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PHYSICAL PERFORMANCE, BODY COMPOSITION AND SOMATOTYPE IN JÁSZSÁG BOYS

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Abstract: *The aim of the present paper was to study the relationship between body build and performance in a non-selected sample of children aged 7–14. The studied points were (1) age-dependent changes in the indices of body build and two physical tests,(2) relatively better and worse body build contrasted with good and bad physical performance,(3) correlation analysis between the examined variables. Correlation analysis showed very low or no connection between the components and body build. This result can be explained in part by the problem of disassembling somatotype into its components and in part by these components being composed indices so the different effects can neutralize each other and the result can be an absence of significant linear correlation.*
Keywords: *Somatotype; Body components; Grip strength; Cooper's test;Correlation analysis.*

Introduction

One of the attractive points in kinanthropometry is whether an extreme physical performance is accompanied by a specific body build and reversed. Many publications have been devoted to this problem. The methods applied may be factor analysis, correlation analysis, and separation and comparison of extreme groups. Each procedure handles the problem in a different way, so the results must be necessarily different.

Body build, composition and size have been accepted as important factors in physical performance. Highly selected elite athletes of the same event are known to be similar in their body build and dissimilar body structures belong to the different events.

However, it is far from simple if we want to answer the question: "What about the growing child athlete?" Body size, proportions, composition, consequently also shape are changing during growth and development. Children develop their abilities, skills in motor, intellectual and emotional actions gradually. The structure of the body and its functions may develop in parallel, but they may diverge during childhood, i.e. they have relative independence. Besides, physical performance is influenced by many other factors, not only body build. When interpreting the results, we have to be aware of this complexity. This problem is continually present in our everyday work, because, for example, we are expected to give a forecast to the coach. That is the reason while we deal with these problems.

The aim of the present paper was to study the relationship between body build and performance in a non-selected sample. The studied points were:

1. Age-dependent changes in the indices of body build and two physical tests.
2. Relatively better and worse body build contrasted with good and bad physical performance.
3. Correlation analysis between the examined variables.

Material and methods

A detailed cross-sectional study was carried out in 1983. The 50% representative sample was taken in the villages and towns of Jászság, one of the now geographical, formerly ethnic regions of Hungary. The subjects of this paper were 2511 boys aged between 7 and 14 years (Table 1). No selection was made in respect of the athletic activity of the children, they largely took part in the school classes of physical education only.

Table 1. Distribution of Jászság children by age and sex.

Age (yr.)	Boys N	Girls N
7	273	276
8	389	343
9	351	325
10	315	301
11	314	282
12	298	285
13	278	281
14	293	270

Body mass, fat mass and lean body mass (LBM) were calculated (Durnin and Rahaman 1967, Siri 1956) and anthropometric somatotype was determined (Carter 1975) to characterize body build. Somatotype components were estimated by using regression equations (Szmodis 1977). The consideration behind the choice of variables was that they would give more complex approach of body structure than single measurements.

Two physical tests were also studied: grip strength and Cooper's test (12-min run-walk). They are assumed to be in connection with body build during growth and development, mainly with muscle mass or LBM. The link between grip strength and overall body size is well documented. This test was measured by an electric dynamometer and was recorded for both hands. The mean of the two scores was analysed. Run-walk test assesses aerobic capacity and refers to the developmental level of cardiorespiratory system supplying energy to the muscles. In this way, the scores of the test are also in connection with body structure. Grip strength was measured in kiloponds and converted to newtons, while the Cooper test in meters.

To study the supposed effect of body size and form on performance we separated two subgroups of boys with an LBM below (small), resp. above (large) one SD from the mean age group and compared the performance scores of the subgroups. The procedure was the same in separating good and bad performers. Subject numbers in the subgroups were different at every age, but corresponded across the respective comparisons so the case numbers are displayed only in the first tables of the given category. Categorization of somatotype subgroups differed from that approach. The boys were separated by a relative component dominance. The somatotype was regarded as having an ecto-, meso- or endomorpic dominance when the named component was above 5 units and exceeded the two other ones by at least two units.

Basic descriptive statistics were calculated. Linear correlations between indices of body build and physical tests were determined for the full sample and for the whole age range.

Results and discussion

Body components are shown in Table 2. Age group differences in LBM displayed an approximately linear series with age until 11 years. There were two breakpoints, however, one at 11 and another at 13 where increases were steeper. The differences between the means of fat mass were relatively steady in prepuberty, while between ages 12 and 13 fat deposition was interrupted. The age trends in body components are in connection with pubertal growth. I have to mention that the body mass of the Jászság boys corresponded roughly to the 50th centile of a recent national sample (Eiben and Pantó 1986). However, compared to the latter, body fat was more by about 6-7% (Eiben et al. 1990). This difference was maintained along age. Peer-age boys from Bakony, another region of Hungary displayed larger LBM (Bodzsár 1984), and from puberty they were much less fat than the Jászság children.

