

GROWTH, MATURATION AND PERFORMANCE

J. Pápai, I. Szmodis, and É. B. Bodzsár

Central School of Sports, Budapest; Department of Anthropology, Eötvös Loránd University, Budapest, Hungary

Abstract: A detailed cross-sectional study was carried out in the Jászság region in 1983. The present paper compares the body structure and performance of children in the different phases of sexual maturation.

The subjects were 1326 children living in the rural area of Jászság. The 780 girls and 546 boys were divided into two groups each according to whether or not they had passed their menarche/oligarche. Age groups of 0.5 yr intervals were formed, beginning at 10.5 and 12 yrs of age in the girls resp. boys.

Among others, body height and mass were measured and anthropometric somatotype was calculated. Performance scores in four motor tests were also recorded (grip strength, standing long jump, 60 cm run and Cooper test).

Descriptive statistics were calculated. Differences between the groups were tested by the t-test.

The relatively more mature boys had larger absolute dimensions, but there were no differences in mean somatotype. The performance scores of the two groups differed significantly except the Cooper test. Girls after menarche were also more ahead in growth and physique than premenarcheal ones. Grip strength was greater in postmenarche; in the other motor tests there were not any differences.

The results suggest that spontaneous development can give but a good basis to develop functional characteristics. However, if habitual activity is of low intensity, performance capacity of youth can never reach its potential or optimal level.

Key words: Biological age; Body dimensions; Growth; Maturation; Somatotype; Motor performance.

Introduction

The study of body dimensions and performance in children of the same chronological age but differing in biological development has been the topic of a good number of reports (Hebbelinck and Borms 1975, Borms et al. 1977, Carron et al. 1977, Beunen et al. 1978, 1988, Beunen and Simons 1990). The use of this approach is quite apparent. The results can be applied not only to normal, but also to athletic children.

Depending on the respective periods of life, the suitability of the methods to estimate the status of biological development may differ (Hebbelinck 1979). Here the onset of sexual maturity was applied.

The purpose of our work was to study adolescent children of different sexual maturity if they differed in some selected somatic characteristics and motor performances.

Material and Methods

Cross-sectional data were collected in the villages of the Jászság region of Hungary in 1983. No selection was made in respect of the athletic activity of the children.

The subjects of the respective chronological age groups were subdivided by their sexual maturity status. Children were regarded as being more mature within their age group if they reported their menarche, resp. first ejaculation had occurred. The subjects' distribution for gender, age and maturity status is shown in *Table 1*.

Stature and body mass as the most widely used dimensions were chosen to describe physical development. As a more complex approach to body build, also the Heath-Carter somatotype was studied (Carter 1975). Somatotype components were estimated by using regression equations (Szmodis 1977).

Table 1. The number of the elements of more and less mature groups

Post-menarcheal	G i r l s Pre-menarcheal	Together	Age (y)	Post- oigarcheal	B o y s Pre- oigarcheal	Together
1	83	84	10.5			
3	83	86	11.0			
6	82	88	11.5			
16	79	95	12.0	2	106	108
27	50	77	12.5	6	83	89
65	39	104	13.0	19	70	89
54	24	78	13.5	39	50	89
77	19	96	14.0	70	27	97
66	6	72	14.5	61	13	74
315	465	780	Together	197	349	546

Table 2. The stature of more and less mature groups (mean and SD, cm)*

Post-menarcheal	G i r l s t	Pre-menarcheal	Age (y)	Post- oigarcheal	B o y s t	Pre- oigarcheal
150.0 ± 0.0		140.6 ± 6.2	10.5			
151.9 ± 4.7		144.3 ± 6.1	11.0			
152.5 ± 3.7	+	145.8 ± 6.7	11.5			
155.4 ± 6.4	+	149.8 ± 7.1	12.0	171.5 ± 13.6		147.5 ± 7.4
156.1 ± 6.0	+	151.4 ± 5.4	12.5	159.9 ± 7.6	+	151.2 ± 7.7
157.8 ± 6.6	+	153.2 ± 5.6	13.0	160.0 ± 5.8	+	154.6 ± 7.7
157.8 ± 5.4	+	154.6 ± 5.8	13.5	165.5 ± 7.5	+	154.9 ± 7.0
159.3 ± 5.3	+	154.3 ± 7.7	14.0	168.2 ± 7.3	+	156.1 ± 10.7
159.1 ± 5.5		156.6 ± 3.5	14.5	167.5 ± 6.8	+	158.3 ± 6.6

