ACTA BIOL. SZEGED. 42, pp. 279-285 (1997)

ADOLESCENT GROWTH OF TRUNK MEASUREMENTS IN ATHLETIC BOYS

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(Received: December 10, 1996)

Abstract

Peak velocities (PVs) in trunk measurements were studied in 41 athletic boys. The children were followed up for at least for 5 yr from an initial age ranging between 10 and 12 yr. The measurements were taken at 6-month intervals. The studied variables were shoulder, chest and hip width and chest depth. The graphical method was applied to estimate the timing and magnitude of PVs. To assess the progress of maturation, Tanner's stages of genital development (TANNER, 1962) and first ejaculation time (spermarche) were used. To determine the relationship between the ages at PV and maturity characters, linear correlations were calculated.

Means PVs were 14.01, 14.21, 14.37 and 14.40 yr for hip width, chest depth, chest widht and shoulder width, respectively. A considerable proportion of the children displayed unimodal velocity curves. In the others, the curves were bimodal. Single peaks were consistently earlier in timing and higher in magnitude.

All velocity peaks occurred in stage G4 of sexual maturation. Ages at PV and on entry into G4 and G5 were positively related. Relations with the spermarche were also positive, but looser.

Key words: peak velocity, maturation, trunk measurements.

Introduction

In Hungary, there have been a number of longitudinal studies dealing with the rapid changes in somatic growth during the adolescent period (HEGEDÜS and SZÉKELY, 1968; BAKONYI et al., 1969; RAJKAI, 1970; SZÖLLŐSI, 1982; SZÖLLŐSI and JÓKAY 1991; VARGHA et al.,1991), and some that also include the progress of sexual maturation and its relation to body build (PÁPAI and BODZSÁR, 1986; PÁPAI and SZABÓ, 1986; BODZSÁR and PÁPAI, 1989; EIBEN et al., 1992).

So far, however, little attention has been paid to the growth and biological development of athletic children (PÁPAI et al., 1991; 1992; SZABÓ et al., 1991; PÁPAI and SZABÓ, 1996) in this respect. The potential effect of selection (and hard physical training) on the timing and magnitude of intense growth and the process of sexual maturation is a most interesting one.

This paper is the second of a series dealing with questions of pubertal growth and maturation. The first study (PÁPAI and SZABÓ, 1996) was devoted to the examination of the characteristics of peak velocities (PVs) in some longitudinal measurements (height, sitting height and lower extremity). This work concentrates on trunk breadth measurements.

The purposes were:

1. to estimate the timing and extent of the peaks of the adolescent growth spurt in four torso breadths: shoulder, chest and hip widths and chest depth;

2. to observe sexual maturation signs at the respective PVs of these dimensions;

3. to study the interrelations of somatic growth and its connections with maturation;

4. to establish whether different sports disciplines exhibit differences in these parameters.

Material and methods

The subjects were 41 boys active in various sports at the Central School of Sports. The follow-up study started from an initial age ranging between 10 and 12 yr and was repeated for at least 5 yr. The measurements were taken at 6-month intervals, in spring and autumn.

Special interest was devoted to the ages at maximum growth velocity and the amplitude of the peak for the four trunk measurements. The measurements were as follows: shoulder width (biacromial diameter), chest width (transverse chest), hip width (biiliocristal diameter) and chest depth (antero-posterior chest).

Maximum yearly increments and ages at these peaks were assessed graphically from the individual growth curves obtained by linear interpolation. The shapes of the curves were also analyzed.

Advance in sexual maturation was estimated by TANNER's rating (1962) of genital stages. Data were also collected by a prospective method for the time of the first ejaculation, spermarche.

Only basic descriptive statistics and correlations are presented. The differences in the groups of boys participating in different sports disciplines were tested by the F-test at 10% after one-way Anova.

Results and discussion

The ages at peak were very close to one another (Table 1). The timing and the succession of peaks demonstrated that the rapid broadening in the different trunk regions occurred occurred in a short time interval.

Our data were in good agreement with the results of the HARPENDEN study (TANNER et al., 1976) and were also close to the data of BUCKLER's (1990) study. Those authors found that the shoulder width lagged behind the hip width. In the present material, this difference was 0.4 years. BEUNEN et al. (1988) observed a later median age at peak for both variables in Belgian boys.

Table 1. Parameters of PVs of athletic boys (n=41).

	Shoulder width		Chest width		Hip width		Chest depth	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Age at PV (yr)	14.40	1.08	14.37	1.12	14.01	1.02	14.21	1.08
PV (cm/yr)	2.57	0.47	1.93	0.52	1.62	0.35	1.43	0.34

The mean age at peak followed a definite order: the earliest spurt was experienced in the hip region, followed by the intense growth in chest depth, and the latest spurt was observable in the chest and shoulder widths.

