

CORRELATION BETWEEN SOME PHYSICAL CHARACTERISTICS AND HAND STRENGTH OF HIGH-SCHOOL STUDENTS

by E. SZÖLLŐSI and M. JÓKAY

(Institute of Hygiene and Epidemiology, Debrecen University Medical School, Debrecen, Hungary; Debrecen City Health Department, Debrecen, Hungary)

Abstract. The authors investigated the correlation between the arm circumference, mid-upper-arm muscle-circumference, some somatic indices, lean body mass and hand strength of 209 (115 boys and 94 girls) high-school students. They established that the arm circumference of boys correlated only slightly (positive) with the hand strength. The coefficient of correlation (r) of the mid-upper-arm muscle circumference is a little higher than the above mentioned one, however, with the right hand, " r " is only slightly different from that of arm circumference (STUDENT's t -tests: significant).

There is no significant correlation between the arm circumference and hand strength in the girls. The mid-upper-arm muscle circumference correlated weak-moderate positive with the hand strength.

These data are compared with the " r " of 4 constitutional index — hand strength and with the " r " of lean body mass (which was calculated from skin-fold data) — hand strength, where the correlations are closer. The authors discuss the possible reasons of the difference.

Key words: body measurements, hand strength, university students.

Introduction

It is a problem of current interest in our country that the chest development of youth has not gone in parallel with the increase of the height measurements. One of the causes for this may be decreased physical activity. Under the present circumstances this effect may be compensated by regular physical training (RAJKAI and JANCsó 1955). Recently also in our country numerous papers are concerned about the question, namely the physical state of the university- and high-school students even weakens during the study years (FUČIK 1975, FRENKL and MÉSZÁROS 1979). In the present paper we strove to obtain information with simple methods on the following questions: 1. What is the development and the physical condition of the high-school students like in Debrecen? 2. Can hand strength be brought into relation with the parameters measured by us and with those which can be calculated from them, respectively?

Material and Methods

In spring of the year 1978 and 1979 we measured the major body measurements of 115 boys and 94 girls who were students of three universities and two high-schools in Debrecen and on whom otherwise a longitudinal growth study is performed. The measurements were as follows: body height, weight, chest

circumference in normal position, at maximum inspiration, maximum expiration, as well as arm circumference. We took the measurements of the skinfold thickness on the triceps, on the subscapular, and the abdominal points with a Harpenden caliper, as well as also the grip strength of the right and the left hand with dynamometer. The age of the measured students was 19—25 years. From the above data various constitutional indices were calculated: KAUP's, ROHRER's, PIGNET's indices and the proportional chest-circumferential ones. From the arm circumference with the help of the triceps skinfold were calculated the "mid-upper-arm circumference" called so by JELLIFFE (1966) (MUAC) then the body fat content and the lean body mass (LBM) by means of PAŘIZKOVÁ (1977). The obtained results were put in correlation with hand strength (HS). We followed with attention whether there was any difference in the results if the investigated persons were divided in to two groups according to the performance in sports. Other kinds of grouping were also made, if this seemed necessary.

Results

The body measurements are demonstrated in Table 1. The stature and the weight of the boys are higher than showed by the data of Debrecen 30—40 years ago (JENEY 1938—39, 1939—40, 1940—41, 1941—42) but the chest and arm circumference are not (BALOGH 1942, RAJKAI 1952). Among the girls only the stature increased, the chest circumference remained the same, similarly, also body weight is the same or lower, arm circumference decreased (JENEY 1940—41, 1941—42, RAJKAI 1952, 1957). Out of the recent publications, our data are most similar to those conducted in the students of the Novi Sad University (GAVRILOVIĆ 1974) as well as Budapest Technical University (TILL and GYENIS 1977). In every measurement the boys observed by us surpass the means of the Hungarian male population of the age of 18—20 years as published by KÁDÁR and VÉLI (1971, 1977) measurement.