Table 2. Body composition.

Age	Body mass (kg)		Fat mass (kg)		Lean body mass (kg)	
(yr.)	Mean	SD	Mean	SD	Mean	SD
7	22.4	3.3	4.6	1.5	17.8	2.1
8	25.0	4.5	5.4	2.4	19.5	2.6
9	27.9	5.1	6.3	2.7	21.5	2.9
10	31.1	5.8	7.3	3.0	23.8	3.2
11	34.7	7.6	8.5	3.9	26.2	4.1
12	39.7	10.0	10.2	5.1	29.4	5.5
13	43.6	8.6	10.4	3.8	32.9	5.5
14	51.9	10.8	13.0	5.5	38.7	6.4

Table 3. Somatotype components.

Age	Endomorphy		Mesomorphy		Ectomorphy	
(yr.)	Mean	SD	Mean	SD	Mean	SD
7	3.2	1.1	4.3	0.7	3.1	1.0
8	3.5	1.4	4.3	0.8	3.3	1.2
9	3.7	1.4	4.2	0.9	3.4	1.2
10	3.9	1.5	4.0	0.9	3.6	1.2
11	4.2	1.6	3.9	1.1	3.8	1.4
12	4.5	1.8	4.1	1.2	3.6	1.6
13	4.2	1.4	3.8	1.0	3.8	1.2
14	4.5	1.7	3.9	1.2	3.7	1.4

At age 7 and 8 boys were balanced mesomorphs (Table 3). In the later ages they remained in the central hexagon. From 10 years of age on mesomorphy was relatively stable with an increasing share of endomorphy and a decreasing one of ectomorphy in the somatotype. The mean endomorphy showed a trend similar to fat mass along the ages. Again, comparing our data to other Hungarian studies (Eiben 1985, Bodzsár 1986, 1992), it was not surprising that the first component of the Jászság boys was markedly higher. Mesomorphy was comparable and the boys in the Bakony study had a more linear body form than the Jászság children.

The differences of the means of grip strength showed two breakpoints, one at 9 and another one at 12 years of age (Table 4). The greatest difference was found between the 13- and 14-year-old boys. It is well known that the development of strength keeps pace with the increase of body mass (Jones 1949, Malina 1975, Beunen et al. 1977, Kriesel 1977). The intense pubertal growth in body mass was experienced at ages 13 and 14 and the traces of it were followed in LBM and also in grip strength. The age-dependent changes in grip strength were similar to changes in LBM.

The age series of mean scores in the Cooper test showed another pattern (Table 4). The changes in this test were not linear with age. There were sudden jumps at ages 8, 10 and 13 which were followed by plateaus. The reasons for this pattern may be manifold. There may be a rearrangement in the structure and proportion of skills and abilities during these years as some studies pointed it out (Ozsváth 1982, Szabó 1993). Intellectual and physical maturation can influence running technique. As running work is a monotonous and long-lasting one, motivation is thought to play significant part in performance (Szmodis 1978).

Table 4. Scores in the physical tests.

Age	Grip strength (N)		Cooper test (m)	
(yr.)	Mean	SD	Mean	SD
7	95	29	1670	330
8	113	33	1770	340
9	139	37	1810	330
10	169	38	2000	340
11	193	44	2070	320
12	219	54	2120	350
13	262	66	2250	390
14	324	84	2290	440

Comparing our results to recent national data (Eiben et al 1991) the boys of Jászság study were behind the reference by about one year in grip strength and above age 9 they had quite low scores in the aerobic test. The SD'-s were slightly smaller in the present sample.

Table 5. Grip strength in boys with small and large LBM.

Age	Large LBM			Small LBM		
(yr.)	N	Mean	SD	N	Mean	SD
7	43	121	34	41	71	18
8	44	137	38	47	96	27
9	51	172	40	48	110	33
10	44	205	42	30	130	28
11	43	225	46	32	153	33
12	43	284	53	33	169	37
13	43	337	83	44	212	41
14	47	404	78	51	241	46

The next question was whether body build had any effect on performance. The subgroups separated by absolute LBM are shown in the next two tables. Boys with a large LBM were better in grip strength in every age group (Table 5). Differences grew with advancing age. This result could be partly explained by the differences in maturity status.

In one of our earlier studies (Pápai et al. 1992) we pointed out that after 12 years of age sexually more developed boys of the same chronological age had been higher and had 5 to 7 kg larger LBM than the less developed ones. The differences in grip strength in this respect were between 60 and 90N. Those differences were less than in this study. Strength development is in connection with the cross-sectional area of muscle. One can assume that there is a proportional relationship between the growth of body dimensions, muscle mass, resp. cross-sectional area and the development of strength is partly based on these positive allometries.