* t = comparison of more and less mature groups
+ = p ≤ 0.05

Table 3. The body mass of more and less mature groups (mean and SD, kg)

Post-menarcheal	G i r l s t	Pre-menarcheal	Age (y)	Post- oigarcheal	B o y s t	Pre- oigarcheal
63.0 ± 0.0		34.3 ± 7.5	10.5			
42.8 ± 12.3		35.8 ± 7.2	11.0			
43.7 ± 5.0	+	35.8 ± 6.4	11.5			
49.4 ± 11.0	+	39.4 ± 7.8	12.0	55.5 ± 3.5		38.0 ± 8.5
48.5 ± 8.9	+	39.4 ± 6.5	12.5	48.4 ± 4.5		41.3 ± 9.1
48.9 ± 8.3	+	40.7 ± 5.9	13.0	48.3 ± 5.4		44.2 ± 9.0
48.6 ± 7.4	+	41.8 ± 8.7	13.5	53.7 ± 9.1	+	44.5 ± 7.1
49.1 ± 6.2	+	40.9 ± 5.7	14.0	55.7 ± 8.6	+	45.8 ± 10.7
49.0 ± 7.5		42.7 ± 2.6	14.5	55.6 ± 9.2		51.3 ± 12.4

Symbols and abbreviations as in Table 2.

Motor performance was estimated by four motor test items, namely grip strength, standing long jump, time of a 60 m dash and distance covered in the 12-min run-walk (Cooper's test) (Nádori et al. 1984).

Intergroup differences were analyzed by Student's *t*-test for independent samples at the 5% level of random error. Statistical analysis was performed from age 11.5 in the girls and from 12.5 years in the boys.

Results

Girls

Data on height and mass (Tables 2 and 3) were comparable with the reports of other Hungarian authors (Bodzsár 1975, 1984, Csóka and Jung 1982, Farkas & Takács 1986, Farkas 1990) in that post-menarcheal girls were taller and heavier in all age groups. By the end of the ages studied, the girls who were still before menarche approached the stature of the post-menarcheal ones, but their body mass at the age of 14.5 was scarcely equal to that of the post-menarcheal girls aged 11.0. This fact shows a more linear body build in comparison with the relatively more mature ones and was supported by the observations concerning somatotype components (Table 4).

Table 4. The component of the endomorphy, mesomorphy and ectomorphy of more and less mature groups (mean and SD, kg)