Table 1
Body measurements of the students

Group	Stature cm	Weight kg	Chest circumference cm			Arm circumference cm
			normal	inspiration	expiration	
Boys \bar{x}	176.86	68.81	89.30	95.17	87.38	26.68
SD	±6.28	±8.78	±5.73	±5.63	±5.57	±2.18
Girls \bar{x}	163.29	54.98	82.84	88.14	80.78	23.61
SD	±5.73	±7.33	±5.40	±5.51	±5.54	±1.95

Hand strength (HS) is shown in Table 2. The right hand is stronger than the left in both sexes. The means calculated by us are higher than the data generally published for this age-group and for university students in this country (ALLODIATORIS 1952, EIBEN 1956, RAJKAI 1969, NÉMETH 1969,

FARMOSI 1972). It is true that the stature and body weight averages are higher now than those measured before. The girls are exceptions to this: the body weight and arm circumference averages measured by ALLODIATORIS exceed ours. The weight, chest circumference and HS of the girls reported by NÉMETH,

Table 2
Hand strength of the students

Boys		Hand strength (kpond)	Girls	
\bar{x}	S.D.		\bar{x}	S.D.
48.21	8.42	right hand	27.08	5.14
44.30	7.63	left hand	25.09	4.67
46.25	7.40	mean	26.08	4.76
46.78	5.46	mean sporting	29.03	4.43
45.98	8.15	mean non-sporting	25.27	4.66

however, are almost the same as those measured by us, whereas the arm circumference is larger than that of the girls of Debrecen. The boys' HS is about the same as that of the third-course students found by BELCHENKO and co-workers (1979) and their stature and weight are similarly identical with those of the students in Debrecen. The body measurements of our girls are less; but their HS is greater than the one described in the paper mentioned before. The arithmetic mean of the HS of the right and left hand is mean hand strength (MHS). This was also calculated for the activity produced in sports. MHS was found to detect an increase particularly among the sporting girls.

In regression calculations the correlation coefficients of the girls' arm circumference did not produce a significant relationship with HS ($r = +0.139$). In the boys, however, a significant positive correlation could be detected although the value of 'r' was low (0.316). With the MUAC, the positive correlation can already be revealed in both sexes. This can be observed in Table 3.

Table 3
Correlation of hand strength with MUAC and LBM

Boys			Characteristics	Girls		
$\bar{x} \pm SD$	r	p <		$\bar{x} \pm SD$	r	p <
234.66 ± 20.99	+0.394	0.001	MUAC mm	195.97 ± 15.28	+0.294	0.01
236.48 ± 20.24	+0.337	0.10	MUAC mm sporting	196.68 ± 13.58	+0.271	n. s.
234.14 ± 21.30	+0.406	0.001	MUAC mm non-sporting	195.93 ± 15.74	+0.311	0.01
57.02 ± 5.95	+0.452	0.001	LBM kg	42.89 ± 4.34	+0.457	0.001
56.98 ± 6.06	+0.560	0.01	LBM kg sporting	44.91 ± 3.40	+0.315	n. s.
57.04 ± 5.95	+0.437	0.001	LBM kg non-sporting	42.34 ± 4.42	+0.432	0.001

Correlation cannot be demonstrated in per cent of body fat and LBM. ALLODIATORIS (1952) and KRIESEL (1977), however, refer to a relation between the HS and the body weight. Therefore, we studied the correlation of the LBM value expressed in kg with HS. As it can be seen in Table 3 the LBM in kg is greater only in the girls among sporting students than non-sporting ones. Despite this, the *r*-value is highest in sporting boys, while the correlation in sporting girls is not significant. Apart from it the MHS presents generally higher *r*-value with the LBM in kg in both sexes, than with the MUAC.

Table 4
Correlation between mean hand strength and Kaup's index

Kaup's index	$\bar{x} \pm SD$	Hand strength $\bar{x} \pm SD$	<i>r</i>	<i>p</i> <
<i>Boys</i>				
Kaup's index	2.19 ± 0.27	46.51 ± 7.66	+0.221	0.05
Kaup's index sporting	2.13 ± 0.20	48.02 ± 6.78	+0.308	n.s.
Kaup's index non-sporting	2.21 ± 0.28	45.97 ± 8.09	+0.223	0.10
Kaup's index 2.0—2.4	2.17 ± 0.11	46.40 ± 7.70	+0.368	0.01
<i>Girls</i>				
Kaup's index	2.03 ± 0.22	26.08 ± 4.84	+0.237	0.05
Kaup's index sporting	2.00 ± 0.19	29.03 ± 4.43	+0.236	n.s.
Kaup's index non-sporting	2.04 ± 0.22	25.27 ± 4.66	+0.232	0.05
Kaup's index > 2.4	2.53 ± 0.09	28.00 ± 3.05	+0.690	0.10