The results of the Cooper test (Table 6) are arranged similarly in this respect.. We could not discover any tendency at all. The results for maturation groups gave the same picture. Is it possible that the estimated absolute muscle mass had no any importance for this test?

Table 6. Cooper test scores in boys with large and small LBM.

Age	Large LBM		Small LBM	
(yr.)	Mean	SD	Mean	SD
7	1560	310	1630	310
8	1720	270	1830	370
9	1740	320	1820	390
10	1850	400	1950	350
11	1990	350	2010	320
12	1900	350	2120	360
13	2290	400	2310	390
14	2100	380	2310	390

We also separated subgroups by component dominance in the somatotype to compare the results in the motor tests. These categories did not correspond to the two ends of the distributions, because many other categories are existing. Somatotypes with mesomorphic dominance were missing after the age of 9. They are missing from the picture. At age 7 we only found children with an ectomorphic dominance.

No differences were discernible in grip strength by these criteria (Table 7). Both ectomorphic and endomorpic build is likely to associate with poor achievement because of the "dead weight" and strength deficiency (Malina and Rarick 1973). The means were smaller than the ours by the LBM categories. The boys with ectomorpic dominance performed better in the Cooper test (Table 8). A more linear body build and a steady and balanced body mass allow the better scores.

Reversing the question we also asked what kind of body build was characteristic for the relatively good and bad performers. By separating the boys for the scores of grip strength (Table 9) it was shown that boys with a higher grip strength had larger LBM and the differences grew with age. The trend was the same we got when LBM was the separating factor.

Table 7. Grip strength against component dominances.

Age (yr.)	Dominantly endomorphic N	Mean	SD	Dominantly ectomorphic N	Mean	SD
7	–	–	–	5	82	28
8	5	140	23	16	112	30
9	13	153	40	18	130	33
10	21	181	40	35	157	34
11	22	199	47	48	181	33
12	41	250	51	28	183	42
13	20	263	49	24	254	64
14	33	326	84	28	276	68

Table 8. Cooper test of boys against component dominances.

Age (yr.)	Dominantly endomorphic Mean	SD	Dominantly ectomorphic Mean	SD
7	–	–	1380	200
8	1650	130	1770	310
9	1580	210	1960	320
10	1620	310	1930	230
11	1760	300	2070	300
12	1900	310	2280	270
13	2030	400	2230	380
14	2000	460	2300	420

Table 9. LBM against high and low scores in grip strength.

Age (yr.)	High scores N	Mean	SD	Low scores N	Mean	SD
7	33	19.5	2.0	43	16.4	1.7
8	56	21.4	3.3	61	18.4	2.1
9	46	24.2	3.0	47	19.3	2.2
10	41	26.8	3.9	43	20.5	3.8
11	43	29.8	4.2	44	22.5	3.9
12	47	35.6	5.8	39	24.4	3.5
13	36	39.3	5.3	31	28.2	3.3
14	42	45.4	4.9	38	30.7	3.6

In the first Figure (Fig. 1) the mean somatotypes of the two subgroups were depicted as somatoplots in the somatochart. The age groups moved in parallel perpendicularly to the axis of ectomorphy. Better performers were less ectomorphic with a mainly meso-endomorphic body build. They started from the endo-mesomorphic zone and reached the field of balanced endomorphy. Their component of mesomorphy did not diminish very much. Poor performers were of the central type almost in the whole age range, i.e. none of the components had even relative dominance. Decrease in mesomorphy was more expressed that in the good performers.

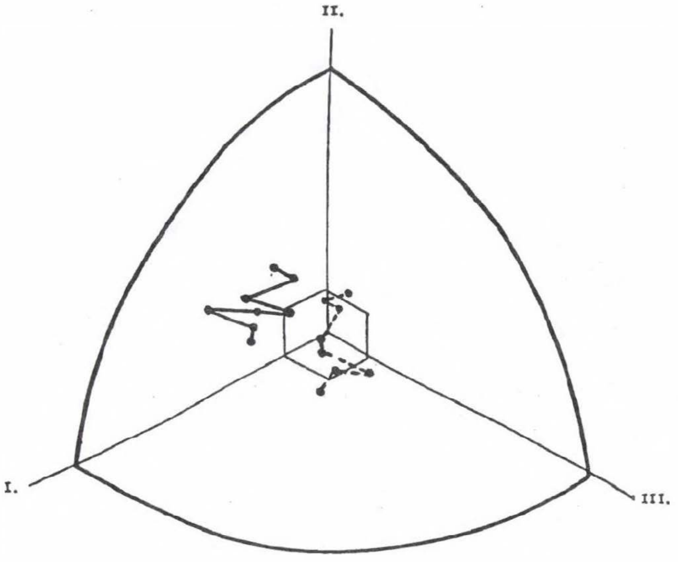

Fig. 1: Somatotype of boys with high and low scores in grip strength.
Full line: high scores, dashed line low scores. I – II – III: somatotype components.

