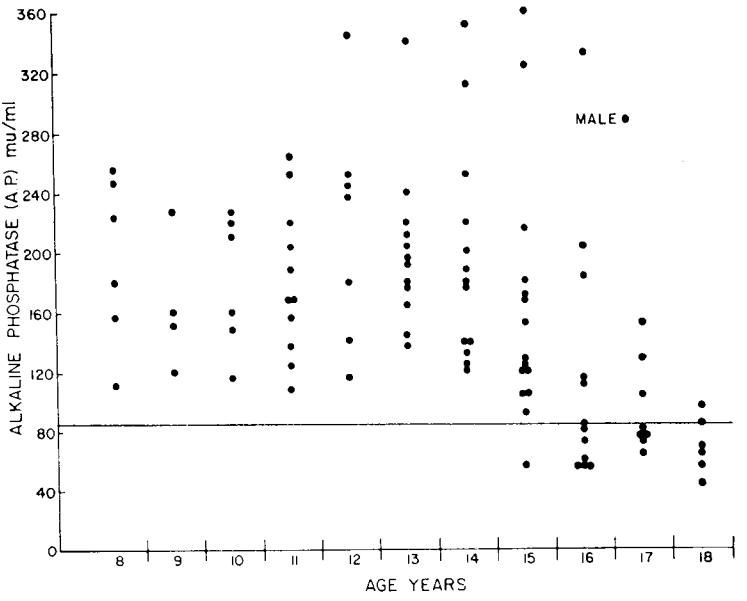


Fig. 1. (males) and **Fig. 2.** (females). Alkaline phosphatase values plotted against stage of pubic hair development. Note the drop in values in Stage 4 in both males and females.



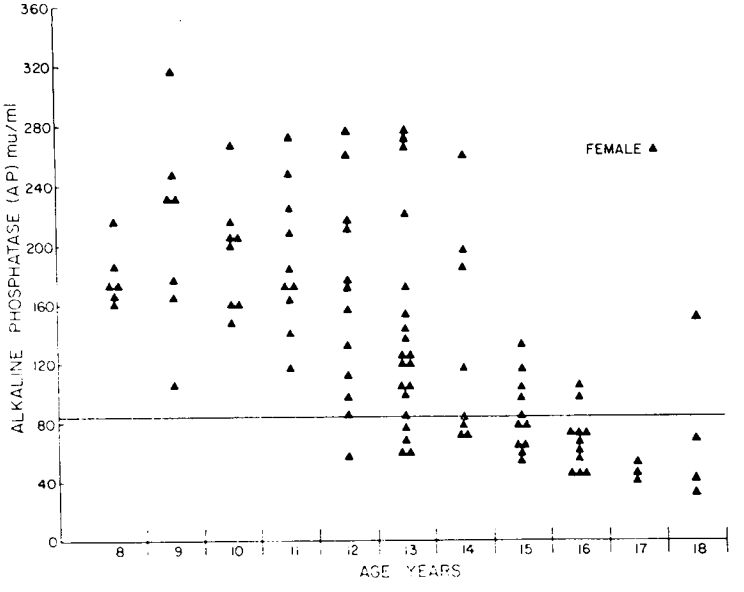


Fig. 3. (males) and **Fig. 4.** (females). Alkaline phosphatase values plotted against age in years. There is a fall with increasing age, slightly earlier in females.

status will help with values over 200 mU/ml, for if the patient is in Stage 3 or less, it is most likely due to skeletal growth, but if the patient has achieved Stage 4 or 5, there should be further evaluation as the increased AP could result from a pathologic process.

Summary

The AP level in 200 prepubertal and pubertal children of both sexes was compared with the stage of pubic hair development. Using the Tanner stages of pubic hair development, it was shown that the first three stages were characterized by high serum AP with many values over 200 mU/ml. There was a statistically significant decline in the AP level during the next two stages of pubic hair development. The clinician should consider this fact when the serum AP level in an adolescent is high.

References

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