When the ages at PV were compared with those in the length measurements (PÁPAI and SZABÓ, 1996), the intense growth in hip width was found almost to coincide with the timing of the peak in the lower extremity (13.94±1.07 yr) and occurred quite close to that for height (14.13±0.91 yr). Simultaneously, the mean age at maximum annual increment for shoulder width was observed earlier than the time at peak in sitting height (14.52±1.00 yr), though they were also close to each other.

The earlier growth spurt in the hip width may be connected with the relatively early lengthening of the lower extremity, contributing to the stabilization of the growing body and the bearing of the increasing body mass.

As regard the timing of the other studied maximum velocities, TANNER (1962) found that the age at PV in chest width coincided with that in hip width, while the intense growth in chest depth occurred at the same mean age as the spurt in sitting height.

Although the succession of the timing of the peaks in our material exhibited a somewhat different pattern from those found in other studies (TANNER, 1962; TANNER et al., 1976; HAUSPIE, 1980; BEUNEN et al., 1988; BUCKLER, 1990; MALINA and BOUCHARD, 1991), the ages at PV fell into the range of these references.

The differences in the timing of the ages at PV for trunk diameters partly reflect the differences in the methods of estimation (MALINA and BOUCHARD, 1991), and are partly due to the greater difficulty in determining the growth spurt for trunk dimensions (HAUSPIE, 1980).

The maximum yearly increment was the largest for the shoulder width and the smallest for the chest depth. When our data were compared with those of others (TANNER, 1962; TANNER et al., 1976; BEUNEN et al., 1988), the means of the respective PVs were slightly smaller in the above-mentioned studies.

Simultaneously, the variability in the magnitude of PVs was slightly greater in our sample. The higher SD can be partly explained by the fact that our boys participated in dissimilar sports disciplines and it is a well-known fact that the various disciplines prefer different body structure. On the other hand, the greater variability may originate from the differences in the techniques applied.

In respect of the shapes of the curves, it is worth noting that for the hip width and chest depth one-third of the children displayed bimodal velocity curves, while in the shoulder and chest widths the proportion of bimodal curves was close to 50%. The timing of the single peaks was consistently earlier and peak velocities were higher. In the boys displaying bimodal velocity curves, the difference between the two modes was about 2 yr, and the later peak usually had the greater magnitude.

ASHIZAWA (1994) studied the velocity curves for height for girls and separated three types of individual curves. She found that 75% of the girls presented one peak, while 23% displayed two peaks. Our data also indicate that both the intra- and the interindividual growth rate varies greatly during the adolescent period, and demonstrate that the acceleration and deceleration in body measurements may follow different pathways. This point needs further investigation.

Table 2. Correlations between the parameters of PV of the examined variables.

	Shoulder width	Chest width	Hip width	Chest depth
Shoulder width	-	0.76	0.54	0.53
Chest width	0.30	-	0.62	0.52
Hip width	0.11	0.02	-	0.67
Chest depth	0.09	0.17	0.22	-

Above the diagonal: age at PV(yr).
Below the diagonal: PV (cm/yr). $r_{39.5\%} = 0.30$

Table 2 contains the coefficients for the age and amplitude at PV. The ages at the respective velocity maxima showed a positive but moderate correlation. The only close connection was found between the age at peak of the chest and shoulder breadths. The three PV amplitudes were unrelated (subdiagonal part of Table 2).

TANNER et al. (1976) also found a close connection between the ages at PV, and no correlation between the amplitudes for shoulder and hip widths.

The progress in sexual maturation was characterized by the mean age of spermarche and the age of entering different stages of genital maturation (Table 3). Some of the boys were in genital stage 3 at the outset, so we could only determine the ages when all boys entered stages 4 and 5.

Data for the time of spermarche have previously been collected from different regions of Hungary (DEZSŐ, 1965; EIBEN and PANTÓ, 1984; EIBEN et al., 1992; PÁPAI, 1992). In the national sample (EIBEN and PANTÓ, 1986), the median value was 14±0.19 yr. PÁPAI et al. (1994) reported a similar median age in a cross-sectional sample of athletic boys. In the Budapest longitudinal study (EIBEN et al., 1992), spermarche occurred at the median age of 13.3 yr when the genital development was between stages 3 and 4. The mean age at spermarche in our athletic boys was found to be lagging almost 1 yr behind that of Budapest boys. The succession of events also differed, as in our sample spermarche occurred in the first third of stage G4.

Table 3. Parameters of maturity variables.

Critical ages	Mean	SD
Age at spermarche (yr)	14.17	0.76
Age on entering G4 (yr)	13.70	0.79
Age on entering G5 (yr)	14.95	0.95

G4-G5: genital stages of sexual development.