In Table 4 we represent the Kaup's indices. The average of the boys slightly exceeds the data published for this age-group in this country but it is nearly identical with the values reported by BALOGH (1942) for university students of the age of 18—26 years in Debrecen 40 years ago. The *r*-values, however, are low. In our opinion Kaup's index in youth that can be considered normal is 2.0—2.4. When grouping according to this, there was no significant correlation under 2.0 and above 2.4 respectively, while between 2.0—2.4 the value was higher than the "*r*" of the average. The value of the Kaup's index in the girls is about the same as the one described with the students of Budapest Technical University by TILL and GYENIS (1977). Also in this case the correlation coefficients are low. When grouping the index according to its value, the correlation under 2.3 has turned out to be weak and not significant whereas above 2.4 the correlation was much closer.

Rohrer's index of the boys is +1.225; *r* = +0.165 (*p* < 0.10). This low correlation coefficient results from the fact that when investigating it grouped according to index value in the leptosome and athlete types the sign of "*r*" is negative while in the pyknic type it is positive. Rohrer's index of the girls is +1.244. Its tendency in leptosomes is negative, in others positive. Otherwise the Rohrer's index found by us is lower than that reported on in the literature

except for the one of the Slovakian 18 year old boys (LIPKOVÁ and GRUNT 1979), whose one agrees with ours. It is lower in sporting students than in non-sporting ones but does not correlate with HS either. To investigate the correlation of the average index value is not reasonable.

The Pignet's index of the boys is higher (+22.16) than the data of the 18—20 year old male persons found by KÁDÁR and VÉLI (1971). The correlation coefficients are generally low negative value. Nevertheless, when grouping according to the index value, the tendency is of positive direction in the athletic type and a rather high negative "r" was found in the pyknic ones (—0.860). HS is by far higher in this group than in the others (52.0 kp).

The average of Pignet's index of the girls is +23.03 the distribution is about the same as in the ones from Novi Sad (GAVRILOVIĆ 1974). The tendency of the correlation is negative. In the case of those with indices lower than +10 a relatively high negative r-value (—0.629) manifests itself, and HS of this group is greater as compared with the leptosomes.

We studied another index: that of the proportional chest circumference (PCC). The average value indicates very low, not significant positive correlation. When dividing the young people in groups there is no correlation with HS in the narrow chested youths whereas the "r" is very high (+0.903) in those with wide chests. The PCC index of the girls is 50.61. Significant correlation could not be found.

Founding ourselves on our investigations, we stated that the body development and HS of the Debrecen students did not differ to a significant degree from the literary data issued lately. It can be demonstrated that HS is in correlation with several indices used by us. But the correlation can be considered close only rather in wide-chested students, held after the constitutional indices of pyknic but of more robust constitution anyway (WELHAM and BEHNKE 1942, PAŘIZKOVÁ et al. 1971). HS rather depends on the development of forearm muscles than on that of the upper-arm, still from it one can get some information on the state of general body strength.