Girls		Age (y)	Boys	
Post-menarcheal	Pre-menarcheal		Post-oi-garcheal	Pre-oi-garcheal
<i>Endomorphy</i>				
8.50 ± 0.00	5.41 ± 1.60	10.5		
5.73 ± 1.65	5.00 ± 1.49	11.0		
5.55 ± 1.86	4.87 ± 1.31	11.5		
6.19 ± 1.72	5.14 ± 1.55	12.0	4.95 ± 0.07	4.62 ± 1.77
6.18 ± 1.49	4.83 ± 1.32	12.5	4.95 ± 1.34	4.81 ± 1.81
6.17 ± 1.46	5.10 ± 1.23	13.0	4.40 ± 0.73	4.80 ± 1.65
5.89 ± 1.40	5.06 ± 1.37	13.5	4.90 ± 1.62	4.52 ± 1.28
5.91 ± 1.19	4.84 ± 1.39	14.0	4.63 ± 1.39	5.10 ± 2.14
6.01 ± 1.32	5.58 ± 0.54	14.5	4.86 ± 1.62	5.85 ± 2.32
<i>Mesomorphy</i>				
7.90 ± 0.00	3.81 ± 0.95	10.5		
3.13 ± 0.84	3.61 ± 0.94	11.0		
3.18 ± 0.69	3.30 ± 0.96	11.5		
3.71 ± 1.33	3.23 ± 1.01	12.0	2.50 ± 1.84	3.94 ± 1.05
3.59 ± 1.21	2.89 ± 0.91	12.5	4.08 ± 0.97	3.97 ± 0.99
3.37 ± 1.39	2.88 ± 0.93	13.0	3.91 ± 0.83	3.88 ± 1.19
3.20 ± 1.39	2.61 ± 0.82	13.5	3.76 ± 1.36	3.80 ± 0.89
3.05 ± 1.09	2.78 ± 1.09	14.0	3.77 ± 1.10	4.02 ± 1.01
3.01 ± 1.19	2.60 ± 0.60	14.5	3.87 ± 1.05	4.44 ± 1.60
<i>Ectomorphy</i>				
0.50 ± 0.00	3.32 ± 1.50	10.5		
3.50 ± 2.01	3.66 ± 1.45	11.0		
3.18 ± 1.31	3.95 ± 1.31	11.5		
2.67 ± 1.72	3.82 ± 1.39	12.0	4.25 ± 1.91	3.80 ± 1.63
2.94 ± 1.43	4.13 ± 1.25	12.5	3.55 ± 1.12	3.68 ± 1.31
3.17 ± 1.39	4.13 ± 1.26	13.0	3.63 ± 0.83	3.63 ± 1.45
3.20 ± 1.39	4.22 ± 1.38	13.5	3.66 ± 1.37	3.62 ± 1.13
3.35 ± 1.31	4.29 ± 1.42	14.0	3.77 ± 1.19	3.60 ± 1.57
3.37 ± 1.36	4.23 ± 0.74	14.5	3.69 ± 1.30	2.89 ± 1.88

Symbols and abbreviations as in Table 2.

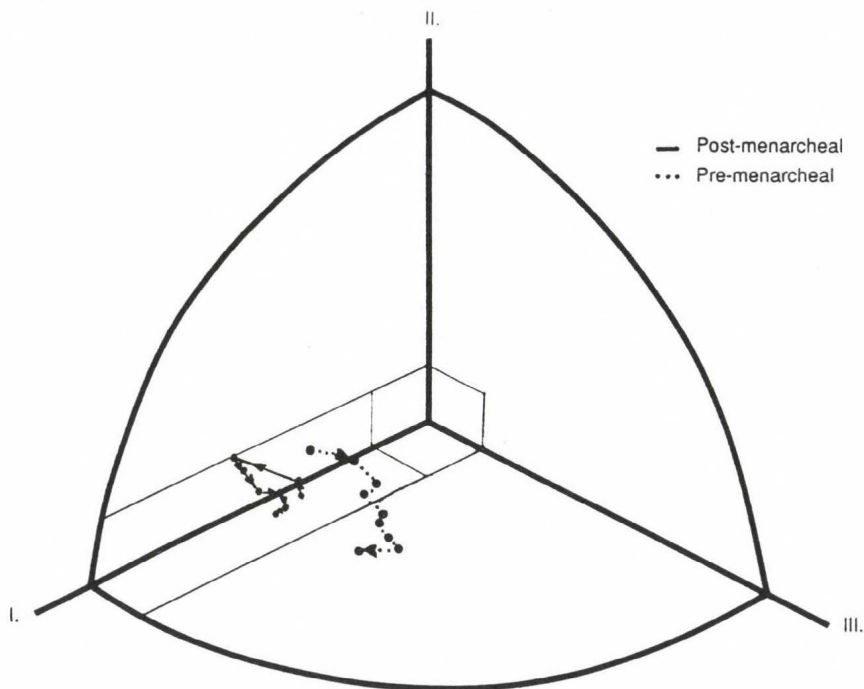


Fig. 1: The means of somatotype in the age groups of pre- and post-menarcheal girls

Mean somatoplots for the girls before menarche started from balanced endomorphy and moved toward increasing ectomorphy. The somatotypes of the post-menarcheal girls displayed considerable stability and stayed in the field of balanced endomorphy (Fig. 1).

The relatively more mature girls had a greater grip strength (Table 5), but their performance in the other motor tests (Tables 6 through 8) was the same as for their less mature peers. Significantly better performance in the Cooper test was noted in the less mature girls at only two ages.