To separate and analyze the good and poor performers in the Cooper test we could not observe LBM dominance in the groups (Table 10). The comparison did not show differences between the boys wit higher and lower performance. The means were less than they were for the grip strength of good performers. This result again supported our earlier data, it was not really muscle mass that determined good or poor results. Somatoplot means on the somatochart also reflected the above mentioned data (Fig 2). Here movement was again perpendicular to the axis of ectomorphy but the wandering of the groups was not parallel and they behaved inversely. The somatotype of the bad performers started from balanced mesomorphy and they became strongly endomorph. Boys with a good performance had a meso-ectomorpic body build and from age 10 on they stayed in the central hexagon.

Table 10. LBM against high and low scores in the Cooper test.

Age	High scores		Low scores	
(yr.)	Mean	SD	Mean	SD
7	17.4	1.6	18.0	2.1
8	19.2	2.2	19.0	2.4
9	20.7	2.5	21.6	3.3
10	23.6	2.6	25.1	4.6
11	25.6	3.6	27.2	4.8
12	28.0	4.2	32.0	7.8
13	33.6	6.3	33.2	5.0
14	38.5	5.2	40.4	7.3

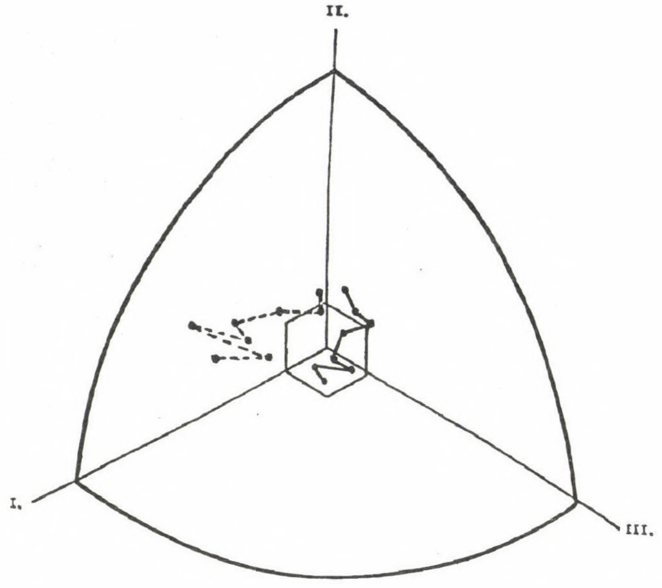

Fig. 2: Somatotype of the boys with high and low scores in the Cooper test.
Full line: high scores, dashed line low scores. I – II – III: somatotype components.

The last table (Table 11) shows the correlations for the studied variables. Grip strength was in a close connection with LBM. Surprisingly it had a positive correlation also with body fat. This linear link can be explained by the effect of age. Of the somatotype components endomorphy behaved like fat mass.

We did not find connection between mesomorphy and grip strength. In the Cooper test the low correlation with LBM showed the latter played no important part in this performance at all. There was no connection with fatness. The low coefficients for the two other components showed that the better performers were slightly linear and less robust. A similar pattern of correlations were reported for another aerobic test (Szabó and Szmodis 1991).

Table 11. Correlations between the indices of body build and physical performance in the Jászság boys.

Indices	Grip strength	Cooper test
Lean body mass	.89	.35
Fat mass	.30	–.10
Endomorphy	.32	–.10
Mesomorphy	–.03	–.23
Ectomorphy	.23	.23

$r_{(p<5\%)} = .19$

Conclusions

We analyzed the connection between body build and physical tests in the whole sample and in its parts. Following from the different approaches it is not necessary that the results should be similar. From the correlation analysis we concluded that good performance in static strength depended more on body size than shape, while in the Cooper test it depended more on other factors than body structure. These results refer to the Jászság children. The other results were in connection only with one part of the sample, i.e. with the extremes. Examination of the extremes involves its limitation: it refers only to these extremes. We proved that children with a higher LBM performed better in static strength and good performers had a higher LBM. This was otherwise for the Cooper test in which muscle mass was not the most important factor. The results we got for the extremes agreed with the correlation analysis.

The interpretation of the connection between somatotype and the motor tests is another matter. Analyzing the extreme groups we found differences in the somatotype of the good and poor performers. There are also some reports that pointed out differences in the motor tests and/or in somatotype. Correlation analysis showed very low or no connection between the components and body build. We could find similar results in the literature (Espenschade and Eckert 1967, Hebbelinck and Borms 1975, Olgün and Gürses 1986, Wear and Miller 1962). This result can be explained in part by the problem of disassembling somatotype into its components and in part by these components being composed indices so the different effects can neutralize each other and the result can be an absence of significant linear correlation.

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