REFERENCES

- ALLODIATORIS, I. (1952): Egyetemi hallgatók testsúlya, testmagasság, tüdőkapacitás és dynamometer méreteiről. — *Ann. Hist.-nat. Musei Nat. Hung.*, 2; 193—198.
- BALOGH, B. (1942): A debreceni egyetemi hallgatók antropológiai vizsgálata az 1938—1939 tanévben. — *A Debreceni T. I. Tud. Társ. II. Osztályának munkáiból*, 8; 1—78.
- BELCHENKO, L. A.—NEDBAEVA, N. D.—YACHNAYA, G. K. (1979): Some indicators of physical development of students of Novosibirsk State University. — *Gig. san.*, 7; 81—82.
- EIBEN, O. (1956): Városi és falusi ifjúság testfejlődésének összehasonlító vizsgálata. — *Biol. Közl.*, 3; 115—134.
- FARMOSI, I. (1972): Főiskolai hallgatók antropometriai és dinamometriai vizsgálata. — *Testn. tud.* 7; 85—97.
- FRENKL, R.—MÉSZÁROS, J. (1979): Testalkati és keringési vizsgálatok orvosegyetemi és testnevelési főiskolai tanulmányok idején. *Egészségtud.*, 23; 1—7.
- FUČIK, A. (1975): Findings assembled in investigations of low and very low physical performance of students of the Agricultural Faculty in Prague. — *Čs. Hyg.*, 20; 395—401.
- GAVRILOVIĆ, Ž. (1974): Some anthropometric characteristics of students from Novi Sad. — *Glasnik Antrop. Društva Jug.*, II; 9—25.
- JELLIFFE, D. B. (1966): *The assessment of the nutritional status of the community*. WHO, Geneva.
- JENEY, E. (1938—39): A debreceni egyetemi hallgatók egészségügyi vizsgálata az 1938—39. tanévben. Debrecen.

- (1939—40): idem 1939—40. tanévben. Debrecen.
 — (1940—41): idem 1940—41. tanévben. Debrecen.
 — (1941—42): idem 1941—42. tanévben. A Debreceni m. kir. T. I. Tud. egyet. 1941—42. Évkönyvéből.
 KÁDÁR, P.—VÉLI, GY. (1971): A 18—20 éves férfilakosság testi fejlettsége. *Anthrop. Közl.*, 15; 97—112.
 — — (1977): A szekuláris trend 100 éve Somogy megyében. — *Anthrop. Közl.*, 21; 93—100.
 KREISEL, G. (1977): Interrelationships between some somatic characteristics and hand strength of 14—18 years old boys and girls. — *In: EIBEN, O. G. (Ed.): Growth and Development; Physique. Symp. Biol. Hung.*, 20; 291—298.
 LIPKOVÁ, V.—GRUNT, J. (1979): The values of Rohrer's and Brugsch's index in a 0—18-year-old population of Slovakia. — *Čs. hyg.*, 24; 213—219.
 NÉMETH, J. (1969): I. és II. éves egyetemi hallgatók antropometriai vizsgálata 1967. — *Testn. Sporteü. Szle.*, 10; 131—135.
 PAŘÍZKOVÁ, J. (1977): *Body Fat and Physical Fitness*. Nijhoff, Hague.
 PAŘÍZKOVÁ, J.—VANECKOVÁ, M.—SPRINAROVÁ, S.—VAMBEROVÁ, M. (1971): Body composition and fitness in obese children before and after special treatment. — *Acta Paediat. Scand. suppl.*, 217; 80—85.
 RAJKAI, T. (1952): Debreceni egyetemi hallgatók antropológiai vizsgálata az 1951. évben. — *Ann. Biol. Univ. Hung.*, 2; 263—277.
 — (1957): A debreceni egyetemek női hallgatóinak antropometriai adatai. — *Acta Univ. Debr. de L. Kossuth nom.*, 4; 257—265.
 — (1969): Szorítóerővizsgálatok. — *Anthrop. Közl.*, 13; 39—57.
 RAJKAI, T.—JANCSÓ, J. (1955): A rendszeres testnevelés hatása az I. és II. éves egyetemi hallgatóknál az 1952/53. és az 1953/54. tanévben. — *Testn. tud.*, 1; 129—146.
 TILL, G.—GYENIS, GY. (1977): The physique of students of the Technical University Budapest. — *In: EIBEN, O. G. (Ed.): Growth and Development; Physique. Symp. Biol. Hung.*, 20; 63—72.
 WELHAM, W. C.—BEHNKE, A. R. (1942): The specific gravity of healthy men. — *J. Am. Med. Ass.*, 118; 498—501.

Authors' addresses: Dr. SZÖLLŐSI ERZSÉBET
 Institute of Hygiene and Epidemiology
 Debrecen University Medical School
 H-4012 Debrecen
 Hungary

Dr. JÓKAY MÁRTA
 Debrecen City Health Department
 H-4029 Debrecen, Dobozi u. 2.
 Hungary