Table 5. The grip strength of more and less mature groups (mean and SD, N)

G i r l s			Age (y)	B o y s	
Post- menarcheal	t	Pre- menarcheal		Post- oigarcheal	Pre- oigarcheal
201.0 ± 0.0		152.7 ± 40.8	10.5		
197.0 ± 73.7		179.0 ± 46.3	11.0		
203.7 ± 33.8		183.8 ± 38.7	11.5		
229.5 ± 77.9		199.7 ± 46.7	12.0	350.0 ± 38.2	220.7 ± 49.2
253.2 ± 67.0	+	213.0 ± 43.0	12.5	293.0 ± 66.4	238.3 ± 52.2
249.2 ± 49.1	+	208.3 ± 46.1	13.0	301.8 ± 74.1	268.4 ± 70.9
253.5 ± 48.3	+	213.7 ± 39.4	13.5	336.2 ± 92.0	269.1 ± 55.6
244.6 ± 38.2	+	218.0 ± 39.1	14.0	371.6 ± 74.3	262.4 ± 58.2
258.0 ± 46.5		242.7 ± 31.2	14.5	368.2 ± 84.1	275.2 ± 47.6

Symbols and abbreviations as in Table 2.

Table 6. The standing long jump of more and less mature groups (mean and SD, cm)

G i r l s		Age (y)	B o y s	
Post- menarcheal	Pre- menarcheal		Post- oigarcheal	Pre- oigarcheal
112.0 ± 0.0	143.0 ± 17.6	10.5		
148.3 ± 7.6	149.1 ± 15.9	11.0		
154.5 ± 7.3	148.9 ± 16.4	11.5		
153.2 ± 17.1	152.2 ± 15.8	12.0	182.5 ± 10.6	159.6 ± 16.6
152.3 ± 19.4	158.4 ± 13.8	12.5	178.2 ± 11.7	+ 163.0 ± 16.0
157.7 ± 17.6	160.9 ± 17.2	13.0	178.9 ± 14.2	+ 167.8 ± 17.7
158.7 ± 16.4	162.2 ± 19.6	13.5	180.7 ± 19.8	+ 171.5 ± 14.2
158.8 ± 19.9	164.7 ± 14.7	14.0	188.4 ± 19.5	+ 172.8 ± 17.0
163.5 ± 14.2	164.5 ± 14.5	14.5	190.1 ± 20.0	+ 170.2 ± 20.2

Symbols and abbreviations as in Table 2.

Table 7. The 60 m dash of more and less mature groups (mean and SD, sec.)

G i r l s		Age (y)	B o y s	
Post- menarcheal	Pre- menarcheal		Post- oigarcheal	Pre- oigarcheal
13.8 ± 0.0	11.6 ± 1.2	10.5		
10.6 ± 0.2	11.4 ± 1.0	11.0		
11.0 ± 1.1	11.3 ± 0.9	11.5		
11.1 ± 0.9	11.0 ± 0.9	12.0	9.2 ± 1.1	10.5 ± 1.3
10.8 ± 1.0	10.8 ± 0.9	12.5	9.8 ± 0.9	+ 10.6 ± 0.8
10.8 ± 0.9	10.8 ± 0.8	13.0	9.7 ± 0.6	+ 10.3 ± 1.0
10.5 ± 0.7	10.6 ± 0.7	13.5	9.6 ± 0.8	+ 9.9 ± 0.6
10.5 ± 0.9	10.3 ± 0.9	14.0	9.3 ± 0.7	+ 10.1 ± 0.9
10.3 ± 0.8	10.8 ± 1.2	14.5	9.3 ± 0.6	+ 10.6 ± 1.0

Symbols and abbreviations as in Table 2.

Table 8. The 12-min run-walk of more and less mature groups (mean and SD, km.)