All the ages at PV fell into the second third of stage G4. TANNER et al. (1976) reported a similar sequence of maturation and somatic events, though in their study the age at entering G4 and G5 was about 0.3 yr earlier than in our material.

Table 4 demonstrates that the age at PV was poorly and negatively related to the extent of PV for shoulder width and chest depth. No relationship was found for chest and hip widths in this respect. TANNER et al. (1976) also reported the absence of a correlation between PV amplitude and age at PV for both shoulder and hip widths.

Table 4. Correlations between growth and maturity parameters.

Correlates	Shoulder width	Chest width	Hip width	Chest depth
Age at PV and PV	-0.44	-0.10	-0.22	-0.44
Age at SA and age at PV	0.34	0.40	0.27	0.43
Age at G4 and age at PV	0.70	0.72	0.65	0.72
Age at G5 and age at PV	0.70	0.71	0.57	0.57

PV: (cm/yr) SA: Spermarche G: Genital stage
r39.5% = 0.30

The correlation between the age at spermarche and age at PV was loose. On the other hand, we found a quite close relationship between the timing of stages G4 and G5 and of the peaks. The morphogenetic and sexual effects of the sexual hormones, known to rise steeply after stage G3 (WINTER, 1978), appeared to dissociate less than the sexual ones proper, such as spermarche and G4.

Table 5. Age at PV of boys taking part in different disciplines.

	Shoulder weight		Chest weight		Hip weight		Chest depth	
Events	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Cycling (N=9)	13.77	1.23	13.72	1.20	13.75	0.75	13.74	0.99
Pentathlon (N=9)	14.24	0.87	13.99	0.53	13.18	0.78	13.90	1.18
Tabletennis (N=6)	14.68	0.60	14.55	1.48	13.92	0.88	14.34	1.00
Gymnastics (N=7)	15.31	1.16	15.48	0.66	15.03	0.60	14.93	1.00

Table 5 displays the age at PV for the various sports events. The timing of the peaks followed the sequence displayed for the grand means of the sample (Table 1). The cyclists were the only exception, in that they all had their ages at maximum velocity at the same time and showed a rather early PV age in general. Gymnasts were the oldest in showing PV in trunk dimensions. Maturation signs occurred the earliest in the cyclists and latest in the gymnasts.

In the case of the chest depth, the mean ages at maximum velocity were similar to one another, while in the other measurements significant differences were found between the timing of the peaks. The cyclists had the earliest growth spurt, and the gymnasts the latest one.

The means of maximum yearly increments (Table 6) were similar for the groups, without any significant difference.

Table 6. PVs of boys taking part in different disciplines.

	Shoulder width		Chest width		Hip width		Chest depth	
Events	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Cycling (N=9)	2.83	0.70	2.08	0.56	1.77	0.27	1.46	0.24
Pentathlon (N=9)	2.51	0.41	1.75	0.30	1.60	0.38	1.43	0.43
Tabletennis (N=6)	2.49	0.40	1.85	0.47	1.77	0.17	1.39	0.17
Gymnastics (N=7)	2.26	0.34	2.36	0.70	1.38	0.35	1.52	0.50

It is of interest that the gymnasts experienced the latest maturation and the latest ages at peak in the examined transversal body dimensions. Similar results were obtained for the longitudinal measurements (PÁPAI and SZABÓ, 1996). Gymnasts undergo selection not only for sport skills, but also for physique. Delayed growth in both the somatic characters and maturation is an advantage in this sport. It was impossible to decide from these data whether this definitely late puberty was due to physical retardation, long-term physical work or both.

Conclusions

1. The timing of the peaks of adolescent growth spurt exhibited a definite sequence in the four trunk measurements and they were positively interrelated. The correlation coefficients displayed a moderate relationship.

2. The observed amplitude of the peaks and the SD's were larger than in other studies. These differences are due partly to the different techniques used, and partly to the composition of the present sample (the children represented different disciplines).

3. The study of the shape of individual velocity curves revealed that the acceleration of the growth in trunk dimensions may follow different patterns. Approximately 50% of the children displayed unimodal curves as concerns the shoulder and chest widths, and two-thirds of them showed the same phenomenon in chest depth and hip width. Single peaks were consistently earlier in timing and higher in amplitude.

4. The signs of sexual maturation were also related. Spermarche occurred in the early phase of stage G4. All the peaks of the studied variables fell within this stage, too. The timing of the peaks and maturation characteristics revealed that the stages of sexual development were in a closer connection with the transversal growth of the trunk than the spermarche.

5. The question of whether sports have any specific effect on adolescent growth is hard to answer. There were certain differences between the groups of events in the timing of the peak. It is a problematic task to explain these minor differences, because individuals may vary markedly within the same group. Further, selection for discipline and physique could conceal the possible effects of long-term training.

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