G i r l s		Age (y)	B o y s	
Post- menarcheal	Pre- menarcheal		Post- oigarcheal	Pre- oigarcheal
1.46 ± 0.00	1.82 ± 0.33	10.5		
1.86 ± 0.10	1.86 ± 0.32	11.0		
1.88 ± 0.19	1.97 ± 0.27	11.5		
1.88 ± 0.32	1.97 ± 0.30	12.0	2.03 ± 0.23	2.20 ± 0.32
1.83 ± 0.36 +	2.03 ± 0.29	12.5	2.49 ± 0.31	2.20 ± 0.36
1.93 ± 0.31 +	2.07 ± 0.26	13.0	2.37 ± 0.45	2.25 ± 0.33
1.96 ± 0.28	1.93 ± 0.26	13.5	2.40 ± 0.35	2.34 ± 0.30
2.02 ± 0.27	2.03 ± 0.31	14.0	2.46 ± 0.42	2.32 ± 0.55
2.07 ± 0.26	2.13 ± 0.38	14.5	2.52 ± 0.39	+ 2.04 ± 0.41

Symbols and abbreviations as in Table 2.

Boys

Stature was significantly taller in the relatively more mature children at all ages while their body mass exceeded that of their less mature peers only at the ages of 13.5 and 14.0 years. No difference was found between the mean somatotypes of the groups. Somatoplots of all ages were only on the borderline between central and balanced

endomorph, except at the age of 14.5 when the somatoplot of the relatively less mature boys was in the field of meso-endomorphy.

The relatively more mature children performed better in all tests except the 12-min run-walk.

Intergender comparison

The boys having already their first ejaculation were taller, heavier and more linear than the post-menarcheal girls from on the age of 13.5 years. Also their physical performance was better.

There was no difference in stature between the relatively less mature boys and girls. Differences in body mass appeared only after the age of 13.5. There was a difference in somatotype, however, since the girls had a more linear build while the boys were more mesomorphic. Grip strength was greater in the boys without any other difference in physical performance.

Discussion

Children of the same chronological age but different sexual maturity were found to display considerable differences of body build and motor performance, depending in extent and manner on the respective gender. Such differences were more marked in the girls; not only body dimensions differed, but also the somatotype.

In respect of body build, these observations can be easily interpreted by the characteristics of female adolescence. Post-menarcheal girls are already past the peak of their adolescent growth spurt (Tanner 1962) and have entered the period of intense fat accumulation (Forbes 1975), while their less mature peers are still rapidly growing.

Boys differed only in their absolute dimensions. It is likely that the observed signs of sexual maturity do not occur in the same phase of growth in the two genders as shown also by the comparison of the boys and girls.

The point of physical performance is another matter. One may think that the larger the body dimensions the better the motor performance. Excepting the 12-min run-walk, this was the case indeed in the boys, but not in the girls. In the girls only grip strength behaved like that.

Of the tests it was grip strength that was most correlated with body dimensions (Asmussen 1973, Kriesel 1977, Beunen et al. 1988). In this test such children that had larger dimensions (Borms et al. 1977, Carron et al. 1977, Beunen et al. 1978, 1990), were more mesomorphic and robust performed better.

The effect of the dimensions was less in the other tests; obviously, other factors, e.g. maturation of neural control mechanisms, skill improving with age, had a greater role. However, the subgroups of differing maturity status were of the same chronological age. Thus, one has to assume that performance is influenced by the pubertal changes through hormonal effects, at least in part. It is the hormonal influence under which dimensions grow, muscle mass, respectively cross-sectional area increases, and in this way, strength improves (Jones 1949, Grumbach 1975, Malina 1975, 1978, Parker et al. 1990). Spontaneous strength development is likely to have an impact on the improvement of other types of physical performance.

The dissimilar hormonal control in boys and girls brings about different constellations of these processes. An earlier maturation in the boys seems to become well manifested

in the development of physical performance. On the other hand, motor performance tends to be better in the later maturing and more linear girls.

Nevertheless, all what has been mentioned is but one possible approach to this complex field of problems in interpreting the data. Another facet which cannot be neglected is the effect of child's social environment. The present state of affairs is such that preparation for the social role makes less demand to acquire physical skills in the girls while it attributes primary importance to the same in the boys. It is most likely that also these factors have an influence on the development of intergender differences.

Spontaneous biological development provides an opportunity to develop physical abilities. The associated processes take, however, a different course in the early than in the late maturers of the same sex as well as in the males and females. Child development can become better balanced under the influence of regular physical exercise of optimum intensity.

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Mailing address: Dr Pápai Júlia
Központi Sportiskola
H-1146 Budapest, Istvánmezei út 3.
Hungary